EGAN, KATHLEEN L., Ph.D. Implementation and Use of Community-Based Prescription Drug Disposal Programs. (2017)
Directed by Dr. Michael Perko. 101 pp.

Encouraging disposal of unused prescription medications through the establishment of community-based prescription drug disposal programs is one prevention strategy that has been used by local communities to combat nonmedical prescription drug use (NMPDU) and associated consequences. The premise is that disposal programs (i.e., drop-boxes and take-back events) provide opportunities for community members to dispose of their unused or expired prescription drugs, ultimately reducing their availability for nonmedical use.

While drop-boxes have been growing in popularity since their introduction in the early 2010s, the extent of their implementation and associated community characteristics had not been assessed. The first objective of this dissertation was to address this gap in knowledge by examining the diffusion of drop-boxes and community characteristics associated with drop-box implementation. Between 2007 and 2016, 311 drop-boxes had been implemented in North Carolina (NC), and 91 out of 100 NC counties had at least one drop-box. The majority of drop-boxes were located at law enforcement agencies but the number of drop-boxes installed in pharmacies had increased in recent years. Counties with a higher percentage of whites and college educated residents, a substance abuse prevention coalition, higher rates of controlled medications (i.e., prescription drugs with abuse potential) dispensed, higher prescription opioid overdose rates, and counties considered to be Appalachian were more likely to be early implementers of drop-boxes.

Prescription drug disposal programs are primary prevention strategies intended to prevent initiation of NMPDU among adolescents by reducing the availability of prescription drugs in the home. While several studies have examined self-reported disposal of unused prescription drugs, none have specifically examined disposal of unused medications by parents of adolescents. The second objective of this dissertation was to examine prescription drug disposal by parents of adolescents. Among 2,300 parents residing in a household prescribed a controlled medication in the past year, only 33.9% disposed of unused medications. Of these, 9.8% used a take-back event, 10.0% a drop-box, 12.8% flushed the medication in a toilet, and 15.0% threw the medication in the trash within the past year (disposal practices were not mutually exclusive). Use of prescription drug disposal programs was associated with awareness of these programs, receiving a prescription for Attention Deficit Hyperactivity Disorder (ADHD), and permissiveness of underage drinking parties. Being a grandparent raising a grandchild, permissiveness of underage drinking parties, and being prescribed pain relievers or medications for ADHD were associated with awareness of prescription drug disposal programs.

Additional research is needed as disposal programs continue to be implemented, especially drop-boxes at pharmacies. It will be important to study the diffusion of drop-boxes at pharmacies, motivations for- and barriers to implementation, and utilization (e.g., quantity of controlled medications disposed) in order to assess the impact of location on the effectiveness of prescription drug disposal programs. Given that awareness of disposal programs is related to utilization, developing and implementing

effective awareness campaigns should be a priority of both research and practice. Despite being implemented in practice for at least 10 years (according to my findings) the research on prescription drug disposal programs is limited but increasing. It is imperative that researchers and practitioners work together to improve, implement, and evaluate this strategy within the context of a comprehensive approach to address NMPDU and associated consequences.

IMPLEMENTATION AND USE OF COMMUNITY-BASED PRESCRIPTION DRUG DISPOSAL PROGRAMS

by

Kathleen L. Egan

A Dissertation Submitted to
the Faculty of The Graduate School at
The University of North Carolina at Greensboro
in Partial Fulfillment
of the Requirements for the Degree
Doctor of Philosophy

Greensboro
2017

Approved by

Dr. Michael Perko

_____

Committee Chair

APPROVAL PAGE

This dissertation written by KATHLEEN L. EGAN has been approved by the following committee of the Faculty of The Graduate School at The University of North Carolina at Greensboro.

Committee Chair_____

Michael Perko

Committee Members_____

Vincent Francisco

_____

Robert Strack

_____

Mark Wolfson

_____

David Wyrick

May 8, 2017
_____
Date of Acceptance by Committee

May 8, 2017
_____
Date of Final Oral Examination

ACKNOWLEDGEMENTS

Hal Hidgon once said that “motivation remains key to the marathon: the motivation to begin; the motivation to continue; and the motivation to never quit.” As a recreational runner, I tend to compare life events to a marathon, especially my doctoral training. In pursuing my doctoral training, my motivation to begin, continue, and never quit was found largely in the people who supported me. I would like to thank all of the individuals who inspired and sustained my motivation:

Dr. Mark Wolfson, my committee member and boss, for taking the time to meet with me in the summer of 2009 when I was at a cross-road in my career, and, subsequently, facilitating my enrollment into the Clinical and Population Translational Science Master’s Program at Wake Forest School of Medicine. His continued support and guidance over the past eight years was instrumental in completing my doctoral training and becoming an independent investigator. Dr. Kimberly Wagoner for encouraging me to follow in her footsteps and pursue my doctoral training at UNC-G. Dr. Vincent Francisco for encouraging me to apply to the program, shepherding me through the first several years, and continuing to be engaged in my training after leaving UNC-G. Dr. Michael Perko for stepping in as my advisor half-way through my training and facilitating the completion of training. Meetings with Dr. Perko always instilled a sense of calmness, even in the most stressful times. Dr. Robert Strack for challenging me to think about the upstream and policy implications of my research. Dr. David Wyrick for providing me with innovative ideas relative to my research. Dr. Eric Gregory for

entrusting me to lead the evaluation of his disposal programs and providing me with data from his community for this dissertation.

Terence and Helen Egan for instilling the importance of an education at a very young age and providing the resources that made it easier for me to achieve a doctoral degree. I am incredibly privileged and blessed to have such supportive parents. My extended family and friends for their support and willingness to lend an ear and hand throughout my training. Dr. Jason Duncan for his never-ending support and patience as I devoted more time to my dissertation than to our home. I am grateful to have married someone who shares the same dedication to their field and the passion to improve the lives of others. While our formal education has ended (as promised in our vows) may we never end our fight to protect the health and well-being of others.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

DEFINITION OF TERMS

Authorized Collector - Manufacturers, distributors, reverse distributors, narcotic treatment programs, hospitals/clinics with an on-site pharmacy, and retail pharmacies that obtain authorization by the Drug Enforcement Administration (DEA) to collect controlled substances for the purpose of destruction (DEA, 2014b)

Availability - Ease and convenience of obtaining substances for misuse or abuse (Babor, Caetano, et al., 2010)

Controlled Medication – Medications that have acceptable medical use but also have abuse and dependency potential. These medications are categorized from Schedule V to II with II being the highest abuse potential while still providing medical benefit (DEA, n.d.-c). These medications require a prescription (DEA, n.d.-d).

Diffusion – Spread of an intervention through a specific population, social system, or community (Rogers, 2010).

Dispense – Transfer of a prescribed medication from an authorized distributed (i.e., pharmacist) to an end user (i.e., patient).

Disposal – Removal of unused or expired medications from the home in a manner that they should not be able to be easily retrieved. Examples include leaving medications with an authorized collector at a drop-box or take back event, flushing medications down the toilet, and throwing medications in the trash.

Home disposal – Disposal of prescription medications at home via throwing away in the trash or flushing in the toilet.

Implementation – Installation and execution of a program.

Nonmedical prescription drug use (also known as misuse) - Intentional or unintentional use of controlled medication without a prescription, in a way other than prescribed, or for the experience or feeling that it causes (SAMHSA, 2015)

Organized disposal - Disposal of prescription medications at prescription drug disposal programs (i.e., drop-boxes and take-back events).

Permanent drug donation box (also known as drop box) – DEA-authorized collection receptacles that assist consumers in safely disposing unused medications (DEA, 2014b)

Rate of adoption – "Relative speed with which an innovation is adopted by members of a social system. It is generally measured as the number of individuals who adopt a new idea in a specified period" (Rogers, 2010)

Take-back event – Events hosted by DEA-authorized collectors that assist consumers in safely disposing unused medications (DEA, 2014b)

CHAPTER I

INTRODUCTION

Statement of the Problem

Nonmedical prescription drug use (NMPDU), the use without a prescription or for the experience and feeling the drugs cause, is the second most common illicit drug use behavior in the United States (Center for Behavioral Health Statistics and Quality, 2015). In 2013, 7.64% of individuals 12 years of age and older reported past 12-month NMPDU (SAMHSA, 2014). Deaths from NMPDU have exceeded the number of deaths due to illicit drugs (NIDA, 2015) and motor vehicles (Jones, 2015). Other adverse consequences of NMPDU include emergency department visits (SAMHSA, 2013b; Warner, Hedegaard, & Chen, 2014), dependence and addiction (Compton et al., 2006), infectious diseases (Bruneau, Roy, Arruda, Zang, & Jutras-Aswad, 2012; Conrad et al., 2015; Zibbell et al., 2015), and community consequences, such as driving while drugged and theft (Berning, Compton, & Wochinger, 2015; Goodnough, 2010). The total economic burden of NMPDU and associated consequences is estimated to exceed $78.5 billion (Florence, Zhou, Luo, & Xu, 2016).

There is a clear need to identify and implement evidence-based strategies to address NMPDU and associated consequences (Levl, Segal, & Miller, 2013; ONDCP, 2011; Ulan, Davison, & Perron, 2013), and there have been several calls to action to do

so. One of the first calls to action, entitled *"Epidemic: Responding to America's Prescription Drug Abuse Crisis,"* was made in 2011 by the Office of National Drug Control Policy (ONDCP, 2011). The American Public Health Association made a policy statement in 2015 entitled *"Prevention and Intervention Strategies to Decrease Misuse of Prescription Pain Medication"* (APHA, 2015). In the spring of 2016, the Centers for Disease Control and Prevention (CDC) introduced guidelines for prescribing opioid medication (Dowell, Haegerich, & Chou, 2016). Following the release of the CDC guidelines, the Surgeon General made a call to action directed to clinicians regarding safe prescribing, screening for opioid use disorder, and connecting those in need with evidence based treatment (http://turnthetiderx.org). These organizations called for a comprehensive public health approach to address NMPDU and associated consequences. The comprehensive approach includes the following strategies to address NMPDU: encouraging appropriate prescribing and use of prescription drug monitoring programs (CDC, 2015; Chou et al., 2009; Gilson, 2012; Gudin, 2012), preventing diversion (i.e., abuse or sale of NMPD) (Farrell et al., 2012; Kolodny, Kreiner et al., 2015; Lasopa et al., 2015), and encouraging disposal of unused medications (DEA, 2014). While some research has been conducted to assess the effectiveness of these strategies, research is still in its infancy. The effectiveness of currently implemented prevention strategies needs to be assessed to ensure the use of the most promising strategies to prevent and reduce NMPDU.

Encouraging disposal of unused prescription drugs through the establishment of prescription drug drop-boxes (herein referred to as "drop-boxes") and take-back events is

one prevention strategy that has been used by local communities (DEA, 2014). Drop-boxes are DEA-authorized collection receptacles (DEA, 2014b) and take-back events have been hosted by DEA-authorized collectors, including law enforcement agencies (DEA, 2014b). Both assist consumers in safely disposing unused medications. The Secure and Responsible Drug Disposal Act of 2010 provided national guidelines for prescription drug disposal programs, which included only allowing for law enforcement agencies to collect unused medication (DEA, 2014). The rationale for prescription drug disposal programs is grounded in the availability hypothesis which suggests that the harder it is to obtain a substance, the less likely it is to be abused (Babor, Caetano, et al., 2010).

Law enforcement agencies began to install drop-boxes around 2010 (DEA, 2014). In October 2014, the Secure and Responsible Drug Disposal Act of 2010 was revised to allow for the installation of drop-boxes at locations other than law enforcement offices, such as pharmacies and medical practices (DEA, 2014b, n.d.-b). Despite their popularity among the prevention community (Firozi, 2014), no study has examined the diffusion of drop-boxes. Based on the Diffusion of Innovations Theory, a number of factors - including community size, socioeconomic status, educational attainment, proximity to other implementers, presence of a local substance abuse prevention coalition, controlled substance prescribing rates, and overdose rates - will differ among communities based on the timing of drop-box implementation (e.g., early adopters compared to late adopters) (Rogers, 2010). I sought to identify this gap in knowledge by conducting a study to

examine the diffusion of drop-boxes and community-level factors that may have facilitated their implementation.

Drop-boxes and take-back events are considered primary prevention strategies. Thus, they are most likely to impact members of the population who have not initiated NMPDU (Adam, 1981; Bloom, 1980; Cowen, 1982; Erickson et al., 2002; Gullotta, 1994). Peak risk of NMPDU initiation is 16 years of age with the majority of NMPD users initiating use by age 12 (Austic, McCabe, Stoddard, Ngo, & Boyd, 2015). This suggests that drop-boxes and take-back events may be most effective at preventing the initiation of NMPDU among adolescents 16 years of age and younger.

The majority of adolescents who report NMPDU obtained them from friends or family for free (Center for Behavioral Health Statistics and Quality, 2015) which suggests that personal medicine cabinets may be the primary source of NMPDs, knowingly or unknowingly to the prescription-holder (Ross-Durow, McCabe, & Boyd, 2013; Stewart et al., 2014). In fact, studies have shown that adolescents have easy and unsupervised access to prescription drugs with abuse potential at home (Friese, Moore, Grube, & Jennings, 2013; S. E. McCabe, West, & Boyd, 2013; Ross-Durow et al., 2013). It is the responsibility of parents of adolescents to monitor, securely store, and dispose of unused controlled medications (National Association of Boards of Pharmacy, n.d.; PROTECT, n.d.; Yanovitzky, 2016).

Several studies have examined disposal practices among non-parent samples. These found that, if medications were disposed, they were most commonly disposed in the trash or by flushing them down the toilet (Kuspis & Krenzelok, 1996; Lewis,

Cucciare, & Trafton, 2014; Ma, Batz, Juarez, & Ladao, 2014; Seehusen & Edwards, 2006). Additionally, many individuals reported keeping unused medications in their home for long periods of time, even after they had ceased taking the medication or the medication had expired (Bates, Laciak, Southwick, & Bishoff, 2011; CDC, 2010; Harris et al., 2013; Ma et al., 2014). One reason that individuals may retain medications after ceasing use is "just in case" they need them in the future (Kennedy-Hendricks et al., 2016; Lewis et al., 2014). This may be especially true among those who have limited or no access to medical care or insurance (Song et al., 2012).

To my knowledge, no studies have examined the likelihood or mechanism by which parents of adolescents dispose of unused prescription drugs or factors that influence disposal behavior. I sought to address this gap in knowledge by conducting a study to assess parental disposal of unused or expired medications.

Purpose of the Study and Specific Aims

The purpose of this dissertation was to examine the implementation and use of community-based prescription drug disposal programs. The specific aims were to (1) determine the diffusion of drop-boxes in North Carolina and community characteristics associated with implementation, and (2) assess the disposal of unused prescription drugs among parents of adolescents.

Significance

This was the first study to systematically examine diffusion, and covariates associated with diffusion, of drop-boxes. The findings provide insight on the spread of drop-boxes across North Carolina and community characteristics associated with drop-

box implementation. Additionally, it elucidated that drop-boxes were first installed in communities where NMPD were readily available as demonstrated by a large number of controlled medications dispensed and high prescription opioid overdose rates. The second study within this dissertation was the first to examine how parents of adolescents dispose of unused prescription medications. It provided information about potential mechanisms to increase the utilization of drop-boxes, especially among parents. Both studies inform future research and practice on a relatively novel substance abuse prevention strategy to address NMPDU.

CHAPTER II

LITERATURE REVIEW

Prevalence of Nonmedical Prescription Drug Use

Nonmedical prescription drug use (NMPDU), the use without a prescription or for the experience and feeling the drugs cause, is the second most common illicit drug use behavior in the United States (Center for Behavioral Health Statistics and Quality, 2015). In 2013, 7.64% of individuals 12 years of age and older reported NMPDU in the past 12-months (SAMHSA, 2014). Rates of NMPDU are highest among 19- to 25-year-olds (11.8% reporting past 12-month NMPDU) followed by 26- to 34-year-olds (9.4%), and 15- to 18-year-olds (8.8%) (SAMHSA, 2014). NMPDs are classified into four different categories – opioids (e.g., Vicodin, Percocet, OxyContin, Opana), tranquilizers (e.g., Ativan, Xanax, Valium, Klonopin), stimulants (e.g., Ritalin, Dexedrine, Adderall, Concerta, methylphenidate), and sedatives (e.g., Ambien, Halcion, Restoril). Opioids are the most common classification of prescription medications abused, followed by tranquilizers, stimulants, and sedatives (Center for Behavioral Health Statistics and Quality, 2015; SAMHSA, 2014).

Consequences of Nonmedical Prescription Drug Use

NMPDU has resulted in a myriad of adverse consequences, including fatal overdose (NIDA, 2015), emergency department visits (SAMHSA, 2013b; Warner et al.,

2014), dependence and addiction (Compton et al., 2006), infectious diseases (Bruneau et al., 2012; Conrad et al., 2015; Zibbell et al., 2015), and community consequences (Berning et al., 2015; Goodnough, 2010). Deaths from prescription drugs exceed the number of deaths due to illicit drugs (NIDA, 2015) and motor vehicles (Jones, 2015). In 2014, there were 25,760 deaths due to prescription drugs compared to 17,465 deaths due to illicit drugs (NIDA, 2015) and 22,276 deaths of due riding in a motor vehicle (NHTSA, 2016). This reflects a 2.8-fold increase in the number of deaths due to prescription medications from 2001 to 2014 (NIDA, 2015). The majority of these deaths involved prescription opioids (18,893), followed by benzodiazepines (also known as tranquilizers) (7,945) (NIDA, 2015).

Prescription drugs have been involved in over half of emergency department (ED) visits related to drug abuse (not including adverse reactions or accidental ingestion) (Warner et al., 2014). The number of ED visits involving prescription drugs doubled from 2004 (626,470) to 2011 (1,428,145). Unlike prescription medication-related deaths, benzodiazepines accounted for the majority of pharmaceutical ED visits (501,207), followed by prescription opioids (420,040) (SAMHSA, 2013b).

Routes of administration of prescription medications for nonmedical use include oral, intranasal, injection, and transdermal. While the majority of nonmedical users report oral misuse, non-oral routes of administration (e.g., snorting and injecting) have been increasing (Kirsh, Peppin, & Coleman, 2012). Injection of prescription medications, primarily opioids, has resulted in an increase in cases of infectious diseases, such as HIV and hepatitis C, due to sharing of drug paraphernalia and needles (Bruneau et al., 2012;

Conrad et al., 2015; Koester, Glanz, & Barón, 2005; Zibbell et al., 2015). An example of HIV transmission due to prescription opioid abuse took place in a small town in Indiana in early 2015. From November 18, 2014, to November 1, 2015 a total of 181 individuals within a community of 4,200 residents tested positive for HIV and 92.3% were co-infected with hepatitis C virus (Peters et al., 2016). The majority of these individuals reported injecting Opana, a prescription opioid oxymorphone (Peters et al., 2016). Individuals who inject prescription medications are at higher risk of dependence and addiction due to the speed at which the drug enters the bloodstream (Compton & Volkow, 2006). Regardless of route of administration, individuals who abuse prescription drugs are susceptible to dependence and addiction (Compton et al., 2006), and 1.9 million people met the criteria of prescription opioid use disorder in 2014 (Center for Behavioral Health Statistics and Quality, 2015).

Communities also experience consequences due to NMPDU. According to the 2013-2014 National Roadside Survey of Alcohol and Drug Use by Drivers, among drivers who tested positive for a substance on a weekend night, the majority were under the influence of prescription medications (6.5%). In comparison, only 1.8% were over the legal limit (blood alcohol content of 0.08 or more) for alcohol (Berning et al., 2015). Additionally, home invasions, thefts, assaults, and homicides have been reported as a result of people attempting to obtain prescription drugs for diversion or personal abuse (Goodnough, 2010).

Nonmedical Prescription Drug Use among Adolescents

Adolescents (ages 12 to 17) have the second highest rate of current and past 12-month NMPDU, following young adults ages 18 to 25 year olds (Center for Behavioral Health Statistics and Quality, 2015). Similar to adults, adverse consequences include emergency department visits and substance use disorders (Center for Behavioral Health Statistics and Quality, 2015). In 2011, 26.6% of ED visits by 12-17 year olds involved nonmedical use of prescription drugs (DAWN, 2011). This equates to 164 adolescents going to the ED each day as a result of NMPDU (SAMHSA, 2013a). There were 168,000 12-17 year olds with prescription opioid use disorder in 2014; the second highest group following 18-25 year olds (Center for Behavioral Health Statistics and Quality, 2015). NMPDU can impact adolescents into adulthood; for example, adolescents who used sedatives and anxiolytics non-medically were more likely than non-users to develop substance use disorder in adulthood (S. E. McCabe, Veliz, Boyd, & Schulenberg, 2016).

Peak risk of initiation of NMPDU is 16 years of age with the majority of NMPD users initiating by age 12 (Austic et al., 2015). In 2010, on an average day, over 2,700 adolescents used prescription drugs non-medically for the first time (SAMHSA, 2013a). Early initiation of substances of abuse has been shown to be associated with higher risk substance use behaviors (DeWit, Adlaf, Offord, & Ogborne, 2000; Hawkins et al., 1997) and more general maladaptive behaviors (Slade et al., 2008; Zhang, Wieczorek, & Welte, 1997).

The majority of adolescents who report NMPDU obtained them from friends or family for free (Center for Behavioral Health Statistics and Quality, 2015; S. E. McCabe

& Boyd, 2005) and about 20% have shared prescription medications with others (Goldsworthy, Schwartz, & Mayhorn, 2008). Studies have shown that adolescents have easy and unsupervised access to prescription medications with abuse potential at home (Friese et al., 2013; S. E. McCabe et al., 2013; Ross-Durow et al., 2013). These findings suggest that personal medicine cabinets may be a primary source of NMPDs, knowingly or unknowingly to the prescription-holder (Ross-Durow et al., 2013; Stewart et al., 2014).

Response to the Nonmedical Prescription Drug Problem

Given the high rates of NMPDU and associated consequences, multiple agencies and organizations have called for a comprehensive public health approach to address this problem. These organizations include the Office of National Drug Control Policy (ONDCP), Centers for Disease Control and Prevention (CDC), National Institute on Drug Abuse (NIDA), the American Public Health Association (APHA), American Medical Association (AMA), and Community Anti-Drug Coalitions of America (CADCA). A comprehensive approach includes ensuring appropriate prescribing practices; improving- and increasing use of prescription drug monitoring programs (AMA Wire, 2015; APHA, 2015; CADCA, 2015b; ONDCP, 2011); increasing the awareness of harms associated with NMPDU (APHA, 2015; CADCA, n.d.; ONDCP, 2011); proper storage and disposal of prescription medications (APHA, 2015; CADCA, n.d.; ONDCP, 2011); increasing access to naloxone and other overdose prevention measures; increasing access to treatment (AMA Wire, 2015; APHA, 2015; CADCA, 2015b); and shutting down “pill mills” and “doctor shoppers” that contribute to drug trafficking (ONDCP, 2011).

These calls to action include primary prevention, harm reduction, and treatment strategies. While strategies in all three categories are important, this dissertation focused solely on a single primary prevention strategy – prescription drug disposal programs. Primary prevention has been defined as "planned efforts to reduce (prevent) the incidence of new cases of dysfunctional behavior and to encourage (promote) behaviors that are known to contribute to functional behaviors" (Gullotta, 1994). Thus, they are most likely to impact members of the population who have not initiated NMPDU, such as adolescents (Adam, 1981; Bloom, 1980; Cowen, 1982; Erickson et al., 2002; Gullotta, 1994).

Most of the primary prevention strategies emphasize the need to address the availability of prescription drugs for nonmedical use. Availability refers to the ease and convenience of obtaining substances for use or abuse (Babor, Caetano, et al., 2010). Strategies that address availability of substances are based on the hypothesis that limiting availability results in decreases of abuse and ultimately decreases of associated substance-related problems (Babor, Caetano, et al., 2010). Availability is not limited to the supply of substances (physical availability) but also the cost (economic availability), attractiveness (psychological availability), and social acceptance by reference groups, such as peers, (social availability) (Babor, Caulkins, et al., 2010). Regarding NMPDU, the following strategies are all grounded in the reductions of physical availability: appropriate prescribing practices, proper storage and disposal, and shutting down "pill mills" and "doctor shoppers" that contribute to drug trafficking. In comparison,

increasing the awareness about the harms associated with prescription drug abuse is related to social and psychological availability.

Prescription Drug Disposal

Encouraging disposal of unused or expired prescription drugs is one NMPDU primary prevention strategy that has been implemented across the United States (DEA, 2014b; ONDCP, 2011). The Secure and Responsible Drug Disposal Act of 2010 provides national guidelines for permanent drug donation boxes (herein referred to as "drop-boxes") and take-back events, the two most common organized and secure disposal strategies (DEA, 2014b). Drop-boxes are available year-round under 24-7 surveillance by an Drug Enforcement Administration (DEA)-authorized collector (i.e., manufacturers, distributors, reverse distributors, narcotic treatment programs, hospitals/clinics with an on-site pharmacy, and retail pharmacies that obtain authorization by the DEA) (DEA, 2014b, n.d.-b). Take-back events typically occur biannually for 1-2 days at a time, and can be held at various locations.

Take-Back Events

In September 2010, the first national DEA-sponsored take-back day was held in local communities across the nation. Over 4,000 communities in all 50 states participated in the first take-back event, which resulted in the return of over 242,000 pounds of over-the-counter (non-controlled) and controlled medications (DEA, 2010). The DEA continued to sponsor these events through fall of 2016 for a total of eleven DEA-sponsored take-back events over six years. Over six million pounds of over-the-counter and controlled medication were collected from all the events (DEA, 2015b, 2016).

Several peer-reviewed studies have examined the quantity and type of medications collected at take-back events (Egan, Gregory, Sparks, & Wolfson, 2016; Gray & Hagemeier, 2012; Ma et al., 2014; Stewart et al., 2014). Table 2.1 provides an overview of the key design components and findings of these studies. A range of 11,406 (Gray & Hagemeier, 2012) to 50,549 (Stewart et al., 2014) controlled medication units (1 unit = 1 pill, 1 milliliter, or 1 patch) were collected across the studies. For all four studies, prescription opioids was the most common controlled medication collected (Egan et al., 2016; Gray & Hagemeier, 2012; Ma et al., 2014; Stewart et al., 2014). However, controlled medications consisted of less than 10% of the total collections (Egan et al., 2016; Gray & Hagemeier, 2012; Ma et al., 2014; Stewart et al., 2014), indicating that the majority of the collections consisted of non-controlled medications (i.e., medications with no abuse potential).

Table 2.1 Overview of Studies on Take-Back Events

	Gray & Hagemeier, 2012	**Ma et al., 2014**	**Stewart et al., 2014**	**Egan et al., 2016**
State	TN	HI	ME	KY
# of Events	6	11	6	3
# of Communities	Information not provided	2 3-day events at 1 location; 9 1-day events at 4 islands at multiple clinics	11 cities	1 county participated in all 3 events and 1 county participated in only 2 events; events lasted 1 day
# of Controlled Substance Units Collected	11,406	Information not provided	50,549	18,069
% of Controlled Substances Representing the Total Collections	9.3% (based on pill bottles)	10% (based on units)	9.1% (based on units)	3.1% (based on weight)
Most Common Controlled Substance Collected	Opioid	Opioid	Opioid	Opioid

Drop-Boxes

To my knowledge, there are three published studies that have examined drop-boxes (Egan et al., 2016; Gray, Hagemeier, Brooks, & Alamian, 2015; Maughan et al., 2016). Maughan et al. (2016) assessed self-reported disposal behavior and behavioral intent following an intervention to encourage disposal and found that 52% in the intervention condition disposed or intended to dispose of their unused opioids compared to 30% in the control condition. The other two studies examined the quantity of controlled medications disposed at drop-boxes (Table 2.2). Gray et al (2015) collected 106,464 controlled substance units over two years in eight communities in north eastern Tennessee and Egan et al., (2016) collected 3,435 over four one-week assessments within five counties in south central Kentucky. In order to compare the two, I estimated the number of controlled mediation units over one year in a single location. In both studies, prescription opioids were the most common controlled medication disposed.

Table 2.2 Overview of Studies on Drop-Boxes

	Gray et al, 2015	**Egan et al., 2016**
Location	NE Tennessee	South Central Kentucky
# of Communities	8	5
Timeframe	2 years	4 – 1 week assessments
# of Controlled Substance Units Collected	106,464	3,435
# of Controlled Substance Units Collected Annually per community, Estimate	6,654	8,931
% of Controlled Substances Representing the Total Collections	4.9% (based on weight)	1% (based on weight)
Most Common Controlled Substance	Opioid	Opioid

Impact of Awareness on Disposal

There are several studies on the impact of marketing and educational programs related to disposal strategies. All found an increase in self-reported disposal following exposure to the campaign or educational program (de la Cruz et al., 2016; Maughan et al., 2016; Seehusen & Edwards, 2006; Yanovitzky, 2016). Additionally, campaign and program exposure was related to an increase in the number of conversations about prescription drug disposal, increase in the number of conversations with kids about the dangers of prescription drug abuse (Yanovitzky, 2016), increased awareness of proper disposal methods, decreased sharing of medications, increased awareness of the dangers of sharing medications, and safe storage of medications (e.g., hidden or locked) (de la Cruz et al., 2016).

Other Disposal Practices

Individuals may dispose of prescription drugs using mechanisms other than take-back events and drop-boxes. Studies on disposal practices found that, if prescription drugs were disposed, they were most commonly disposed in the trash or by flushing them down the toilet (Bates et al., 2011; Kuspis & Krenzelok, 1996; Lewis et al., 2014; Ma et al., 2014; Seehusen & Edwards, 2006). A broad range of individuals (7.2-91.0%) reported storing prescription drugs in their homes, even after they had ceased taking the medication or the medication had expired, with some reporting that they kept unused prescriptions in their home for more than a year (Bates et al., 2011; Harris et al., 2013; Kennedy-Hendricks et al., 2016; Kuspis & Krenzelok, 1996; Lewis et al., 2014; Ma et al., 2014; Seehusen & Edwards, 2006). The broad variation was likely due to differences in

study samples (size and population) as well as the questions that were asked pertaining to disposal practices. Specific to disposal of prescription opioids, 67-86% of individuals (e.g., adult surgical patients and Veterans) reported having an excess of prescription opioids and 53-93% reported retaining them even if they ceased use (Bates et al., 2011; Harris et al., 2013; Lewis et al., 2014).

One reason that individuals report retaining unused prescription drugs after ceasing use is "just in case" they need them in the future (Kennedy-Hendricks et al., 2016; Lewis et al., 2014). This may be especially true among those who have limited or no access to medical care or insurance. Individuals with limited or no health insurance have reported behaviors to extend their prescription medications, such as using less than prescribed (Goins, Williams, Carter, Spencer, & Solovieva, 2005; Kenne et al., 2016). Thus, it is important to understand possible reasons for retaining unused medications in order to facilitate disposal of unused medications.

The current literature begins to elucidate the potential effectiveness of disposal programs. Specifically, we have an estimate on the number of controlled medications returned via disposal programs and how this number compares to the number of controlled medications dispensed. Additionally, the literature suggests that awareness of disposal programs may increase their use but there is still large variation in the number of people that dispose of their unused medication and the mechanism by which they dispose. There are still many gaps in the prescription drug disposal program literature, including the diffusion of disposal programs, availability and accessibility of disposal programs, awareness and use of disposal programs by at-risk population (e.g., parents of

adolescents), the impact of disposal programs on norms and attitudes surrounding disposal of unused or expired programs, and their impact on NMPDU.

Theoretical Perspectives

The premise of secure disposal practices can be grounded in the Socio Ecological Model (Bronfenbrenner, 1977) and the Availability Hypothesis. Study 1, which focuses on the diffusion of drop-boxes in North Carolina, is grounded in Diffusion of Innovation Theory (Rogers, 2010). Study 2, which examines prescription drug disposal among parents of adolescents, is grounded in Theory of Planned Behavior (Ajzen, 1991).

Socio Ecological Model

The adaptation of Bronfenbrenner's Social-Ecological Model for health promotion states that interventions that impact intrapersonal, interpersonal, institution, community, and policy factors are necessary for behavior change (McLeroy, Bibeau, Steckler, & Glanz, 1988). Encouraging disposal of unused and expired prescription drugs at drop-boxes and take-back events should be considered both a community and intrapersonal intervention. While these strategies are implemented by community organizations at the community-level, individuals must ultimately make the decision to utilize them.

The Availability Hypothesis

Availability refers to the ease and convenience of obtaining substances for use or abuse (Babor, Caetano, et al., 2010). Limiting the availability of substances, such as NMPDs, is not a novel approach to drug abuse prevention (Babor, Caetano, et al., 2010; Babor, Caulkins, et al., 2010). Strategies that address availability of substances are based

on the hypothesis that limiting availability results in decreases of abuse and ultimately decreases of associated substance-related problems (Babor, Caulkins, et al., 2010; Maddahian, Newcomb, & Bentler, 1986; Paschall, Grube, & Kypri, 2009; Popova, Giesbrecht, Bekmuradov, & Patra, 2009). Several domains of availability have been identified - legal, physical, economic, social, and psychological (Babor, Caulkins, et al., 2010; Ziel, 2015). Legal and physical availability refer to the supply of substances and economic availability refers to the cost (Babor, Caulkins, et al., 2010; Ziel, 2015). Social availability refers to social acceptance by reference groups, such as peers, which may or may not influence psychological availability (attractiveness of the substance) (Babor, Caulkins, et al., 2010; Ziel, 2015). The rationale behind drop-boxes and take-back events is that they provide opportunities for individuals to dispose of unused prescription drugs which reduces their physical availability and ultimately minimizes the likelihood of abuse or diversion.

Diffusion of Innovation

Diffusion theories have been used by multiple fields, including substance abuse prevention (Rogers, 2010), to examine transfer of knowledge, experiences with the application of technologies and practices, and the spread of technologies and practices through populations (Green, Ottoson, García, & Hiatt, 2009). One such theory is Roger's Diffusion of Innovation Theory (Rogers, 2010). According to Rogers's theory, diffusion is the process by which an innovation (e.g., a new idea, practice, or object) is communicated through certain channels over time among members of a social system.

Characteristics of innovations that determine rate of adoption include relative advantage, compatibility, complexity, trialability, and observability. *Relative advantage* refers to the perceived advantage of the innovation by potential adopters. *Compatibility* refers to the degree that the innovation is perceived to be consistent with the values and needs of potential adopters. *Complexity* is the perceived difficulty to use or implement the innovation. *Trialability* is the degree to which the innovation could be experimented with prior to adoption. *Observability* refers to the visibility of the results by others. Innovations that are perceived by potential adopters to have greater relative advantage, compatibility, trialability, observability, and less complexity are more likely to adopted more rapidly than others (Rogers, 2010).

Regarding prescription drug disposal programs, communities with NMPDU problems may perceive high *relative advantage* of adopting drop-boxes or take-back events, especially if they are perceived to be effective. The perceived difficulty to implement drop-boxes and take-back events (*complexity*) is likely based on support within and outside the implementing organization. When secure disposal strategies were first implemented, only law enforcement agencies could implement them but many conducted events and obtained drop-boxes with the help of substance abuse prevention coalition (Fischer & Murphy, 2016). Take-back events are likely to have more *trialability* than drop-boxes since they do not require long-term structural changes for implementation. The results of take-back events have been made very visible (*observability*) by the DEA and organizations that have implemented events. These

results have primarily been positive and included the quantity (most often based on weight) of collection (DEA, 2014a, 2014c, 2015a, 2015b, 2016).

Characteristics of potential adopters also influence the likelihood of adoption. According to Rogers (2010), adopters of innovations can be grouped into one of five categories: innovators, early adopters, early majority, late majority, and laggards (Figure 2.1; Rogers, 2010). Innovators and early adopters are more likely than late adopters and laggards to have more formal education, higher social status, larger units, greater exposure to mass media channels of communication, greater change agent contact, greater knowledge of innovations, and greater social participation (Rogers, 2010).

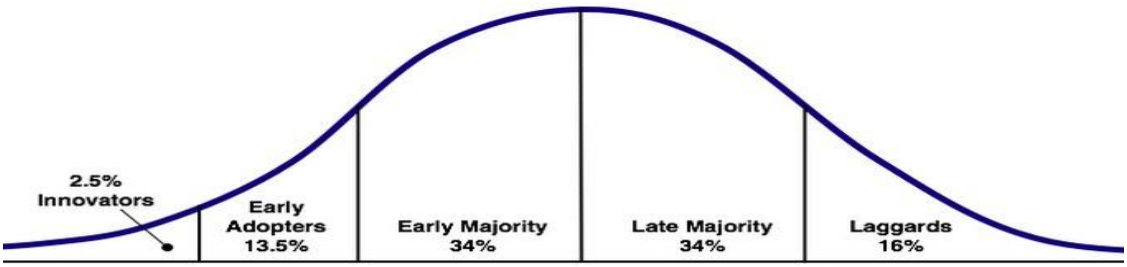

Figure 2.1 Adopter Categories Based on Rogers's Diffusion of Innovations (2010)

Theory of Planned Behavior

The Theory of Planned Behavior (TPB) (Ajzen, 1991) suggests that behavior is guided by three beliefs: (1) consequences or other attributes of the behavior (attitude), (2) normative expectations of others (normative beliefs), and (3) factors that may facilitate or hinder behavior. These three beliefs lead to the formation of a behavioral intention and ultimately the behavior of interest. The TPB is a commonly used theory in the development of behavioral change media campaigns (Hornik & Yanovitzky, 2003).

Additionally, it has been applied for predicting recycling (Knussen, Yule, MacKenzie, & Wells, 2004), a similar behavior to disposal of prescription drugs. In applying the TPB to disposal of unused or expired prescription drugs (see Figure 2.2), favorable attitudes towards disposing prescription drugs, the expectation that disposing prescription drugs will prevent NMPDU and opportunities for disposal should lead to the intention to dispose of prescription drugs followed by the actual disposal of prescription drugs.

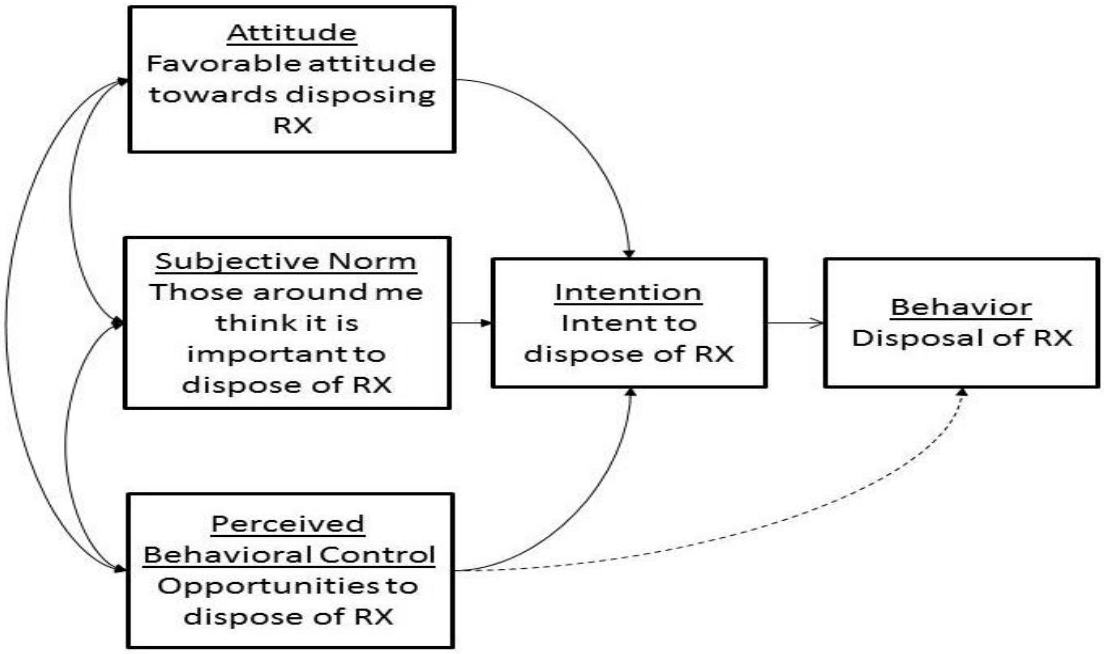

Figure 2.2 Application of Theory Planned Behavior to Disposal of Prescription Drugs

Summary

Prescription drug disposal programs (i.e., drop-boxes and take-back events) have been implemented throughout communities in the US with the intent of reducing the availability of prescription drugs for nonmedical use. There are a limited number of

studies that have been conducted on drop-boxes and take-back events. The majority of these studies have examined the potential impact of disposal programs on prescription drug availability by examining the number and type of controlled medications disposed via take-back events and drop-boxes (Egan et al., 2016; Gray et al., 2015; Gray & Hagemeier, 2012; Ma et al., 2014; Stewart et al., 2014). These studies found that a small percent of the collections consisted of controlled medications (Egan et al., 2016; Gray et al., 2015; Gray & Hagemeier, 2012; Ma et al., 2014; Stewart et al., 2014) and a miniscule amount of the controlled medications dispensed over a year (Egan et al., 2016). Assessments of a media campaign (Yanovitzky, 2016) and disposal education delivered at medical facilities (Maughan et al., 2016) showed promise of increasing the likelihood that individuals will dispose of unused medications. However, none of these studies focused primarily on parents of adolescents. Given that disposal programs are primary prevention strategies, they have the most promise among populations who have yet to initiate NMPDU such as adolescents. Additional research on organized disposal strategies is needed to assess their reach and effectiveness in reducing the availability of prescription drugs for misuse, changing community norms involving disposal, and reducing NMPDU.

CHAPTER III

METHODOLOGY

The overall objective of this dissertation was to expand the current research on community-based prescription drug disposal programs by examining the implementation of drop-boxes and utilization of these programs by parents of adolescents. In order to achieve this objective, two studies were conducted with the respective aims: (1) determine the diffusion of drop-boxes in North Carolina and community characteristics associated with implementation; and (2) examine disposal of unused prescription drugs by parents of adolescents.

The first study included all 100 counties in North Carolina and the second study was conducted within one county located in south central Kentucky. North Carolina and Kentucky were selected as settings for both practical and scientific reasons. For practical reasons, both states were selected due to existing partnerships which made data collection feasible. The first study, which assessed the diffusion of drop-boxes and characteristics associated with diffusion, utilized data (e.g., drop-boxes and community substance abuse prevention coalitions) from existing partnerships within North Carolina. The second study, which assessed parental disposal behaviors, utilized data that was collected by a community partner as part of a contract on which I served as the Principal Investigator. With respect to scientific reasons, both North Carolina and Kentucky have high rates of opioid prescriptions (Figure 3.1) and opioid-related overdose deaths. In 2012, Kentucky

ranked 4th with an opioid prescribing rate of 128.4 per 100 persons and North Carolina ranked 13th with an opioid prescribing rate of 96.6 per 100 persons (Paulozzi, Mack, & Hockenberry, 2014). In 2015, Kentucky had the 7th highest age-adjusted prescription opioid overdose rate with a rate of 15.3 per 100,000 and North Carolina had the 19th highest rate with a rate of 8.7 per 100,000 (Kaiser Family Foundation, 2017).

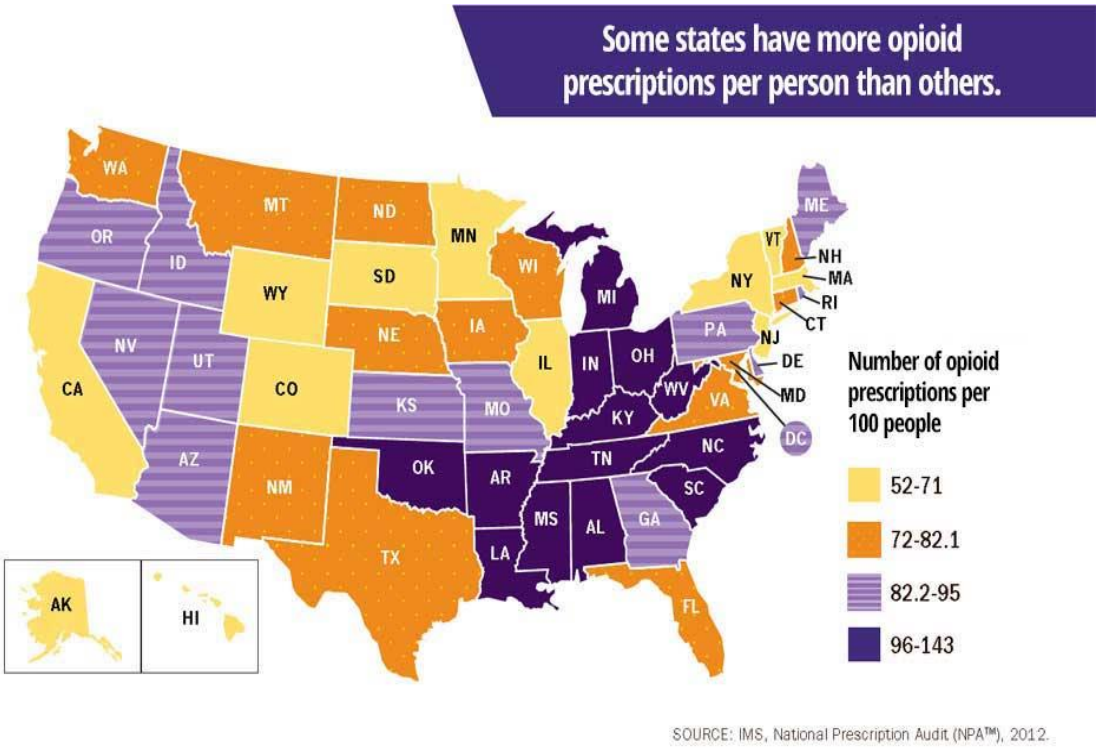

Figure 3.1. State-to-State Variability of Opioid Prescribing Rates in 2012

Study 1

Aim and Hypotheses

The aim of study 1 was to examine the diffusion of drop-boxes and associated community characteristics in North Carolina. I hypothesized that a substantial number

of, but not all, counties would have installed drop-boxes and some counties would have more than one drop-box. Additionally, the majority of drop-boxes would be housed in law enforcement agencies but a growing number would be housed in other locations such as pharmacies. I hypothesized that county characteristics would vary based on the timing by which the county implemented a drop-box. Specifically, I hypothesized that (1) high overdose and controlled medication prescribing rates would be positively associated with earlier drop-box adoption since these counties have higher prevention needs based on Rogers's concept of 'relative advantage' (2010); (2) the presence of a local substance abuse prevention coalition would be associated with earlier drop-box adoption since these agencies have been involved in the facilitation of drop-box implementation based on Rogers's concept of 'change agent' (2010); and (3) earlier drop-box adoption would be associated with larger population size, higher socioeconomic status, higher level of education, and proximity to other early adopters (i.e., adjacency to county with a drop-box) based on Rogers's theory pertaining to characteristics of early adopters (2010).

Research Design

Several of the focal independent variables were only available at the county-level (i.e, rate of prescription opioid overdoses and number of controlled medications dispensed) so county was the unit of analysis. I created a database with all 100 counties in North Carolina. The database included the following variables: county; presence of a drop-box; year of implementation of the drop-box; address of the drop-box; rate of prescription opioid overdoses; number of controlled medications dispensed; presence of

a substance abuse prevention coalition; Appalachian county; county census data (population, race, ethnicity, median income, educational attainment of residents); and adjacency to a county with a drop-box.

Measures

Drop-Boxes. A multi-step approach was utilized to determine the presence and year of implementation of drop-boxes in counties in North Carolina. First, a list of potential drop-box locations was compiled using the DEA's Controlled Substance Public Disposal Location (DEA, n.d.-a) and the North Carolina Operation Medicine Drop (Safe KidsNC, n.d.) search utilities. The DEA's list only included DEA-authorized collectors (i.e., pharmacies and other health care facilities) so law enforcement agencies, which do not require DEA authorization, were not included on the list. The North Carolina Operation Medicine Drop website was based on organizations (e.g., police departments, sheriff's offices, pharmacies, etc.) submitting their information to be included on the website, and thus may not include all drop-box locations in the state. In order to identify law enforcement agencies that may not have been included on the NC Operation Medicine Drop website, a list of all Sheriff's offices in North Carolina was obtained from the North Carolina Sheriff's Association (http://ncsheriffs.org/sheriffs) and a list of all police departments in North Carolina was obtained from USACops (http://www.usacops.com/nc/; the final list excluded colleges, schools, business/malls, military bases, & airport public safety). Following the compilation of a list of all possible drop-box locations in North Carolina (i.e., law enforcement agencies and DEA-authorized collectors), a web-search was conducted to determine drop-box

implementation and date of implementation for all the locations on list. Search terms included the location name and “drop box” or “dispose” or “disposal.” If a drop-box and/or the date of implementation could not be identified in the web-search, the location (e.g., law enforcement agency or pharmacy) was called to determine if they had a drop-box and the year that it was implemented.

Opioid Overdoses Deaths. The number of prescription opioid deaths by year and county from 2010 to 2015 was obtained from the North Carolina State Center for Health Statistics. The rate per 100,000 residents by year and county was calculated based on population size of each county using American Community Survey 5-year estimates (United States Census Bureau / American FactFinder, 2015).

Controlled Medications Dispensed. The number of controlled medication (opioid, benzodiazepine, and stimulant) pills dispensed by year and county from 2011 to 2016 was obtained from the North Carolina Controlled Reporting System, which is controlled by the NC Department of Health and Human Services (DHHS). The number per person each year was calculated by dividing the total number by the population size of each county using American Community Survey 5-year estimates (United States Census Bureau / American FactFinder, 2015). Dispensing data

Substance Abuse Prevention Coalition. The presence of a substance abuse prevention coalition in each county by year from 2011 to 2017 was determined from lists obtained from the North Carolina Parent Resource Center and the North Carolina Coalition Initiative Coordinating Center at Wake Forest School of Medicine.

Percent of Adjacent Counties with a Drop-Box. In order to create this variable, the number of counties which border or touch each county in North Carolina was determined. Then, the percentage of adjacent counties that had a drop-box each year from 2010 to 2016 was calculated.

Appalachian County. Appalachian counties were identified from the Appalachian Regional Commission and were coded as yes vs no (https://www.arc.gov/appalachian_region/TheAppalachianRegion.asp).

Data Analysis

Cox (proportional hazards) regression model was used to assess the relationship between the specified covariates and time of first drop-box implementation in each county. The Cox model is a survival analysis regression model which can examine the relationship between event incidence and a set of covariates. The relationship is expressed as a hazard function; which is the instantaneous event probability at a given time. Unlike other survival models, the baseline hazard function is estimated non-parametrically so the survival times are not assumed to follow a particular statistical distribution, for this reason, Cox regression is the most commonly used multivariate approach for analyzing survival data (Bradburn, Clark, Love, & Altman, 2003a). Essentially, the Cox model is a multiple linear regression of the logarithm of the hazard. Thus, a value of βi greater than 0, or a hazard ratio greater than one, is indicative that as ith increases, the event hazard increases and the length of time until implementation decreases (i.e, faster implementation) (Bradburn et al., 2003a). Power of a survival analysis is related to the number of events rather than the sample size, and simulations

suggest that at least 10 events are necessary for each covariate (Bradburn, Clark, Love, & Altman, 2003b). Covariates in the Cox model can be time-invariant, meaning that they do not change over time, or time-dependent. For the time-dependent covariates, the statistical program compares the current covariate value of the subject that had the event to the current values of the other subjects who have yet to experience the event (Therneau, Crowson, & Atkinson, 2017).

In order to be included in the analysis, the implementation date of the drop-box had to be known and counties had to implement a drop-box no earlier than 2011 (due to data available for segmented time-dependent covariates). Two counties that implemented a drop-box before 2011 (2007 and 2010) were left censored and not included in the analysis. There were three counties with unknown drop-box implementation dates and they were not included in the analysis. Among the sample of 95 counties, 86 had an event and only six covariates were included in the multivariate model which should have resulted in enough power to conduct the analysis (Bradburn et al., 2003b).

There were seven time-invariant variables: population size, percentage of the population who are white, percentage of the population who are Hispanic, median household income, percentage of the population who live in rural area, percentage of the population with a four-year college degree or higher, and Appalachian county. There were four segmented time-dependent covariates: the annual rate of opioid overdoses, annual rate of controlled medications prescribed, presence of a substance abuse coalition, and percent adjacent counties with a drop-box. All the segmented time-

dependent covariates, except annual rate of controlled medications prescribed, were examined the year prior to drop-box implementation (e.g., association with 2010 rate of opioid overdoses with drop-box implementation in 2011). The annual rates of controlled medications prescribed and drop-box implementation were analyzed in the same year (e.g., 2011 rate of controlled medications prescribed and drop-box implementation in 2011) due to 2011 being the first year that the data was available. Tests for collinearity were conducted and revealed no issues (VIFs were < 2). All analyses were computed using SPSS version 24 (IBM Corp., Armonk, NY).

Assumptions and Limitations

There were several limitations that should be addressed. First, while the implementation date was found for some drop-box locations through a web-search, many of the dates relied on calls to the agency that housed the drop-box. The individuals may not have been able to accurately recall the year that the drop-box was implemented introducing recall bias. Second, the study was only conducted in North Carolina and may not be generalizable to other states. However, the findings may be more generalizable to states that have similar characteristics as North Carolina especially those ranked in the top 20 for both opioid prescribing and opioid overdose rates and that have Appalachian counties. Other covariates that were not examined may have contributed to the implementation of drop-boxes. For example, funding opportunities may have had a significant contribution to the implementation of drop-boxes. Over the study period, there were several funding mechanisms that supported substance abuse prevention in communities. These included Substance Abuse and Mental Health

Services Administration's (SAMHSA) Strategic Prevention Framework State Initiative Grant, Office of Juvenile Justice and Delinquency Prevention's Enforcing Underage Drinking Laws Program, SAMHSA's Partnerships for Success, North Carolina's Department of Health and Human Services, and Project Lazarus. Given the variability in the timing of the funding and the availability of the data, these funding opportunities were not included as possible covariates. Additionally, there may have been partnerships outside of substance abuse prevention coalitions that facilitated drop-box implementation (e.g., Healthy Carolinians, Safe Kids, environmental organizations).

Study 2

Aim and Hypotheses

The aim was to examine how parents of adolescents dispose of unused prescription drugs and the extent to which awareness of prescription drug disposal programs (i.e., drop-boxes and take-back events) and access to medical insurance influence parents' disposal behaviors. The premise of the study was grounded in Ajzen's Theory of Planned Behavior in that exposure to awareness campaigns on prescription drug disposal would influence parents' attitudes, subjective norms, and perceived control pertaining to the disposal of prescription medications which would ultimately lead to their disposal (Figure 3.2). Based on the current literature pertaining to prescription drug disposal practices, I hypothesized that parents of adolescents would be more likely to dispose of medications at home via flushing them down the toilet and/or throwing them out in the trash rather than at organized disposal opportunities, such as drop-boxes and take-back events. Additionally, awareness of organized disposal

opportunities would be associated with any disposal of medications, and parents of adolescents with private medical insurance would be more likely to dispose of unused medications compared to parents who did not have any medical insurance or had government-provided insurance.

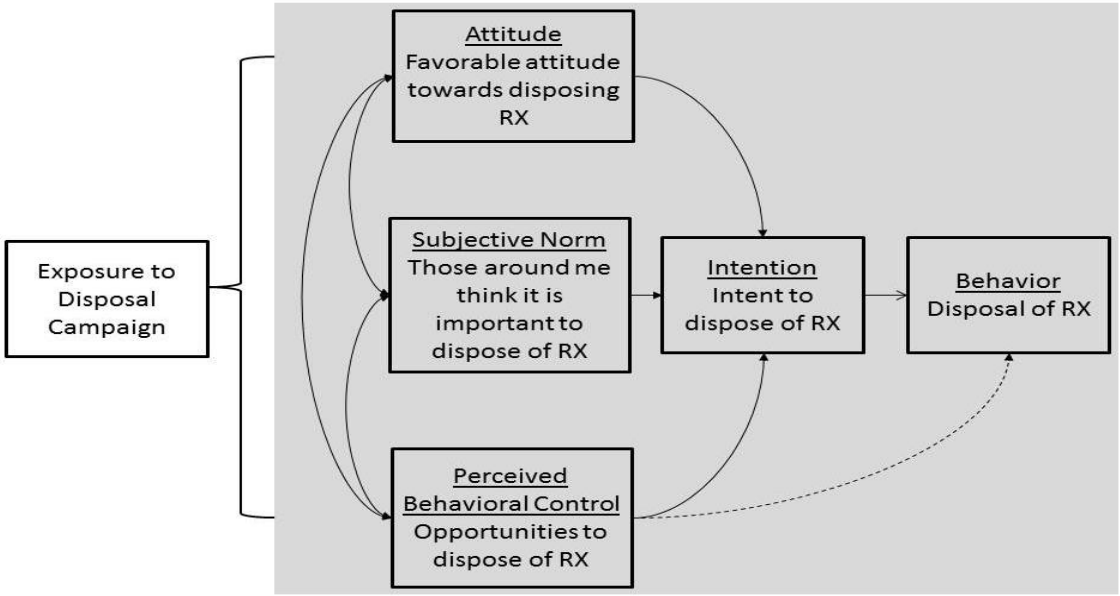

Figure 3.2 Application of Theory Planned Behavior to Awareness Campaign Related to Prescription Drug Disposal Programs

Research Design

In order to test my hypotheses, I analyzed secondary data from two parent surveys conducted in the fall of 2015 by a community partner in Bowling Green, Kentucky. Parents of kindergarten through 12th grade students in 18 elementary, 5 middle, and 3 high schools in south central Kentucky were recruited to participate in one of two paper surveys based on the school that they attended. Parents of K-5 through 5th grade received the "Family Resource Center Parent Survey" (Appendix A) and parents

of 6th through 12th graders received the "Youth Service Center Parent Survey" (Appendix B). Surveys were distributed by each school to parents as part of a back to school paperwork packet. Participation was voluntary with no incentives or reminders. Out of approximately 15,000 distributed surveys, a total of 6,981 parents completed the survey (46.5%). The Wake Forest School of Medicine Institutional Review Board approved the study protocol for secondary data analysis.

Organized Disposal

DEA-sponsored take-back events were held by law enforcement agencies in the surveyed county biannually since 2010. Additionally, there were three drop-boxes within the surveyed county – one at the Warren County Sheriff's Office, one at the Bowling Green Police Department (approximately 100 yards from the Sheriff's Office), and one at the Kentucky State Police Post 3. The first drop-box was installed in 2012. Take-back events and drop-boxes were marketed within the county to increase awareness of availability and disposal. Marketing consisted of periodic advertisements in local newspapers, social media, inserts within pharmacy bags at checkout, and printed labels on controlled substances.

Measures

Disposal Practices. The primary outcome was parental practices of disposing unused or expired prescription drugs. We examined any disposal of prescription drugs as well as organized (i.e., take-back events and drop-boxes) and home (i.e., flushing down the toilet and throwing them in the trash) disposal. Four items were used to assess ways in which prescription drugs were disposed within the past 12 months: (1) "If your

community participates in DEA Take Back Events, did you drop off unused medications within the past 12 months?"; (2) "If your community has permanent Rx Disposal sites, have you dropped off unused medications within the past 12 months?"; (3) "Have you discarded unused medications in your trash within the past 12 months?"; and (4) "Have you discarded unused medications by flushing them in the toilet within the past 12 months?". These items were combined into a single item to assess any disposal of prescription drugs within the past 12 months. Organized disposal was assessed by combining (1) and (2), and home disposal was assessed by combining (3) and (4).

Grade of Child, Single Parent, and Grandparent Raising Grandchildren. The type of school (categorized as elementary, middle, or high school) that the child of the parent attended was used as a covariate. This item was provided in the dataset but was not queried on the surveys. The item assessing whether or not the parent was single was only included of the survey of elementary school parents. "Are you a grandparent raising your grandchildren?" was asked of all parents.

Medical Insurance. Any health insurance coverage and type of health insurance coverage was used as a covariate. Three items assessed health insurance coverage: (1) "Do you have private insurance?"; (2) "Do you have a medical card?"; and (3) "Do you have KCHIP (KY Children's Health Insurance Program)?". Items (2) and (3) were combined into a single item to assess government-assisted health insurance. Health insurance was trichotomized – private health insurance, government-assisted health insurance, and no health insurance.

Assistance Covariates. Several items assessed different needs of the parents. We created the following three needs: (1) basic, (2) substance misuse prevention or treatment, and (3) abuse at home. Assistance with basic needs was asked of all parents and consisted of food, clothing, and housing. Needs with substance misuse prevention or treatment and abuse at home were only asked of parents of middle and high school age adolescents. The following response options to the stem – "Do you need help with the following?" - were combined to create the need assistance with substance misuse prevention or treatment: 'tobacco education/treatment,' 'alcohol education/treatment,' 'illegal drug use education/treatment,' 'prescription drug education/treatment,' 'inhalant abuse,' 'community resources available to treat alcohol/drug abuse issues,' and 'parenting classes to address alcohol/tobacco/drug use.' The following response options to the stem – "Do you need help and/or information about the following?" – were combined to create the assistance with abuse at home item: 'domestic violence' and 'abuse in the home.'

Permissive and Protective Factors. All parents were queried on their permissiveness to underage drinking (UAD) party attendance. The following two items were combined to create the permissive to UAD parties: "Would you approve of your child attending a party where youth their age were drinking?" and "Would you approve of your child attending a party where adults are providing alcohol to youth (not their child)?". Protective factors were only asked of elementary school parents. The following items were combined to create a protective behaviors item: "Do you read to your

children?," "Do you help your child with homework during the week?," and "Would you be interested in serving as a volunteer at your child's school?."

Awareness of Organized Disposal Opportunities. Two items assessed whether or not parents were aware of disposal opportunities in their communities: (1) "Do you know if your community participates in the DEA Rx Take Back Events?" and (2) "Do you know if your community has permanent Rx Disposal sites where you can drop off your unused medications?". Communities where the parents resided did conduct DEA RX take-back events and had drop-boxes sites as described above.

Access to Prescription Drugs. All analyses were restricted to households that had been prescribed a controlled prescription drug within the past 12 months. Three items were used to assess whether a member of the household had been prescribed a controlled prescription drug within the past 12 months: (1) "Has someone in your household been prescribed a pain killer within the past 12 months?"; (2) "Has someone in your household been prescribed a medication for ADHD within the past 12 months?"; and (3) "Has someone in your household been prescribed medication for anxiety within the past 12 months?".

Data Analysis

Analyses consisted of descriptive statistics and bivariate and multivariate logistic regression. Bivariate and multivariate logistic regression were conducted to examine correlates of disposal. A post hoc multivariate logistic regression analysis was conducted to examine the correlates of awareness of disposal opportunities. Only variables that were statistically significant a $p<0.1$ in bivariate analyses and on both surveys were

included in the multivariate logistic regression analysis. All analyses were restricted to parents who live with someone who has been prescribed a controlled medication within the last year. All analyses were computed using SPSS version 24 (IBM Corp., Armonk, NY).

Assumptions and Limitations

There were several disadvantages to utilizing secondary data collection including the lack of all measures desired and inability to influence data collection (Smith et al., 2011). The parent survey data did not include general demographics which are typically included in regression analysis, such as gender, age of participant, and race/ethnicity. Given the lack of individual-level demographic variables, I reported the county-level demographic variables to give an overview of the demographics of the surveyed communities. Additionally, the options for disposal were restricted to the most common disposal practices so if there were other disposal practices, they were not captured. While we know which school administered the survey, we do not know if the parent had multiple children at the same or different schools at the time of the study (e.g., the parent participated in the elementary school survey but also has a child in middle school). If a parent has multiple children in different schools (e.g., elementary and middle) they may have been invited and, subsequently, participated in the survey twice.

CHAPTER IV

DIFFUSION OF MEDICATION DROP-BOXES IN NORTH CAROLINA FROM 2007 TO 2016

Egan KL, Wolfson M, Francisco VT, Strack RW, Wyrick DL, Perko MA. Diffusion of Medication Drop-Boxes in North Carolina from 2007 to 2016. *Addictive Behaviors*. (Pre-Submission).

Abstract

Objectives

To examine the implementation and diffusion of medication drop-boxes in North Carolina (NC).

Methods

Cox proportional hazards models were used to examine covariates associated with rate of first drop-box implementation in NC between 2007 and 2016.

Results

311 drop-boxes were implemented in 91 (out of 100) counties. Most drop-boxes were in law enforcement agencies (78.8%) and a growing number were in pharmacies (14.5%). Counties with a higher percentage of whites, more educated residents, a substance abuse prevention coalition, higher rates of controlled medications dispensed and prescription opioid overdose, and that were Appalachian were more likely to be early adopters. In the multivariate model, only level of education and rates of controlled medicines dispensed were significant.

Conclusions

A growing number of drop-boxes are being implemented in law enforcement offices and pharmacies. Given that communities with higher rates of controlled medication dispensing likely have the highest need for disposal opportunities, it is promising that they are early adopters.

Policy Implications

Future research should examine the diffusion process in other states, and is needed to assess the effectiveness of drop-boxes as they become more widespread in a variety of locations.

Manuscript

Introduction

Nonmedical prescription drug use (NMPDU), the use without a prescription or for the experience and feeling the drugs cause, is the second most common illicit drug use behavior in the United States (Center for Behavioral Health Statistics and Quality, 2015). It is associated with a myriad of adverse consequences, including overdose deaths (CDC, 2015a; Chen, Hedegaard, & Warner, 2015), emergency department visits (SAMHSA, 2013b; Warner et al., 2014), dependence and addiction (Compton et al., 2006), infectious diseases (Bruneau et al., 2012; Conrad et al., 2015; Zibbell et al., 2015), and community consequences (Berning et al., 2015; Goodnough, 2010).

The supply of prescription drugs is high; over 3.9 billion controlled medications are being dispensed by retail pharmacies annually (CDC, 2015b). Not only are a substantial number of prescription medications being dispensed but many are going

unused. Previous studies found that only 2%-34% of individuals use all of their prescribed medications (Bates et al., 2011; Kuspis & Krenzelok, 1996; Lewis et al., 2014), and 7.2-91.0% report retaining prescribed medications in their homes, even after ceasing use or the medication expired (Bates et al., 2011; Harris et al., 2013; Kennedy-Hendricks et al., 2016; Kuspis & Krenzelok, 1996; Lewis et al., 2014; Ma et al., 2014; Seehusen & Edwards, 2006). Thus, personal medicine cabinets may be a primary source of controlled medications for nonmedical use, knowingly or unknowingly to the prescription-holder (Ross-Durow et al., 2013; Stewart et al., 2014). In fact, research consistently has found that the most commonly reported sources of controlled medications for nonmedical use are friends or family for free (Center for Behavioral Health Statistics and Quality, 2015; S. E. McCabe & Boyd, 2005).

Based on the availability hypothesis, reducing the availability of excess prescription medications by facilitating their disposal may be a promising strategy to reduce NMPDU (Babor, Caetano, et al., 2010). Permanent drug donation boxes (herein referred to as “drop-boxes”) is one of the common prescription drugs disposal strategies implemented in communities across the United States (DEA, 2014b; ONDCP, 2011). The Secure and Responsible Drug Disposal Act of 2010 provides national guidelines for the implementation of drop-boxes (DEA, 2014b). Initially, drop-boxes could only be located at law enforcement offices but following the establishment of the final rule to the Secure and Responsible Drug Disposal Act of 2010, in October 2014, drop-boxes could be implemented by authorized manufacturers, distributors, reverse distributors, narcotic treatment programs, hospitals/clinics with an on-site pharmacy, and retail pharmacies

(DEA, 2014b). Currently, drop-boxes can be made available to the public year-round under 24-7 surveillance by a Drug Enforcement Administration (DEA)-authorized collector (e.g., law enforcement and pharmacies). In order for drop-boxes to be effective, they must be easily accessible to community members. While it is known that organizations, such as law enforcement agencies and pharmacies, have been implementing drop-boxes, to our knowledge, no study has systematically examined drop-box diffusion and implementation or community characteristics associated with implementation.

Diffusion theories have been used by multiple fields, including substance abuse prevention (Rogers, 2010), to examine transfer of knowledge, experiences with the application of technologies and practices, and the spread of technologies and practices through populations (Green et al., 2009). One such theory is Roger's Diffusion of Innovation Theory (Rogers, 2010). According to Rogers's theory, diffusion is the process by which an innovation (e.g., a new idea, practice, or object) is communicated through certain channels over time among members of a social system. Characteristics of innovations and adopters impact how rapidly an innovation is communicated and subsequently adopted. Relative advantage is one innovation characteristic that is thought to influence the rate of adoption. Relative advantage refers to the perceived advantage of the innovation by potential adopters (Rogers, 2010). Applied to the diffusion and implementation of drop-boxes, communities with NMPDU problems (e.g., high controlled medication prescribing rates and prescription opioid overdose rates) may perceive high relative advantage of adopting drop-boxes, especially if they are perceived

to be effective. Characteristics of potential adopters that influence likelihood of adoption include: more formal education, higher social status, larger units, greater change agent contact, and greater knowledge of innovations (Rogers, 2010).

North Carolina is ranked in the top 20 states for both opioid prescribing and opioid overdose rates. North Carolina has an opioid prescribing rate of 96.6 per 100 persons (Paulozzi et al., 2014) and opioid overdose death rate 8.7 per 100,000 (Kaiser Family Foundation, 2017). Thus, North Carolina has a need for effective strategies to address the availability of prescription drugs in order to reduce NMPDU and associated consequences. The objective of this study was to examine the diffusion and implementation of drop-boxes in North Carolina. We assessed the number and location of drop-boxes implemented in North Carolina and county-level covariates associated with the rate of implementation. We hypothesized that (1) high overdose and controlled medication prescribing rates would be positively associated with earlier drop-box adoption since these counties have higher prevention needs based on Rogers's concept of 'relative advantage' (2010); (2) the presence of a local substance abuse prevention coalition would be associated with earlier drop-box adoption since these agencies have been involved in the facilitation of drop-box implementation based on Rogers's concept of 'change agent' (2010); and (3) earlier drop-box adoption would be associated with larger population size, higher socioeconomic status, higher level of education, and proximity to other early adopters based on Rogers's theory pertaining to characteristics of early adopters (2010).

Methods

We created a database of all counties in North Carolina (n=100). Several of the focal independent variables were only available at the county-level (i.e, rate of prescription opioid overdoses and number of controlled medications dispensed) so county was the unit of analysis. The following variables were added to the database per county: presence of a drop-box; year of implementation of the drop-box; address of the drop-box; rate of opioid overdoses; number of controlled medications dispensed per person; presence of a substance abuse prevention coalition; Appalachian county; county census data (population, race, ethnicity, median income, educational attainment of residents); and adjacency to a county with a drop-box.

Measures

Drop-Boxes. A multi-step approach was used to determine the presence and year of implementation of drop-boxes in counties in North Carolina. First, a list of potential drop-box locations was compiled using the DEA's Controlled Substance Public Disposal Location (DEA, n.d.-a) and the North Carolina Operation Medicine Drop (Safe KidsNC, n.d.) search utilities. The DEA's list only included DEA-authorized collectors (i.e., pharmacies and other health care facilities) so law enforcement agencies, which do not require DEA authorization, were not included on the list. The North Carolina Operation Medicine Drop website was based on organizations (e.g., police departments, sheriff's offices, pharmacies, etc.) submitting their information to be included on the website, and thus may not include all drop-box locations in the state. In order to identify law enforcement agencies that may not have been included on the NC Operation Medicine

Drop website, a list of all Sheriff's offices in North Carolina was obtained from the North Carolina Sheriff's Association (http://ncsheriffs.org/sheriffs) and a list of all police departments in North Carolina was obtained from USACops (http://www.usacops.com/nc/; the final list excluded colleges, schools, business/malls, military bases, & airport public safety). Following the compilation of a list of all possible drop-box locations in North Carolina (i.e., law enforcement agencies and DEA-authorized collectors), a web-search was conducted to determine drop-box implementation and date of implementation for all the locations on list. Search terms included the location name and "drop box" or "dispose" or "disposal." If a drop-box and/or the date of implementation could not be identified in the web-search, the location was called by phone to determine if they had a drop-box and the year that it was implemented.

Opioid Overdose Deaths. The number of prescription opioid deaths by year and county from 2010 to 2015 were obtained from the North Carolina State Center for Health Statistics. The rate per 100,000 residents by year and county were calculated based on population size of each county using American Community Survey 5-year estimates (United States Census Bureau / American FactFinder, 2015).

Controlled Medications Dispensed. The number of controlled medication (opioid, benzodiazepine, and stimulant) pills dispensed by year and county from 2011 to 2016 were obtained from the North Carolina Controlled Reporting System which is controlled by NC Department of Health and Human Services (DHHS). The number per person each year was calculated by dividing the total number by the population size of each county

using American Community Survey 5-year estimates (United States Census Bureau / American FactFinder, 2015).

Substance Abuse Prevention Coalition. The presence of a substance abuse prevention coalition in each county by year from 2011 to 2016 was determined from lists obtained from the North Carolina Parent Resource Center and the North Carolina Coalition Initiative Coordinating Center at Wake Forest School of Medicine.

Percent of Adjacent Counties with a Drop-Box. In order to create this variable, the number of counties which border or touch each county in North Carolina was determined. Then, the percentage of adjacent counties that had a drop-box each year from 2010 to 2016 was calculated.

Appalachian County. Appalachian counties were identified from the Appalachian Regional Commission and were coded as yes vs no (https://www.arc.gov/appalachian_region/TheAppalachianRegion.asp).

Census Data. Educational attainment, median household income, population size, race (% white), and ethnicity (% Hispanic) were obtained from the American Community Survey 5-year estimates (United States Census Bureau / American FactFinder, 2015). Education attainment was coded as the percent of county residents with a Bachelor degree or higher.

Statistical Analysis

Cox proportional hazards regression model was used to assess the relationship between the specified covariates and implementation of a drop-box. In order to be included in the analysis, the implementation date of the drop-box had to be known and

counties had to implement a drop-box no earlier than 2011 (due to years available for time-dependent covariates). There were three counties with unknown drop-box implementation dates and two counties that implemented a drop-box before 2011 which resulted in a sample of 95 counties.

There were seven time invariant variables: population size, percentage of the population who are white, percentage of the population who are Hispanic, median household income, percentage of the population who live in rural area, percentage of the population with a four-year college degree or higher, and Appalachian county. There were four segmented time-dependent covariates: the annual rate of opioid overdoses per 100,000, annual rate of controlled medications prescribed per person, presence of a substance abuse coalition, and percent adjacent counties with a drop-box. All the time-dependent covariates, except annual rate of controlled medications prescribed, were examined the year prior to drop-box implementation (e.g., association with 2010 rate of opioid overdoses with drop-box implementation in 2011). The annual rate of controlled medications prescribed and drop-box implementation were analyzed in the same year (e.g., 2011 rate of controlled medications prescribed and drop-box implementation in 2011). This was due to annual rate of controlled medications only being available as early as 2011. Tests for collinearity revealed no such issues (VIFs were < 2). All analyses were computed using SPSS version 24 (IBM Corp., Armonk, NY).

Results

Drop-Box Implementation

There were 311 drop-boxes implemented in North Carolina as of December 31, 2016 (Table 4.1). Of those, 154 were at police departments, 91 at Sheriff's Offices, 45 were at pharmacies, and 21 were at other locations (e.g., hospitals, town halls, and fire stations). Across all nine years, law enforcement agencies (e.g., police departments and Sheriff's offices) were the most common agencies to implement a drop-box. However, in 2014, following the final rule to the Secure and Responsible Drug Disposal Act of 2010 a growing number of pharmacies started implementing drop-boxes; and in 2016 30 new drop-boxes had been implemented in pharmacies.

Table 4.1 Drop-Box Implementation by Location and Year

	Year									
Location	**2007**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**Unknown**	**Total**
Police	1	-	14	13	23	31	24	36	12	154
Sheriff	-	1	11	19	11	18	15	9	7	91
Pharmacy	-	-	-	1	0	5	7	30	2	45
Other	-	-	1	2	1	3	2	10	2	21

Out of the 100 counties in North Carolina, 91 had a drop-box installed (Table 4.2). The first drop-box was installed in 2007 and the second was installed in 2010. There were 13 counties that got their first drop-box in 2011, 20 in 2012, 18 in 2013, 18 in 2014, 9 in 2015, and 8 in 2016. Agencies in three counties could not recall the exact year that their drop-box had been implemented; these counties were not included in the survival analysis.

Table 4.2. Characteristics of the Sample

	Full Sample (n=95)
Drop-Boxes[1]	86 (90.5%)
Year of Implementation	
2007	-
2010	-
2011	13
2012	20
2013	18
2014	18
2015	9
2016	8
None[1]	9
Date Unknown	-
Population Size *(mean (st. dev.))*	100,998 (154,757)
% White *(mean (st. dev.))*	72.4% (17.7%)
% Black *(mean (st. dev.))*	20.2% (16.4%)
% American Indian *(mean (st. dev.))*	1.6% (4.9%)
% Asian *(mean (st. dev.))*	1.1% (1.3%)
% Hawaiian or Pacific Islander *(mean (st. dev.))*	0% (0%)
% Hispanic *(mean (st. dev.))*	6.9% (4.0%)
Median Income *(mean (st. dev.))*	$41,966 ($8,145)
% Rural Population *(mean (st. dev.))*	60.6% (28.6%)
% Residents with Bachelor Degree or Higher *(mean (st. dev.))*	20.4% (9.2%)
RX Death Rate Year Prior to Implementation *(mean (st. dev.))*	10.0 (9.6)
RX Dispensing Rate Year of Implementation *(mean (st. dev.))*	103.6 (31.1)
Substance Abuse Coalition Year Prior to Implementation	41 (4.1)
Adjacent to County with Drop-Box Year of Implementation	4.0% (3.4%)

[1]Between January 1, 2011 and December 31, 2016

Correlates of Drop-Box Implementation

In the univariate analyses (Table 4.3), counties with a higher percentage of whites (HR=1.03; 95% CI: 1.01, 1.04; p<0.001) and individuals with a bachelor's degree or higher (HR=1.03; 95% CI: 1.01, 1.05; p=0.009), considered to be Appalachian (HR=2.12; 95% CI: 1.32, 3.39; p=0.002), have a substance abuse prevention coalition (HR=1.59; 95% CI: 1.04, 2.44; p=0.033), higher prescription opioid death rates (HR=1.04; 95% CI: 1.01, 1.06; p=0.001) and higher rates of controlled medications dispensed (HR=1.01; 95% CI: 1.01, 1.02; p=0.001) were associated with decreased time

until drop-box implementation (i.e., faster implementation). In the multivariate Cox Regression model (Table 4.4), after adjusting for all statistically significant variables (at p<0.1), with every percentage increase of individuals with a bachelor's degree or higher and controlled medicine unit dispensed per person the likelihood of drop-box implementation increased by 4% (HR=1.04; 95% CI: 1.01, 1.07; p=0.014) and 1% (HR=1.01; CI: 1.00, 1.02; p=0.008), respectively.

Table 4.3 Hazard Ratios from the Univariate Cox PH Model for Drop-Box Implementation

		Univariate Analysis		
Covariate	**Coefficient (bi)**	**HR [exp(bi)]**	**95% CI**	**P-value**
Population Size	0.00	1.00	1.00, 1.00	0.174
% White	0.03	1.03	1.01, 1.04	<0.001
% Hispanic	0.02	1.02	0.97, 1.07	0.434
Median Income	0.00	1.00	1.00, 1.00	0.239
% Rural	-0.01	0.99	0.99, 1.00	0.993
Appalachian	0.75	2.12	1.32, 3.39	0.002
% Bachelor +	0.03	1.03	1.01, 1.05	0.009
RX Death Rate	0.03	1.04	1.01, 1.06	0.001
RX Dispensing Rate	0.01	1.01	1.01, 1.02	0.001
Substance Abuse Coalition	0.47	1.59	1.04, 2.44	0.033
% Adjacent Counties with Drop-Box	0.01	1.01	1.00, 1.02	0.103

HR = hazard ratio, CI = confidence interval

Table 4.4 Hazard Ratios from the Multivariate Cox PH Model for Drop-Box Implementation

		Multivariate Analysis		
Covariate	**Coefficient (bi)**	**HR [exp(bi)]**	**95% CI**	**P-value**
% White	0.01	1.01	0.99, 1.03	0.213
Appalachian	0.10	1.10	0.62, 1.97	0.740
% Bachelor +	0.04	1.04	1.01, 1.07	0.014
RX Death Rate	0.01	1.01	0.99, 1.04	0.372
RX Dispensing Rate	0.01	1.01	1.00, 1.02	0.008
Substance Abuse Coalition	0.19	1.21	0.75, 1.94	0.431

HR = hazard ratio, CI = confidence interval

Discussion

To our knowledge, this was the first study to examine the diffusion and implementation of drop-boxes. We found that, over nine years, 311 drop-boxes had been installed in 91 counties in North Carolina. While the majority of drop-boxes were located in law enforcement agencies, in recent years, a growing number of pharmacies began to implement drop-boxes. The earlier pharmacy drop-boxes were in locally-owned pharmacies but in 2016 Walgreens installed 22 drop-boxes in North Carolina (Fitzgerald, 2016). While the number of drop-boxes in North Carolina is growing, there are only 311 drop-boxes for a population of 9,845,333 spread across 53,819 square miles (United States Census Bureau / American FactFinder, 2015). In order for drug disposal programs to have an impact on reducing the availability of prescription drugs for nonmedical use, it is imperative that they are readily available and accessible to the general public. The expansion of drop-boxes in pharmacies, a location where the general public patrons more frequently than a law enforcement agency, may result in greater utilization of drop-boxes. Currently, research has only assessed the use of drop-boxes at law enforcement agencies (Egan et al., 2016; Gray et al., 2015). Additional research is needed to assess the utilization of drop-boxes that are located in pharmacies in order to evaluate their potential impact.

Consistent with our hypothesis based on Rogers's concept of 'relative advantage' (2010), we found that high overdose and controlled medication prescribing rates were positively associated with earlier drop-box implementation in univariate models. Additionally, counties with higher percentage of whites and that were Appalachian were

early implementers of drop-boxes which is important given that whites (Vaughn, Nelson, Salas-Wright, Qian, & Schootman, 2016) and Appalachian communities (Jr, R, & Cg, 2008; McDonald, Carlson, & Izrael, 2012) are disproportionality impacted by NMPDU and associated consequences. After accounting for all statistically significant covariates, prescribing rates remained significant but overdose rates, percentage of white residents, and Appalachian counties were no longer statistically significant. This finding suggests that counties with higher controlled medication prescribing rates may have been early adopters of drop-boxes in order to reduce the availability of excess prescribed medications. The findings from both the univariate and multivariate analyses are promising in that counties in need of strategies that impact the availability of prescription drugs for nonmedical use were implementing disposal programs early in the prescription drug epidemic.

Substance abuse prevention coalitions have been working in communities to implement prescription drug disposal programs (CADCA, 2014; Fischer & Murphy, 2016; Yanovitzky, 2016). Our finding that the presence of a local substance abuse prevention coalition was associated with earlier drop-box implementation in the univariate but not the multivariate model, suggests that, without accounting for other county characteristics, substance abuse prevention coalitions may have been a ‘change agent’ (Rogers, 2010) involved in facilitation of drop-box implementation. As a change agent, substance abuse prevention coalitions may have emphasized the need for drop-boxes to be installed at law enforcement agencies, provided information about how to obtain and maintain a drop-box, and ensured that the plan was translated into action

(Haider & Kreps, 2004). Additionally, substance abuse prevention coalitions may have funding sources to assist with the cost associated with drop-boxes (e.g., Drug-Free Communities). Thus, communities that have substance abuse prevention coalitions may be more willing and better equipped to implement strategies to reduce NMPDU and associated consequences.

While population size, socioeconomic status (based on median income), and proximity to other early adopters were not associated with earlier implementation of drop-boxes, the percentage of individuals with a bachelor's degree or higher level was significantly related to earlier drop-box implementation in both the univariate and multivariate model. This is consistent with Rogers' Diffusion of Innovations Theory which suggests that early adopters tend to have more years of formal education and, thus, generally have higher socioeconomic status (Rogers, 2010). Higher socioeconomic status may facilitate earlier knowledge about drop-boxes due to an increased number of communication channels through group membership and conference attendance (e.g., Community Anti-Drug Coalitions of America), as well as, access to opinion leadership who could support drop-box implementation (Rogers, 2010).

Limitations

There were several limitations that should be addressed. First, while the implementation date was found for some drop-box locations through a web-search, many of the dates relied on calls to the agency that housed the drop-box. The individuals may not have been able to accurately recall the year that the drop-box was implemented, thus, introducing recall bias. Second, the study was only conducted in North Carolina and may

not be generalizable to other states. However, the findings may be more generalizable to states that have similar characteristics as North Carolina especially those ranked in the top 20 for both opioid prescribing and opioid overdose rates and that have Appalachian counties. Additionally, other covariates that were not examined may have contributed to the implementation of drop-boxes. For example, funding opportunities may have had a significant contribution to the implementation of drop-boxes. Over the study period, there were several funding mechanisms that supported substance abuse prevention in communities. These included Substance Abuse and Mental Health Services Administration's (SAMHSA) Strategic Prevention Framework State Initiative Grant, Office of Juvenile Justice and Delinquency Prevention's Preventing Underage Drinking, SAMHSA's Partnerships for Success, North Carolina's Department of Health and Human Services, and Project Lazarus. Given the variability in the timing of the funding and the limited availability of the data, these funding opportunities were not included as possible covariates. Additionally, there may have been partnerships outside of substance abuse prevention coalitions that facilitated drop-box implementation (e.g., Healthy Carolinians, Safe Kids, environmental organizations). Also, adverse events in a community, such as a prescription opioid overdose death, may have influenced adoption of a drop-box.

Public Health Implications

Given the surplus of prescribed medications in communities, opportunities for individuals to safely dispose of unused or expired medications, such as drop-boxes, is an important strategy to reduce the availability of prescription medications for nonmedical

use and diversion. However, if drop-boxes are not widely available in locations were the general public frequently patrons, their potential may not be fully utilized. This was the first study to examine the diffusion of drop-boxes to dispose of unused or expired medications. There was a total of 311 drop-boxes implemented in 91 out of 100 counties in North Carolina over nine years. While the majority of drop-boxes were located at law enforcement agencies, there were a growing number of pharmacies that implemented drop-boxes in more recent years. Additionally, the finding that communities with higher rates of controlled medication were more likely to be earlier adopters of drop-boxes is promising given that they likely have the highest need for disposal opportunities. Future research is needed to assess the effectiveness of drop-boxes as they become more widespread in a variety of locations.

CHAPTER V

DISPOSAL OF PRESCRIPTION DRUGS BY PARENTS OF ELEMENTARY, MIDDLE, AND HIGH SCHOOL STUDENTS

Egan KL, Gregory E, Wolfson M, Francisco VT, Strack RW, Wyrick DL, Perko MA. Disposal of prescription drugs by parents of elementary, middle, and high school students. *Journal of Adolescent Health* (Pre-Submission).

Abstract

Purpose

The objective of this study was to examine how parents of elementary, middle, and high school students dispose of unused prescription medications and correlates of disposal.

Methods

In the fall of 2015, parents of youth attending 18 elementary, 5 middle, and 3 high schools in one county located in south central Kentucky were surveyed. A total of 6,981 parents completed the survey (approximately 46.5% response rate). Multivariate logistic regression was conducted to examine correlates of disposal of prescription medication and awareness of disposal opportunities.

Results

Among 2,300 parents residing in a household prescribed a controlled medication in the past year, only 33.9% disposed of unused prescription medications. Of those who

disposed, 9.8% used a take-back event, 10.0% a drop-box, 12.8% flushed the medication in a toilet, and 15.0% threw the medication in the trash. Organized disposal (e.g., take-back event or drop-box) was associated with permissiveness of underage drinking parties, awareness of disposal opportunities, and ADHD prescription. Being a grandparent raising a grandchild, permissiveness towards underage drinking, and pain reliever or ADHD prescriptions were associated with awareness of organized disposal opportunities.

Conclusions

Among parents of adolescents, increasing awareness of medicine disposal opportunities may be a promising mechanism to increase the use of take-back events and drop-boxes. Additional research is needed to assess the most effective messages and message delivery to increase awareness and use of organized disposal opportunities. Also, given that there were parents who were aware of disposal opportunities who did not dispose of unused medications (n=901), research is needed to assess barriers and facilitators of medication disposal.

Manuscript

Implications and Contributions

Despite medicine cabinets being the most common source of prescription medications for nonmedical use among adolescents, only 33.9% of parents disposed unused medications in the past year. Further research is needed to assess messaging and message delivery to increase awareness and use of medicine disposal opportunities.

Introduction

Nonmedical prescription drug use (NMPDU), use of a prescription drug not prescribed to you or for the feeling the drugs caused (Center for Behavioral Health Statistics and Quality, 2015), is the second most common illicit drug use behavior among adolescents in the United States following marijuana. Adolescents have the second highest rate of current and past 12-month NMPUD, following young adults ages 18 to 25 year of age (Center for Behavioral Health Statistics and Quality, 2015). Adverse health consequences of NMPDU include substance use disorders, emergency department visits, and death (Center for Behavioral Health Statistics and Quality, 2015).

Peak risk of NMPDU initiation is 16 years of age with the majority initiating use by age 12 (Austic et al., 2015). Early initiation is associated with high risk substance use behaviors (DeWit et al., 2000; Hawkins et al., 1997) and general maladaptive behaviors which can carry into adulthood (Slade et al., 2008; Zhang et al., 1997). For example, adolescents who used prescription sedatives and anxiolytics non-medically were more likely than non-users to develop substance use disorder in adulthood (S. E. McCabe et al., 2016).

Friends or family members are the most common sources of NMPD for adolescents (Center for Behavioral Health Statistics and Quality, 2015; S. E. McCabe & Boyd, 2005). Approximately 20% of 12-17 year olds have reported sharing a prescription medication with someone (Goldsworthy et al., 2008). Adolescents have easy and unsupervised access to prescription medications with abuse potential at home (Friese et al., 2013; S. E. McCabe et al., 2013; Ross-Durow et al., 2013) which suggest that

personal medicine cabinets may be a primary source of prescription medications for nonmedical use, knowingly or unknowingly to the prescription-holder (Ross-Durow et al., 2013; Stewart et al., 2014). Managing access to prescription drugs by storing them out of reach and in a locked cabinet or safe has been one approach to mitigate diversion (ONDCP, 2011).

A broad percentage (7.2-91.0%) report retaining prescribed medications in their homes, even after ceasing use or the medication expired; some report keeping unused prescription medications over a year (Bates et al., 2011; Harris et al., 2013; Kennedy-Hendricks et al., 2016; Kuspis & Krenzelok, 1996; Lewis et al., 2014; Ma et al., 2014; Seehusen & Edwards, 2006). Specific to prescription opioids, a range of 53-93% individuals reported retaining them even if they ceased use (Bates et al., 2011; Harris et al., 2013; Lewis et al., 2014). Thus, another approach to prevent diversion has been to encourage the disposal of unused or expired medications (ONDCP, 2011).

Encouraging disposal through the promotion of permanent drug donation boxes (herein referred to as “drop-boxes”) and take-back events, the two most common organized disposal strategies, has been implemented across the US (DEA, 2014b; ONDCP, 2011). The Secure and Responsible Drug Disposal Act of 2010 provided national guidelines for drop-boxes and take-back events (DEA, 2014b). Drop-boxes can be made available year-round under surveillance of a Drug Enforcement Administration (DEA)-authorized collector (DEA, 2014b, n.d.-b). Take-back events typically occur biannually for 1-2 days at a time. Several studies have assessed how individuals dispose of, or not, unused medications. These studies have found that, if medications were

disposed, they were most commonly disposed in the trash or by flushing them down the toilet (Bates et al., 2011; Kuspis & Krenzelok, 1996; Lewis et al., 2014; Ma et al., 2014; Seehusen & Edwards, 2006). One study found that 9% of adults reported use of organized disposal opportunities (Yanovitzky, 2016). To our knowledge, no studies have examined the prescription drug disposal behaviors of parents of adolescents. Understanding how parents dispose of unused and expired prescription medications is needed given that the average age of initiation is 16 years old (Austic et al., 2015).

Several studies examined the impact of marketing and educational programs on disposal of prescription medications. All found an increase in self-reported disposal following exposure to the campaign or educational program (de la Cruz et al., 2016; Maughan et al., 2016; Seehusen & Edwards, 2006; Yanovitzky, 2016). Additionally, campaign and program exposure was related to increased conversations with others about medicine disposal and kids about the dangers of prescription drug abuse (Yanovitzky, 2016), increased awareness of proper disposal methods, decreased sharing of medications, increased awareness of the dangers of sharing medications, and secure storage of medications (e.g., hidden or locked) (de la Cruz et al., 2016).

One reason that individuals report retaining unused prescription medications after ceasing use is “just in case” they need them in the future (Kennedy-Hendricks et al., 2016; Lewis et al., 2014). This may be especially prominent among those who have limited or no access to medical care or insurance or need assistance with basic needs (e.g., food and clothing). Individuals with limited or no health insurance have reported behaviors to extend their prescription medications, such as using less than prescribed

(Goins et al., 2005; Kenne et al., 2016). Thus, it is important to understand possible reasons for retaining unused medications in order to facilitate disposal of unused medications.

Given that youth commonly report obtaining prescription medications for abuse from friends and family members, disposing of unused medications is expected to be an important strategy for minimizing NMPDU. The objective of this study was to examine how parents of elementary, middle, and high school students dispose of unused prescription medications and correlates of disposal.

Methods

Research Design

We analyzed secondary data from two parent surveys conducted in the fall of 2015 by a community partner in one county in south central Kentucky. Parents of students in 18 elementary, 5 middle, and 3 high schools were recruited to participate in one of two paper surveys based on the school that they attended (K-5 through 5th grade vs. 6th through 12th grade). Surveys were distributed by each school as part of a back-to-school packet. Out of about 15,000 distributed surveys, a total of 6,981 parents completed the survey (approximately 46.5% response rate). The Wake Forest School of Medicine Institutional Review Board approved the study protocol for secondary data analysis.

Organized Disposal

DEA-sponsored take-back events were held by law enforcement agencies in the surveyed county biannually since 2010. Additionally, there were three drop-boxes within the surveyed county located at law enforcement agency offices at the time of the survey.

The first drop-box was installed in 2012. Marketing take-back events and drop-boxes consisted of periodic advertisements in newspapers, social media, inserts within pharmacy bags at checkout, and printed labels on controlled substances.

Measures

Disposal Practices. The primary outcome was parental practices of disposing unused or expired prescription drugs. We examined any disposal of prescription drugs as well as organized (i.e., take-back events and drop-boxes) and home (i.e., flushing down the toilet and throwing them in the trash) disposal. Four items assessed ways in which prescription drugs were disposed within the past 12 months: (1) "If your community participates in DEA Take Back Events, did you drop off unused medications within the past 12 months?"; (2) "If your community has permanent Rx Disposal sites, have you dropped off unused medications within the past 12 months?"; (3) "Have you discarded unused medications in your trash within the past 12 months?"; and (4) "Have you discarded unused medications by flushing them in the toilet within the past 12 months?". These items were combined into a single item to assess any disposal of prescription drugs within the past 12 months. Organized disposal was assessed by combining (1) and (2), and home disposal was assessed by combining (3) and (4).

Grade of Child, Single Parent, and Grandparent Raising Grandchildren. The type of school (categorized as elementary, middle, or high school) that the child of the parent attended was used as a covariate. This item was provided in the dataset but was not queried on the surveys. The item assessing whether or not the parent was single was

only included of the survey of elementary school parents. “Are you a grandparent raising your grandchildren?” was asked of all parents.

Medical Insurance. Any health insurance coverage and type of health insurance coverage was used as a covariate. Three items assessed health insurance coverage: (1) “Do you have private insurance?”; (2) “Do you have a medical card?”; and (3) “Do you have KCHIP (KY Children’s Health Insurance Program)?”. Items (2) and (3) were combined into a single item to assess government-assisted health insurance. Health insurance was trichotomized – private health insurance, government-assisted health insurance, and no health insurance.

Assistance Covariates. Several items assessed different needs of the parents. We created the following three needs: (1) basic, (2) substance misuse prevention or treatment, and (3) abuse at home. Assistance with basic needs was asked of all parents and consisted of food, clothing, and housing. Needs with substance misuse prevention or treatment and abuse at home were only asked of parents of middle and high school age adolescents. The following response options to the stem – “Do you need help with the following?” - were combined to create the need assistance with substance misuse prevention or treatment: ‘tobacco education/treatment,’ ‘alcohol education/treatment,’ ‘illegal drug use education/treatment,’ ‘prescription drug education/treatment,’ ‘inhalant abuse,’ ‘community resources available to treat alcohol/drug abuse issues,’ and ‘parenting classes to address alcohol/tobacco/drug use.’ The following response options to the stem – “Do you need help and/or information about the following?” – were combined to create the assistance with abuse at home item: ‘domestic violence’ and ‘abuse in the home.’

Permissive and Protective Factors. All parents were queried on their permissiveness to underage drinking (UAD) party attendance. The following two items were combined to create the permissive to UAD parties: “Would you approve of your child attending a party where youth their age were drinking?” and “Would you approve of your child attending a party where adults are providing alcohol to youth (not their child)?”. Protective factors were only asked of elementary school parents. The following items were combined to create a protective behaviors item: “Do you read to your children?,” “Do you help your child with homework during the week?,” and “Would you be interested in serving as a volunteer at your child’s school?.”

Awareness of Organized Disposal Opportunities. Two items assessed whether or not parents were aware of disposal opportunities in their communities: (1) “Do you know if your community participates in the DEA Rx Take Back Events?” and (2) “Do you know if your community has permanent Rx Disposal sites where you can drop off your unused medications?”.

Access to Prescription Drugs. Three items were used to assess whether a member of the household had been prescribed a controlled prescription drug within the past 12 months: “Has someone in your household been prescribed a (1) pain killer/(2) medication for ADHD/(3) medication for anxiety within the past 12 months?”.

Data Analysis

Analyses consisted of descriptive statistics and multivariate logistic regression. Bivariate and multivariate logistical regression were conducted to examine correlates with disposal. A post hoc multivariate logistic regression analysis was conducted to

examine the correlates of awareness of disposal opportunities. Only variables that were included on both surveys were included in the multivariate logistic regression analysis. All analyses were restricted to parents who lived with someone who has been prescribed a controlled prescription medication within the last year. All analyses were computed using SPSS version 24 (IBM Corp., Armonk, NY).

Results

Sample and Community Characteristics

As shown in Table 5.1, about half of the sample had a child in elementary school, 28.3% had a child in middle school, and 15.3% had a child in high school. About a quarter were single parents and approximately 5% were a grandparent raising a grandchild. The majority had either private (56.8%) or government (26.7%) insurance and the remaining were uninsured. Approximately 13% needed assistance with basic needs such as food or clothing. A small number of parents needed assistance with substance abuse prevention or treatment (1.2%) or abuse in the home (0.5%). The majority of the sample conducted protective behaviors (97.5%) and a small percentage were permissive of their child attending a party where drinking would be present (1.1%).

Table 5.1 Sample Characteristics

	Overall Sample (n=6,981) N (%)	Household Prescribed RX in Past Year (n=2,300) N (%)	Any Disposal* (n=788) N (%)	Organized Disposal* (n=278) N (%)
Grade of Child				
Elementary	3,938 (56.4)	1,296 (55.7)	464 (58.9)	159 (57.2)
Middle	1,975 (28.3)	648 (27.8)	207 (26.3)	76 (27.3)
High	1,068 (15.3)	384 (16.5)	117 (14.8)	43 (15.5)
Single[1]	1,032 (27.1)	345 (27.3)	128 (28.4)	
Grandparent Raising Grandchildren	321 (4.8)	159 (7.0)	54 (7.1)	25 (9.5)
Type of Insurance				
Private insurance	3,801 (56.8)	1,429 (63.3)	496 (64.8)	165 (62.5)
Government (Medicaid and/or K-Chip)	1,861 (26.7)	629 (27.8)	206 (26.9)	78 (29.5)
None	1,025 (15.3)	201 (8.9)	63 (8.2)	21 (8.0)
Needs help with basic needs	872 (12.8)	302 (13.2)	112 (14.5)	39 (14.8)
Needs help with substance misuse prevention/Txt[2]	37 (1.2)	19 (1.8)	8 (2.5)	2 (1.7)
Needs help with domestic violence & abuse at home[2]	15 (0.5)	11 (1.1)	1 (0.3)	0 (0.0)
Permissive of UAD party attendance	73 (1.1)	37 (1.6)	27 (3.4)	24 (8.7)
Protective Behaviors[1]	2,565 (97.5)	796 (98.5)	286 (98.6)	98 (99.0)
Awareness of Disposal Opportunities				
Any (Event or Drop-Box)	1,829 (26.2)	901 (39.0)	407 (51.7)	242 (68.9)
Take-Back Events	1,393 (21.6)	701 (30.6)	380 (48.3)	175 (68.6)
Drop-Box	1,220 (19.0)	598 (26.2)	280 (36.6)	197 (74.9)
Type of RX Prescribed*				
Pain reliever	1,529 (23.6)	1,529 (66.2)	565 (72.1)	195 (70.7)
ADHD	860 (13.3)	860 (37.1)	300 (38.3)	124 (44.9)
Anxiolytic	978 (15.1)	978 (42.2)	359 (45.8)	124 (45.1)

Method of disposal*				
None	5,145 (78.8)	1,535 (66.1)	-	-
Any	1,388 (21.2)	788 (33.9)	788 (100)	-
Take-Back Event	389 (6.3)	215 (9.8)	215 (28.9)	215 (78.8)
Permanent Disposal Unit	370 (6.0)	218 (10.0)	218 (29.3)	218 (80.7)
Flush	436 (6.8)	294 (12.8)	294 (38.0)	38 (14.4)
Trash	654 (10.1)	345 (15.0)	345 (15.0)	28 (10.8)

*Restricted to those who reported having a RX in the household within the past year.
[1]Only asked on the elementary school parent survey.
[2]Only asked on the middle and high school parent survey.

Participants' children attended a school within a county with a population of 113,792. The median age of the county was 32.7. The majority of the population was White (83.6%) followed by African American (9.1%) and Hispanic (4.5%). There were 19.1% of the residents living in poverty and 18.8% under 65 years of age without insurance (U.S. Census Bureau, 2010).

Parent Disposal Practices

Of the 2,300 households prescribed a controlled medication in the past year, 33.9% disposed of unused prescription medications. Of those who disposed, 9.8% used a take-back event, 10.0% used a drop-box, 12.8% flushed the medication in a toilet, and 15.0% threw the medication away in the trash (Figure 5.1). Disposal practices were not mutually exclusive and multiple mechanisms of disposal were reported.

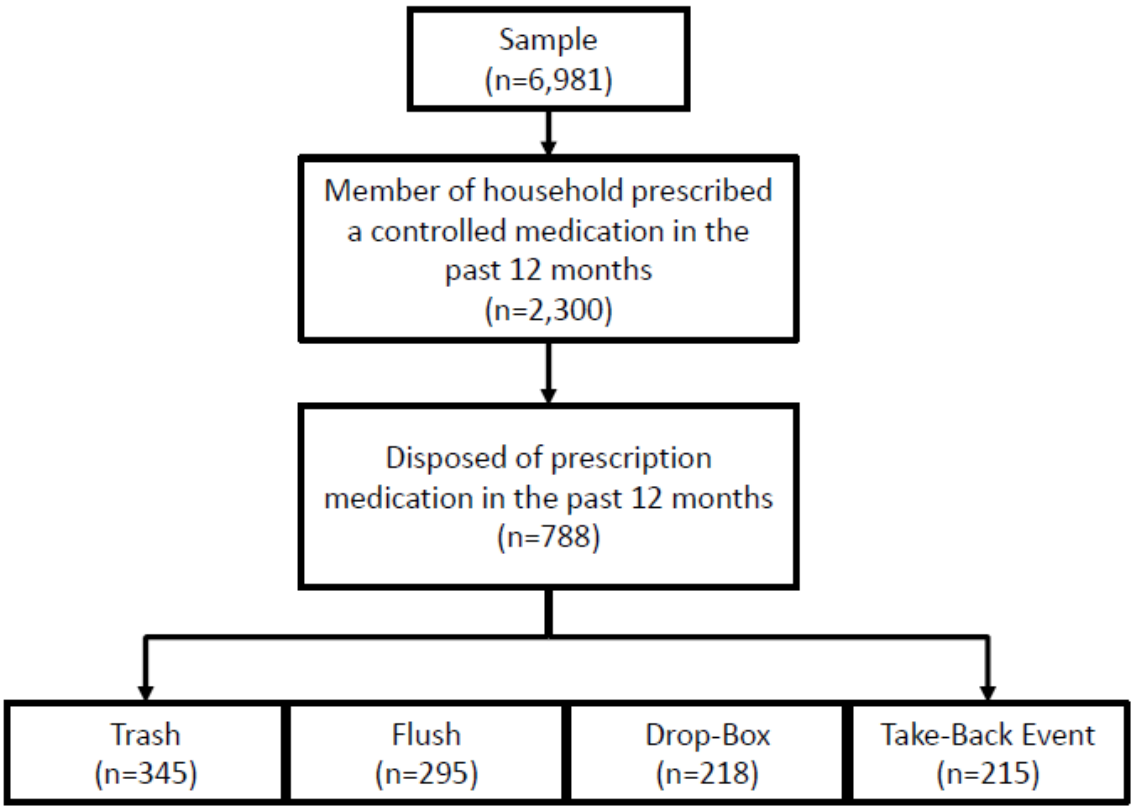

Figure 5.1. Flow Chart of Participants' Disposal Practices

Multivariate Logistic Regression

Any vs. No Disposal (Table 5.2). After controlling for possible covariates, parents who were aware of any organized disposal were more likely to dispose of unused medications compared to those who were not aware (AOR=1.70; 95% CI: 1.41, 2.03; p<0.001). Parents were significantly more likely to dispose of unused medications if their household had been prescribed a painkiller (AOR=1.64; 95% CI: 1.32, 2.03; p<0.001), ADHD medication (AOR=1.25; 95% CI: 1.02, 1.53; p=0.029), or an anxiolytic (AOR=1.38; 95% CI: 1.14, 1.68; p>0.001) compared to being prescribed another medication in the past year.

Organized vs. No Disposal (Table 5.2). Parents who were permissive of UAD parties were significantly more likely to dispose of unused medications using organized disposal opportunities compared to parents who did not approve of UAD parties (AOR=6.4; 95% CI: 2.29, 17.86; p<0.001). Parents who were aware of any organized disposal were significantly more likely to dispose of their unused medications using organized disposal opportunities compared to those who were not aware (AOR=12.47; 95% CI: 8.40, 18.55; p<0.001). Parents were significantly more likely to dispose of unused medications using organized disposal opportunities if their household had been prescribed an ADHD medication compared to being prescribed another medication in the past year (AOR=1.38; 95% CI: 1.01, 1.90; p=0.042).

Home vs. No Disposal (Table 5.2). Parents who were aware of any organized disposal were significantly less likely to dispose of unused medications at home compared to those who were not aware (AOR=0.63; 95% CI: 0.50, 0.80; p<0.001). Parents were significantly more likely to dispose of unused medications at home if their household had been prescribed a painkiller (AOR=1.99; 95% CI: 1.54, 2.57; p<0.001) or an anxiolytic (AOR=1.56; 95% CI: 1.27, 1.99; p>0.001) compared to being prescribed another medication in the past year.

Organized vs. Home Disposal (Table 5.2). Parents who were aware of any organized disposal were significantly more likely to dispose of unused medications at organized disposal opportunities compared to those who were not aware (AOR=1.60; 95% CI: 1.16, 2.01; p<0.001). Parents were significantly less likely to dispose of unused medications using organized disposal if their household had been prescribed a pain

reliever (AOR=0.50; 95% CI: 0.39, 0.65; p>0.001) or an anxiolytic (AOR=0.63; 95% CI: 0.50, 0.79; p>0.001) compared to being prescribed another medication in the past year.

Table 5.2 Multivariate Logistic Regression by Disposal Type (n=2,300)

	Any Disposal Vs. None AOR (95% CI); p-value	Organized Disposal Vs. None AOR (95% CI); p-value	Home Disposal Vs. None AOR (95% CI); p-value	Organized Disposal Vs. Home AOR (95% CI); p-value
Grade of child				
Elementary	-	-	-	-
Middle	0.91 (0.73, 1.13); 0.398	1.08 (0.76, 1.52); 0.673	0.85 (0.66, 1.09); 0.198	1.18 (0.92, 1.52); 0.198
High	0.79 (0.61, 1.0); 0.082	0.96 (0.63, 1.44); 0.825	0.76 (0.55, 1.03); 0.074	1.33 (0.97, 1.80); 0.074
Grandparent raising grandchild	0.89 (0.62, 1.28); 0.537	0.96 (0.56, 1.64); 0.869	0.82 (0.53, 1.28); 0.384	1.22 (0.78, 1.90); 0.384
Type of insurance				
Private insurance	-	-	-	-
Government (Medicaid/K-Chip)	0.90 (0.72, 1.13); 0.374	1.13 (0.80, 1.61); 0.490	0.80 (0.62, 1.03); 0.088	1.25 (0.97, 1.62); 0.088
None	0.92 (0.65, 1.29); 0.618	0.95 (0.54, 1.66); 0.852	0.88 (0.59, 1.31); 0.525	1.14 (0.77, 1.69); 0.525
Needs help with basic needs	1.27 (0.96, 1.68); 0.096	1.17 (0.74, 1.85); 0.493	1.27 (0.92, 1.76); 0.144	0.79 (0.57, 1.09); 0.144
Permissive of UAD party	2.19 (0.94, 5.10); 0.070	6.40 (2.29, 17.86); 0.001	0.48 (0.10, 2.23); 0.347	2.09 (0.45, 9.77); 0.347
Awareness of disposal opportunities	1.70 (1.41, 2.04); 0.001	12.47 (8.40, 18.55); 0.001	0.63 (0.50, 0.80); 0.001	1.60 (1.16, 2.01); 0.001
Type of RX prescribed*				
No controlled medication	-	-	-	-
Pain reliever	1.64 (1.32, 2.03); 0.001	1.13 (0.80, 1.59); 0.494	1.99 (1.54, 2.57); 0.001	0.50 (0.39, 0.65); 0.001
ADHD	1.25 (1.02, 1.53); 0.029	1.38 (1.01, 1.90); 0.042	0.17 (0.93, 1.49); 0.166	0.85 (0.67, 1.07); 0.166
Anxiolytic	1.38 (1.14, 1.68); 0.001	1.14 (0.84, 1.56); 0.400	1.56 (1.27. 1.99); 0.001	0.63 (0.50, 0.79); 0.001

Awareness of Disposal Opportunities

Multivariate logistic regression illustrated that parents who were aware of any organized disposal were significantly more likely to dispose of unused medications at organized disposal opportunities (Table 5.2). However, 28.7% of parents who were aware of organized disposal opportunities and had a household prescribed a controlled medication within the past year did not use organized disposal opportunities (Table 5.3).

Table 5.3 Awareness and Use of Organized Disposal Opportunities (n=2,300)

		Use of organized disposal opportunities	
		Yes	No
Awareness of organized disposal opportunities	Yes	242 (10.5%)	659 (28.7%)
	No	36 (1.6%)	1,435 (62.4%)

Grandparents who were raising grandchildren (AOR=1.43; 95% CI: 1.02, 2.00; p=0.041) and parents who were permissive of underage drinking parties (AOR=2.42; 95% CI: 1.04, 5.63; p=0.041) were more likely to be aware of organized disposal opportunities. Parents were significantly more likely to be aware of organized disposal opportunities if their household had been prescribed a pain reliever (AOR=1.69; 95% CI: 1.37, 2.08; p>0.001) or an ADHD medication (AOR=1.27; 95% CI: 1.05, 1.54; p=0.016) compared to being prescribed another medication in the past year (Table 5.4).

Table 5.4 Logistic Regression of Awareness of Organized Disposal Opportunities (n=2,300)

	Bivariate Aware Vs. Not Aware OR (95% CI); p-value	**Multivariate** Aware Vs. Not Aware AOR (95% CI); p-value
Grade of child		
Elementary	-	-
Middle	0.92 (0.76, 1.11); 0.383	0.93 (0.75, 1.14); 0.488
High	0.94 (0.75, 1.19); 0.630	0.93 (0.73, 1.20); 0.583
Single parent*	0.95 (0.73, 1.22); 0.667	-
Grandparent raising grandchild	1.47 (1.07, 2.04); 0.019	1.43 (1.02, 2.00); 0.041
Type of insurance		
Private insurance	-	-
Government (Medicaid and/or K-Chip)	0.83 (0.68, 1.00); 0.055	0.86 (0.69, 1.06); 0.153
None	0.79 (0.58, 1.08); 0.138	0.78 (0.56, 1.08); 0.133
Needs help with basic needs	0.86 (0.67, 1.11); 0.249	0.83 (0.62, 1.09); 0.178
Needs help with substance misuse prevention/txt*	1.19 (0.48, 2.99); 0.710	-
Permissive of UAD party attendance	5.01 (2.36, 10.68); 0.001	2.42 (1.04, 5.63); 0.041
Protective behaviors*	0.93 (0.29, 2.95); 0.900	-
Type of RX prescribed		
Pain reliever	1.59 (1.32, 1.91); 0.001	1.69 (1.37, 2.08); 0.001
ADHD	1.04 (0.87, 1.23); 0.685	1.27 (1.05, 1.54); 0.016
Anxiolytic	1.07 (0.900, 1.26); 0.456	1.17 (0.97, 1.42); 0.096

*Not included in the multiple logistic analyses due to only being asked on one of two surveys and insignificant in bivariate analysis.

Discussion

To our knowledge, this was the first study to examine medicine disposal behaviors of parents of adolescents. We found that 2,300 participants resided in a household where someone had been prescribed a controlled medication (e.g., pain reliever, ADHD medication, and anxiolytic) in the past year and, of those, only 33.1% reported disposing an unused or expired medication in the past year. Among those who disposed of a medication in the past year 15% used the trash, 13% flushed the medication

down the toilet, 10% used a take-back event, and 10% used a drop-box (not mutually exclusive; Figure 5.1). Our findings corroborate previous studies that found if people dispose of their medications, they are more likely to throw them in the trash or flush them down the toilet (Bates et al., 2011; Kuspis & Krenzelok, 1996; Law, Schier, Martin, Chang, & Wolkin, 2015), and expand upon them by specifically examining take-back event and drop-boxes among parents of adolescents. While we did not assess the number of households with excess medications, previous studies found that 67%-98% (Bates et al., 2011; Kuspis & Krenzelok, 1996; Lewis et al., 2014) individuals do not use all of their prescribed medications which suggests that more than 44% of our sample did not use all of their prescribed medication.

The positive and statistically significant relationship between awareness and use of organized disposal opportunities suggests that parents who are made aware of organized disposal opportunities may be more likely to use them compared to parents who are not aware. Likewise, parents who were aware of organized disposal were less likely to use home disposal practices which has both positive diversion and environmental implications. This finding is similar to that of other studies which found an increase in self-reported disposal following exposure to the campaign or educational program about medication disposal (de la Cruz et al., 2016; Maughan et al., 2016; Seehusen & Edwards, 2006; Yanovitzky, 2016). Our findings, in conjunction with previous studies, support the need to implement more effective awareness campaigns that reach a greater number of parents in order to encourage disposal of controlled medications. However, not all parents who were aware of disposal opportunities used

them (28.7%) indicating that research is needed to assess barriers and facilitators of disposal.

Having a member in the household prescribed a controlled medication (i.e., pain reliever, ADHD medication, or anxiolytic) was correlated with awareness of organized disposal opportunities and any type of disposal practice. One of the strategies used to market organized disposal strategies was to affix labels with the drop-box location on pill bottles and include information about prescription drug misuse with the controlled medication. The use of this strategy may account for our findings related to awareness of disposal opportunities. Even though individuals may have been more aware of disposal opportunities, they were still more likely to retain or dispose of their medications at home. Additional research is needed to assess barriers and facilitators to using drop-boxes and take-back events.

Parents who were permissive of underage drinking parties were more aware of and more likely to use organized disposal opportunities than not disposing of their medications at all. Previous research suggests that parents who are permissive of underage drinking parties were more likely to reduce harms associated with underage drinking (e.g., drinking and driving) and teaching their children to drink responsibly (Friese, Grube, Moore, & Jennings, 2012). While we did not assess motivations for disposal, parents who were permissive of underage drinking parties may be more aware of substance abuse prevention efforts in their community and more likely to dispose of unused or expired medications as one mechanism to reduce the harms that could occur at an underage drinking party (e.g., simultaneous consumption of prescription medications

and alcohol (Egan, Reboussin, Blocker, Wolfson, & Sutfin, 2012; S. McCabe, Cranford, Morales, & Young, 2006)). An alternative explanation is that parent permissiveness of underage drinking parties may be a proxy for an unmeasured variable, specifically White race (Peterson, Hawkins, Abbott, & Catalano, 1994). Further research is needed to examine parental motives for disposal of prescription medications.

Assumptions and Limitations

There are several disadvantages to utilizing secondary data collection including the lack of all measures desired and inability to influence data collection (Smith et al., 2011). The parent survey data does not include general demographics which are typically included in regression analysis, such as gender, age of participant, and race/ethnicity. The options for disposal were restricted to the most common disposal practices; if other disposal methods were practiced, they were not captured. While we know which school (i.e., elementary, middle, high) administered the survey, we do not know if the parent has multiple children at the same or different schools (e.g., the parent participated in the elementary school survey but also has a child in middle school). If a parent has multiple children in different schools (e.g., elementary and middle) they may have been invited and, subsequently, participated in the survey twice. While we know whether or not someone in the household was prescribed a controlled medication, we are not able to discern the type (e.g., controlled vs. non-controlled prescription or classification of controlled medication) of prescription medication that was disposed. Our study was conducted in south central Kentucky and may not be generalizable to other communities.

Conclusion

Currently, research on the use of drop-boxes and take-back events is limited. Most studies have focused on quantity and type of medications disposed through organized disposal opportunities (Egan et al., 2016; Gray et al., 2015; Gray & Hagemeier, 2012; Ma et al., 2014; Stewart et al., 2014). Egan et al (2016) found that organized disposal accounted for 0.3% of all controlled medications dispensed in the study community and called for research to improve this strategy. Our findings suggest that increasing awareness of disposal opportunities is a promising mechanism to increase the use of organized disposal opportunities among parents of adolescents. Future research should assess approaches to messaging and message delivery to increase awareness and use of organized disposal opportunities. Also, given that not all parents aware of disposal opportunities used them, research is needed to assess barriers and facilitators of disposal.

CHAPTER VI

DISCUSSION

Summary of Findings

The purpose of this dissertation was to examine the implementation and use of community-based prescription drug disposal programs. The two studies that were conducted as part of this dissertation examined (1) the diffusion of drop-boxes in North Carolina and community characteristics associated with drop-box implementation and (2) disposal of unused prescription drugs by parents of adolescents. These studies build on my previous research on prescription drug disposal programs which examined the number of controlled medications disposed at take-back events and drop-boxes to the number dispensed in the same county (Egan et al., 2016). My colleagues and I found that only 0.3% of controlled medications dispensed were subsequently disposed using a prescription drug disposal program. Given these findings, we called for community agencies to focus on a comprehensive approach which addresses both the prescribing of controlled medications along with providing opportunities for the disposal, and for the improvement of prescription drug disposal programs. This dissertation was the first step to inform the improvement of prescription drug disposal programs.

In order to understand how drop-boxes could be improved, first, I needed to examine how widespread drop-boxes had been implemented and where they had been installed (e.g., law enforcement agencies, pharmacies, etc.). The objective of the first

study included in this dissertation, entitled *"Diffusion of Medication Drop-Boxes in North Carolina from 2007 to 2016,"* aimed to examine the diffusion of drop-boxes in North Carolina through the lens of Rogers' Diffusion of Innovations. I found that there were 311 drop-boxes implemented in 91 counties from 2007 through 2016, and the majority were located in law enforcement agencies but a growing number were being implemented in pharmacies. Among pharmacy drop-boxes, initially, the majority were in locally-owned pharmacies but Walgreens implemented 22 drop-boxes in 2016. The engagement of a corporate pharmacy in prescription drug disposal may have a substantial impact in drop-box utilization. In order to examine community characteristics which may have facilitated the implementation of drop-boxes, Rogers' Diffusion of Innovations was applied to a community context. I found that counties with a higher percentage of whites, more educated residents, substance abuse prevention coalition, higher rates of controlled medications dispensed and prescription opioid overdose, and considered to be Appalachian were more likely to be early adopters. In a multivariate model, level of education and rates of controlled medicines dispensed were the only significant covariates. Not only did these findings elucidate community characteristics that may have facilitated early adoption of drop-boxes, they also confirmed that communities with a larger need for drop-boxes, based on high prescribing and opioid overdose death rates, were more likely to implement drop-boxes earlier.

Given that prescription drug disposal is a primary prevention strategy intended to prevent initiation of NMPDU among adolescents by reducing the availability of prescription drugs in the home, it was important to examine how parents of adolescents

were utilizing prescription drug disposal programs. The objective of the second study in this dissertation, entitled *"Disposal of prescription drugs by parents of elementary, middle, and high school students,"* was to assess prescription drug disposal practices of parents of adolescents. I found that among 2,300 parents residing in a household prescribed a controlled medication in the past year, only 33.9% disposed of their unused medications. Of those who disposed, 9.8% used a take-back event, 10.0% a drop-box, 12.8% flushed the medication in a toilet, and 15.0% threw the medication in the trash. Use of prescription drug disposal programs (i.e., take-back event or drop-box) was associated with awareness of these opportunities, receiving a prescription for ADHD, and permissiveness of underage drinking parties. Being a grandparent raising a grandchild, permissiveness of underage drinking parties, and being prescribed pain relievers or prescriptions for ADHD were associated with awareness of prescription drug disposal programs. Given that awareness of disposal programs is related to utilization, developing and implementing effective awareness campaigns should be a priority of both research and practice.

Future Research and Public Health Practice

Future Research

The body of literature on community-based disposal programs is growing but still in its infancy. Additional research is needed as prescription drug disposal programs, especially drop-boxes, continue to be implemented in communities. I only assessed the implementation of drop-boxes in NC. Thus, research is needed to determine the diffusion of drop-boxes in other states. While I found that NC had 311 drop-boxes installed in 91

counties, it is not evident how accessible these drop-boxes are to the general population. In order to determine the accessibility of drop-boxes, future research should examine how far individuals need to travel to their closest drop-box, how far away drop-boxes are from pharmacies, and the hours of operation of the drop-boxes in order. Given that the published studies, thus far, have focused on take-back events and drop-boxes located at law enforcement agencies, research is especially needed to examine drop-boxes implemented at pharmacies. Specifically, it is important to study the diffusion of drop-boxes at pharmacies, the motivations for- and barriers to implementation, and the utilization of pharmacy drop-boxes (e.g., quantity of controlled medications disposed).

The findings from the second study in this dissertation suggest that increasing awareness of disposal opportunities will increase their utilization. Thus, research to develop effective media and awareness campaigns should be a priority. This research should encompass both effective content and delivery of messaging to influence diffusion. Additionally, future studies should expand the focus beyond self-reported and observed disposal of prescribed medications and assess attitudes and norms pertaining to prescription medicine disposal.

Public Health Practice

First and foremost, states and communities should ensure that there is a comprehensive and accurate list of drop-boxes easily accessible to residents. While there were several lists available in NC, they were not accurate or up-to-date. This is a deterrent for community members to use these disposal programs. States should assess the extent of implementation across the communities to ensure that there are enough

disposal opportunities to serve their residents, especially in areas that may be at higher risk. While NC had 311 drop-boxes installed in 91 counties, I question if that is really sufficient for a state with a population of 9,845,333 spread across 53,819 square miles (United States Census Bureau / American FactFinder, 2015). Additionally, accessibility to drop-boxes should be maximized in order to make it easier for individuals to use them.

While some communities provided multiple messages on various platforms (e.g., Facebook, websites, local newspapers) pertaining to the availability of drop-boxes, many did not. Community organizations should ensure that their residents are aware of disposal opportunities, especially given our finding pertaining to the association between awareness and use of disposal programs. Additionally, community organizations should assess the population that should be targeted with messages pertaining to disposal and tailor messages specifically to that group. Given the age of initiation of NMPDU, adolescents and parents of adolescents should be considered target populations in every community.

Table 6.1 Research and Practice Implications

Future Research	Practice
• Diffusion of drop-boxes in other states • Accessibility of drop-boxes • Impact of drop-boxes at pharmacies • Effective messaging (content & delivery) to influence the use of disposal opportunities • Impact of disposal opportunities on attitudes & norms pertaining to prescription drug disposal	• Comprehensive approach that includes both addressing prescribing of controlled medications & disposal • Increase awareness of disposal opportunities • Increase accessibility of drop-boxes • Implementation of evidence-based messaging • Evaluation of current disposal efforts

With over 3.9 billion controlled medications being dispensed by retail pharmacies annually (CDC, 2015b) and many going unused (Bates et al., 2011; Kuspis & Krenzelok, 1996; Lewis et al., 2014), it is imperative that practice and research is also devoted to minimizing the number of controlled medications prescribed and, subsequently, dispensed into communities. Efforts have already been made to intervene with "criminal prescribers" and "pill mills" through law enforcement operations, such as the DEA's "Operation Pilluted" (DEA, 2015a) and state pain clinic laws (CDC, 2012). Prescription Drug Monitoring Programs (PDMPs) have been implemented in all but one of 50 states (NAMSDL, 2014). There have been several studies conducted which suggest that implementation of a strong PDMP is a promising strategy to reduce high-risk prescribing (Gilson et al., 2012), NMPDU (Reifler et al., 2012), and overdose (Delcher et al., 2015). Medical associations (Chou et al., 2009; Gudin, 2012) and the CDC (CDC, 2015c) have issued guidelines on prescribing controlled medications with abuse potential, and prescribers are being trained to follow these new guidelines and best practices for prescribing controlled medications (Brown et al., 2012; Cochella et al., 2011).

Despite being implemented in practice for at least 10 years (according to my findings) the research on prescription drug disposal programs is limited but increasing. It is imperative that researchers, public health educators, and practitioners work together to improve, implement, and evaluate this strategy within the context of a comprehensive approach, which also addresses the prescribing of controlled medications, to address NMPDU and associated consequences.

REFERENCES

Adam, C. T. (1981). A descriptive definition of primary prevention. *Journal of Primary Prevention*, *2*(2), 67–79. https://doi.org/10.1007/BF01333744

Ajzen, I. (1991). The theory of planned behavior. *Organizational Behavior and Human Decision Processes*, *50*(2), 179–211. https://doi.org/10.1016/0749-5978(91)90020-T

APHA. (2015). Prevention and Intervention Strategies to Decrease Misuse of Prescription Pain Medication. Retrieved May 23, 2016, from https://www.apha.org/policies-and-advocacy/public-health-policy-statements/policy-database/2015/12/08/15/11/prevention-and-intervention-strategies-to-decrease-misuse-of-prescription-pain-medication

Austic, E., McCabe, S. E., Stoddard, S. A., Ngo, Q. E., & Boyd, C. (2015). Age and Cohort Patterns of Medical and Nonmedical Use of Controlled Medication Among Adolescents: *Journal of Addiction Medicine*, *9*(5), 376–382. https://doi.org/10.1097/ADM.0000000000000142

Babor, T., Caetano, R., Casswell, S., Edwards, G., Giesbrecht, N., Graham, K., … Rossow, I. (2010). *Alcohol: No Ordinary Commodity* (2nd ed.). Oxford: Oxford University Press. Retrieved from https://books.google.com/books/about/Alcohol_No_Ordinary_Commodity.html?id=bbcdAAAAQBAJ

Babor, T., Caulkins, J., Edwards, G., Fischer, B., Foxcroft, D., Humphreys, K., … Strang, J. (2010). *Drug Policy and the Public Good*. New York: Oxford University Press. Retrieved from

http://www.oxfordscholarship.com/view/10.1093/acprof:oso/9780199557127.001.0001/acprof-9780199557127

Bates, C., Laciak, R., Southwick, A., & Bishoff, J. (2011). Overprescription of postoperative narcotics: a look at postoperative pain medication delivery, consumption and disposal in urological practice. *The Journal of Urology*, *185*(2), 551–555. https://doi.org/10.1016/j.juro.2010.09.088

Berning, A., Compton, R., & Wochinger, K. (2015). *National Roadside Survey of alcohol and drug use by drivers* (No. DOT HS 812 118). Washington, DC: National Highway Traffic Safety Administration. Retrieved from http://www.trb.org/Main/Blurbs/172097.aspx

Bloom, M. (1980). A working definition of primary prevention related to social concerns. *The Journal of Prevention*, *1*(1), 15–23. https://doi.org/10.1007/BF01114540

Bradburn, M. J., Clark, T. G., Love, S. B., & Altman, D. G. (2003a). Survival Analysis Part II: Multivariate data analysis – an introduction to concepts and methods. *British Journal of Cancer*, *89*(3), 431–436. https://doi.org/10.1038/sj.bjc.6601119

Bradburn, M. J., Clark, T. G., Love, S. B., & Altman, D. G. (2003b). Survival Analysis Part III: Multivariate data analysis – choosing a model and assessing its adequacy and fit. *British Journal of Cancer*, *89*(4), 605–611. https://doi.org/10.1038/sj.bjc.6601120

Bronfenbrenner, U. (1977). Toward an experimental ecology of human development. *American Psychologist*, *32*(7), 513–531. https://doi.org/10.1037/0003-066X.32.7.513

Brown, M. E., Swiggart, W. H., Dewey, C. M., & Ghulyan, M. V. (2012). Searching for answers: proper prescribing of controlled prescription drugs. *Journal of Psychoactive Drugs*, *44*(1), 79–85.

Bruneau, J., Roy, É., Arruda, N., Zang, G., & Jutras-Aswad, D. (2012). The rising prevalence of prescription opioid injection and its association with hepatitis C incidence among street-drug users. *Addiction*, *107*(7), 1318–1327. https://doi.org/10.1111/j.1360-0443.2012.03803.x

CADCA. (2014, August 7). Coalitions in action: michigan coalition combats prescription drug abuse with red med boxes. Retrieved August 15, 2014, from http://www.cadca.org/resources/detail/coalitions-action-michigan-coalition-combats-prescription-drug-abuse-red-med-boxes

CDC. (2010). *Adult Use of Prescription Opioid Pain Medications --- Utah, 2008* (MMWR No. 59(06)) (pp. 153–157). Retrieved from https://www.cdc.gov/mmwr/preview/mmwrhtml/mm5906a1.htm

CDC. (2012). Menu of pain management clinic regulation. Retrieved from http://www.cdc.gov/phlp/docs/menu-pmcr.pdf

CDC. (2015a). National vital statistics system mortality data. Retrieved June 11, 2015, from http://www.cdc.gov/nchs/deaths.htm

CDC. (2015b, April 3). Data Overview. Retrieved April 19, 2015, from http://www.cdc.gov/drugoverdose/data/index.html

CDC. (2015c, October 16). Draft CDC Guideline for Prescribing Opioids for Chronic Pain. Retrieved from http://www.cdc.gov/drugoverdose/prescribing/guideline.html

Center for Behavioral Health Statistics and Quality. (2015). *Behavioral Health Trends in the United States: Results from the 2014 National Survey on Drug Use and Health* (NSDUH Series H-50 No. HHS Publication No. SMA 15-4927). Retrieved from Retrieved from http://www.samhsa.gov/ data/

Chen, L., Hedegaard, H., & Warner, M. (2015). *Quickstats: rates of deaths from drug poisoning and drug poisoning involving opioid analgesics — united states, 1999–2013* (Morbidity and Mortality Weekly Report No. 64). Hyattsville, MD. Retrieved from http://www.cdc.gov/mmwr/preview/mmwrhtml/mm6401a10.htm

Chou, R., Fanciullo, G. J., Fine, P. G., Adler, J. A., Ballantyne, J. C., Davies, P., … Miaskowski, C. (2009). Clinical Guidelines for the Use of Chronic Opioid Therapy in Chronic Noncancer Pain. *The Journal of Pain*, *10*(2), 113–130.e22. https://doi.org/10.1016/j.jpain.2008.10.008

Cochella, S., & Bateman, K. (2011). Provider Detailing: An Intervention to Decrease Prescription Opioid Deaths in Utah. *Pain Medicine*, *12*, S73–S76. https://doi.org/10.1111/j.1526-4637.2011.01125.x

Compton, W. M., & Volkow, N. D. (2006). Abuse of prescription drugs and the risk of addiction. *Drug & Alcohol Dependence*, *83*, S4–S7. https://doi.org/10.1016/j.drugalcdep.2005.10.020

Conrad, C., Bradley, H. M., Broz, D., Buddha, S., Chapman, E. L., Galang, R. R., … Centers for Disease Control and Prevention (CDC). (2015). Community Outbreak of HIV Infection Linked to Injection Drug Use of Oxymorphone--Indiana, 2015. *MMWR. Morbidity and Mortality Weekly Report*, *64*(16), 443–444.

Cowen, E. L. (1982). Primary prevention research: Barriers, needs and opportunities. *Journal of Primary Prevention*, *2*(3), 131–137. https://doi.org/10.1007/BF01324206

DAWN. (2011). Analysis ran on 2016-08-24 (12:00 PM EDT) using SDA 3.5: Tables.

de la Cruz, M., Reddy, A., Balankari, V., Epner, M., Frisbee-Hume, S., Wu, J., … Bruera, E. (2016). The Impact of an Educational Program on Patient Practices for Safe Use, Storage, and

Disposal of Opioids at a Comprehensive Cancer Center. *The Oncologist*. https://doi.org/10.1634/theoncologist.2016-0266

DEA. (2010). American Public Overwhelmingly Responds to DEA Prescription Drug Take-Back Effort. Retrieved April 18, 2015, from http://www.dea.gov/divisions/hq/2010/pr100510p.html

DEA. (2014a). DEA and Partners Collect 309 Tons of Pills on Ninth Prescription Drug Take-Back Day. Retrieved April 19, 2015, from http://www.dea.gov/divisions/hq/2014/hq110514.shtml

DEA. Secure and Responsible Drug Disposal Act of 2010, Pub. L. No. 174, 79 21 CFR Parts 1300, 1301, 1304, 1305, 1307, and 1317 (2014). Retrieved from http://www.deadiversion.usdoj.gov/fed_regs/rules/2014/2014-20926.pdf

DEA. (2014c, September 23). DEA's Ninth and Final Prescription Drug Take Back Day Being Held Saturday September 27. Retrieved September 29, 2014, from http://www.justice.gov/dea/divisions/hq/2014/hq092314.shtml

DEA. (2015a, May 20). DEA Announces Largest-Ever Prescription Drug Operation. Retrieved September 19, 2015, from http://www.dea.gov/divisions/no/2015/no052015.shtml

DEA. (2015b, October 1). DEA'S Prescription Drug Take-Back Effort-- A Big Success. Retrieved December 11, 2015, from http://www.dea.gov/divisions/hq/2015/hq100115.shtml

DEA. (2016). DEA Collects Record-Setting Amount of Meds at Latest National Rx Take-Back Day. Retrieved May 20, 2016, from http://www.dea.gov/divisions/hq/2016/hq050616.shtml

DEA. (n.d.-a). Controlled Substance Public Disposal Locations - Search Utility. Retrieved May 24, 2017, from https://apps.deadiversion.usdoj.gov/pubdispsearch/spring/main?execution=e1s1

DEA. (n.d.-b). Disposal regulations: registrant fact sheet. Retrieved from http://www.deadiversion.usdoj.gov/drug_disposal/fact_sheets/disposal_registrant.pdf

DEA. (n.d.-c). Drug Scheduling. Retrieved April 24, 2017, from https://www.dea.gov/druginfo/ds.shtml

DEA. (n.d.-d). Practitioner's Manual - SECTION V. Retrieved April 24, 2017, from https://www.deadiversion.usdoj.gov/pubs/manuals/pract/section5.htm

Delcher, C., Wagenaar, A. C., Goldberger, B. A., Cook, R. L., & Maldonado-Molina, M. M. (2015). Abrupt decline in oxycodone-caused mortality after implementation of Florida's Prescription Drug Monitoring Program. *Drug and Alcohol Dependence*, *150*, 63–68. https://doi.org/10.1016/j.drugalcdep.2015.02.010

DeWit, D. J., Adlaf, E. M., Offord, D. R., & Ogborne, A. C. (2000). Age at first alcohol use: A risk factor for the development of alcohol disorders. *The American Journal of Psychiatry*, *157*(5), 745–50.

Dowell, D., Haegerich, T. M., & Chou, R. (2016). CDC Guideline for Prescribing Opioids for Chronic Pain — United States, 2016. *MMWR. Recommendations and Reports*, *65*(1), 1–49. https://doi.org/10.15585/mmwr.rr6501e1

Egan, K., Gregory, E., Sparks, M., & Wolfson, M. (2016). From dispensed to disposed: Evaluating the effectiveness of disposal programs through a comparison with prescription drug monitoring program data. *The American Journal of Drug and Alcohol Abuse*.

Egan, K., Reboussin, B., Blocker, J., Wolfson, M., & Sutfin, E. (2012). Simultaneous use of non-medical ADHD prescription stimulants and alcohol among undergraduate students. *Drug and Alcohol Dependence*. https://doi.org/10.1016/j.drugalcdep.2012.12.004

Erickson, P., Butters, J., Walko, K., Butterill, D., Caverson, R., Fischer, B., … Tupker, E. (2002, May). CAMH and Harm Reduction: A Background Paper on its Meaning and Application for Substance Use Issues. Retrieved September 14, 2015, from http://www.camh.ca/en/hospital/about_camh/influencing_public_policy/public_policy_submissions/harm_reduction/Pages/harmreductionbackground.aspx

Firozi, P. (2014). Prescription drug drop-off boxes spread across U.S. Retrieved April 19, 2015, from http://www.usatoday.com/story/news/nation/2014/07/11/prescription-drug-disposal-grants/12416887/

Fischer, B., & Murphy, Y. (2016). Policy Measures for Prescription Opioids and Harms: Enough to Protect Public Health? A Comment on Yanovitzky (2016) and Piper et al. (2016). *Journal of Studies on Alcohol and Drugs*, *77*(4), 566–567. https://doi.org/10.15288/jsad.2016.77.566

Fitzgerald, E. (2016). Walgreens adds local medicine disposal dropoff. Retrieved April 21, 2017, from http://www.newbernsj.com/business/20160804/walgreens-adds-local-medicine-disposal-dropoff

Florence, C. S., Zhou, C., Luo, F., & Xu, L. (2016). The Economic Burden of Prescription Opioid Overdose, Abuse, and Dependence in the United States, 2013: *Medical Care*, *54*(10), 901–906. https://doi.org/10.1097/MLR.0000000000000625

Friese, B., Grube, J. W., Moore, R. S., & Jennings, V. K. (2012). Parents' Rules about Underage Drinking: A Qualitative Study of Why Parents Let Teens Drink. *Journal of Drug Education*, *42*(4), 379–391. https://doi.org/10.2190/DE.42.4.a

Friese, B., Moore, R. S., Grube, J. W., & Jennings, V. K. (2013). How Parents of Teens Store and Monitor Prescription Drugs in the Home. *Journal of Drug Education*, *43*(3), 223–233. https://doi.org/10.2190/DE.43.3.b

Gilson, A. M., Fishman, S. M., Wilsey, B. L., Casamalhuapa, C., & Baxi, H. (2012). Time series analysis of California's prescription monitoring program: impact on prescribing and multiple provider episodes. *The Journal of Pain: Official Journal of the American Pain Society*, *13*(2), 103–111. https://doi.org/10.1016/j.jpain.2011.09.006

Goins, R. T., Williams, K. A., Carter, M. W., Spencer, S. M., & Solovieva, T. (2005). Perceived Barriers to Health Care Access Among Rural Older Adults: A Qualitative Study. *The Journal of Rural Health*, *21*(3), 206–213. https://doi.org/10.1111/j.1748-0361.2005.tb00084.x

Goldsworthy, R. C., Schwartz, N. C., & Mayhorn, C. B. (2008). Beyond Abuse and Exposure: Framing the Impact of Prescription-Medication Sharing. *American Journal of Public Health*, *98*(6), 1115–1121. https://doi.org/10.2105/AJPH.2007.123257

Goodnough, A. (2010, September 23). Police, Battling Wave of Crime, Urge Homeowners to Turn in Old Prescriptions. *The New York Times*. Retrieved from http://www.nytimes.com/2010/09/24/us/24drugs.html

Gray, J., Hagemeier, N., Brooks, B., & Alamian, A. (2015). Prescription Disposal Practices: A 2-Year Ecological Study of Drug Drop Box Donations in Appalachia. *American Journal of Public Health*, *105*(9), e1–e6. https://doi.org/10.2105/AJPH.2015.302689

Gray, J., & Hagemeier, N. E. (2012). Prescription drug abuse and DEA-sanctioned drug take-back events: characteristics and outcomes in rural Appalachia. *Archives of Internal Medicine*, *172*(15), 1186–1187. https://doi.org/10.1001/archinternmed.2012.2374

Green, L. W., Ottoson, J. M., García, C., & Hiatt, R. A. (2009). Diffusion theory and knowledge dissemination, utilization, and integration in public health. *Annual Review of Public Health*, *30*, 151–174. https://doi.org/10.1146/annurev.publhealth.031308.100049

Gudin, J. A. (2012). Clinical strategies for the primary health care professional to minimize prescription opioid abuse. *Postgraduate Medicine*, *124*(3), 131–138. https://doi.org/10.3810/pgm.2012.05.2556

Gullotta, T. P. (1994). The what, who, why, where, when, and how of primary prevention. *The Journal of Primary Prevention*, *15*(1), 5–14. https://doi.org/10.1007/BF02196343

Haider, M., & Kreps, G. L. (2004). Forty Years of Diffusion of Innovations: Utility and Value in Public Health. *Journal of Health Communication*, *9*(sup1), 3–11. https://doi.org/10.1080/10810730490271430

Harris, K., Curtis, J., Larsen, B., Calder, S., Duffy, K., Bowen, G., … Tristani-Firouzi, P. (2013). Opioid Pain Medication Use After Dermatologic Surgery: A Prospective Observational Study of 212 Dermatologic Surgery Patients. *JAMA Dermatology*, *149*(3), 317. https://doi.org/10.1001/jamadermatol.2013.1871

Hawkins, J. D., Graham, J. W., Maguin, E., Abbott, R., Hill, K. G., & Catalano, R. F. (1997). Exploring the Effects of Age of Alcohol Use Initiation and Psychosocial Risk Factors on Subsequent Alcohol Misuse. *Journal of Studies on Alcohol*, *58*(3), 280.

Hornik, R., & Yanovitzky, I. (2003). Using Theory to Design Evaluations of Communication Campaigns: The Case of the National Youth Anti-Drug Media Campaign. *Communication Theory*, *13*(2), 204–224. https://doi.org/10.1111/j.1468-2885.2003.tb00289.x

Jones, S. (2015). 46,471: Drug Overdoses Killed More Americans Than Car Crashes or Guns. Retrieved September 21, 2016, from http://www.cnsnews.com/news/article/susan-jones/dea-drug-overdoses-kill-more-americans-car-crashes-or-firearms

Jr, H., R, W., & Cg, L. (2008). Prescription opioid use in the rural Appalachia: a community-based study. *Journal of Opioid Management*, *4*(2), 63–71.

Kaiser Family Foundation. (2017). Prescription Opioid Overdose Deaths and Death Rate per 100,000 Population (Age-Adjusted). Retrieved April 16, 2017, from http://kff.org/other/state-indicator/prescription-opioid-overdose-deaths-and-death-rate-per-100000-population-age-adjusted/

Kenne, D. R., Hamilton, K., Birmingham, L., Oglesby, W. H., Fischbein, R. L., & Delahanty, D. L. (2016). Perceptions of Harm and Reasons for Misuse of Prescription Opioid Drugs and Reasons for Not Seeking Treatment for Physical or Emotional Pain Among a Sample of College Students. *Substance Use & Misuse*, 1–8. https://doi.org/10.1080/10826084.2016.1222619

Kennedy-Hendricks, A., Gielen, A., McDonald, E., McGinty, E. E., Shields, W., & Barry, C. L. (2016). Medication Sharing, Storage, and Disposal Practices for Opioid Medications Among US Adults. *JAMA Internal Medicine*, *176*(7), 1027. https://doi.org/10.1001/jamainternmed.2016.2543

Kirsh, K., Peppin, J., & Coleman, J. (2012). Characterization of Prescription Opioid Abuse in the United States: Focus on Route of Administration. *Journal of Pain & Palliative Care Pharmacotherapy*, *26*(4), 348–361. https://doi.org/10.3109/15360288.2012.734905

Knussen, C., Yule, F., MacKenzie, J., & Wells, M. (2004). An analysis of intentions to recycle household waste: The roles of past behaviour, perceived habit, and perceived lack of

facilities. *Journal of Environmental Psychology*, *24*(2), 237–246. https://doi.org/10.1016/j.jenvp.2003.12.001

Koester, S., Glanz, J., & Barón, A. (2005). Drug Sharing Among Heroin Networks: Implications for HIV and Hepatitis B and C Prevention. *AIDS and Behavior*, *9*(1), 27–39. https://doi.org/10.1007/s10461-005-1679-y

Kuspis, D. A., & Krenzelok, E. P. (1996). What happens to expired medications? A survey of community medication disposal. *Veterinary and Human Toxicology*, *38*(1), 48–49.

Law, R., Schier, J., Martin, C., Chang, A., & Wolkin, A. (2015). *Notes from the Field: Increase in Reported Adverse Health Effects Related to Synthetic Cannabinoid Use — United States, January–May 2015* (Morbidity and Mortality Weekly Report No. 64(22)) (pp. 618–619). Atlanta, GA: Centers for Disease Control and Prevention. Retrieved from http://www.cdc.gov/mmwr/preview/mmwrhtml/mm6422a5.htm?s_cid=mm6422a5_w

Levl, J., Segal, L., & Miller, A. (2013). *Prescription Drug Abuse: Strategies to Stop the Epidemic 2013*. Washington, D.C.: Trust for America's Health. Retrieved from http://healthyamericans.org/assets/files/TFAH2013RxDrugAbuseRpt16.pdf

Lewis, E. T., Cucciare, M. A., & Trafton, J. A. (2014). What do Patients do with Unused Opioid Medications? *The Clinical Journal of Pain*, *30*(8), 654–662. https://doi.org/10.1097/01.ajp.0000435447.96642.f4

Ma, C. S., Batz, F., Juarez, D. T., & Ladao, L. C. (2014). Drug Take Back in Hawaiʻi: Partnership Between the University of Hawaiʻi Hilo College of Pharmacy and the Narcotics Enforcement Division. *Hawai'i Journal of Medicine & Public Health*, *73*(1), 26–31.

Maddahian, E., Newcomb, M. D., & Bentler, P. M. (1986). Adolescents' substance use: impact of ethnicity, income, and availability. *Advances in Alcohol & Substance Abuse*, *5*(3), 63–78. https://doi.org/10.1300/J251v05n03_05

Maughan, B. C., Hersh, E. V., Shofer, F. S., Wanner, K. J., Archer, E., Carrasco, L. R., & Rhodes, K. V. (2016). Unused opioid analgesics and drug disposal following outpatient dental surgery: A randomized controlled trial. *Drug and Alcohol Dependence*. https://doi.org/10.1016/j.drugalcdep.2016.08.016

McCabe, S., Cranford, J., Morales, M., & Young, A. (2006). Simultaneous and Concurrent Polydrug Use of Alcohol and Prescription Drugs: Prevalence, Correlates, and Consequences. *Journal of Studies on Alcohol*, *67*(4), 529–537.

McCabe, S. E., & Boyd, C. J. (2005). Sources of prescription drugs for illicit use. *Addictive Behaviors*, *30*(7), 1342–1350. https://doi.org/10.1016/j.addbeh.2005.01.012

McCabe, S. E., Veliz, P., Boyd, C. J., & Schulenberg, J. E. (2016). Medical and nonmedical use of prescription sedatives and anxiolytics: Adolescents' use and substance use disorder symptoms in adulthood. *Addictive Behaviors*. https://doi.org/10.1016/j.addbeh.2016.08.021

McCabe, S. E., West, B. T., & Boyd, C. J. (2013). Leftover prescription opioids and nonmedical use among high school seniors: a multi-cohort national study. *The Journal of Adolescent Health: Official Publication of the Society for Adolescent Medicine*, *52*(4), 480–485. https://doi.org/10.1016/j.jadohealth.2012.08.007

McDonald, D. C., Carlson, K., & Izrael, D. (2012). Geographic variation in opioid prescribing in the U.S. *The Journal of Pain: Official Journal of the American Pain Society*, *13*(10), 988–996. https://doi.org/10.1016/j.jpain.2012.07.007

McLeroy, K. R., Bibeau, D., Steckler, A., & Glanz, K. (1988). An ecological perspective on health promotion programs. *Health Education Quarterly*, *15*(4), 351–377.

NAMSDL. (2014). *Compilation of Prescription Monitoring Program Maps*. Charlottesville, VA. Retrieved from http://www.namsdl.org/library/F2582E26-ECF8-E60A-A2369B383E97812B/

National Association of Boards of Pharmacy. (n.d.). AWARxE. Retrieved October 20, 2015, from http://www.awarerx.org/

NHTSA. (2016). *Traffic Safety Report 2014* (No. DOT HS 812 261). Washington, D.C.: US Department of Transportation. Retrieved from https://crashstats.nhtsa.dot.gov/Api/Public/ViewPublication/812261

NIDA. (2015). Overdose Death Rates. Retrieved June 2, 2016, from https://www.drugabuse.gov/related-topics/trends-statistics/overdose-death-rates

ONDCP. (2011). Epidemic: Responding to America's Prescription Drug Abuse Crisis. Retrieved from https://www.whitehouse.gov/sites/default/files/ondcp/issues-content/prescription-drugs/rx_abuse_plan.pdf

Paschall, M. J., Grube, J. W., & Kypri, K. (2009). Alcohol control policies and alcohol consumption by youth: a multi-national study. *Addiction*, *104*(11), 1849–1855. https://doi.org/10.1111/j.1360-0443.2009.02698.x

Paulozzi, L. J., Mack, K. A., & Hockenberry, J. M. (2014). Variation among states in prescribing of opioid pain relievers and benzodiazepines — United States, 2012. *Journal of Safety Research*, *51*, 125–129. https://doi.org/10.1016/j.jsr.2014.09.001

Peters, P. J., Pontones, P., Hoover, K. W., Patel, M. R., Galang, R. R., Shields, J., … Duwve, J. M. (2016). HIV Infection Linked to Injection Use of Oxymorphone in Indiana, 2014–2015.

New England Journal of Medicine, *375*(3), 229–239. https://doi.org/10.1056/NEJMoa1515195

Peterson, P. L., Hawkins, J. D., Abbott, R. D., & Catalano, R. F. (1994). Disentangling the Effects of Parental Drinking, Family Management, and Parental Alcohol Norms on Current Drinking by Black and White Adolescents. *Journal of Research on Adolescence*, *4*, 203–227. https://doi.org/10.1207/s15327795jra0402_3

Popova, S., Giesbrecht, N., Bekmuradov, D., & Patra, J. (2009). Hours and Days of Sale and Density of Alcohol Outlets: Impacts on Alcohol Consumption and Damage: A Systematic Review. *Alcohol and Alcoholism*, *44*(5), 500–516. https://doi.org/10.1093/alcalc/agp054

PROTECT. (n.d.). Up & Away. Retrieved October 20, 2015, from http://upandaway.org/

Reifler, L. M., Droz, D., Bailey, J. E., Schnoll, S. H., Fant, R., Dart, R. C., & Bucher Bartelson, B. (2012). Do prescription monitoring programs impact state trends in opioid abuse/misuse? *Pain Medicine (Malden, Mass.)*, *13*(3), 434–442. https://doi.org/10.1111/j.1526-4637.2012.01327.x

Rogers, E. M. (2010). *Diffusion of Innovations* (4th ed.). New York, NY: Simon and Schuster.

Ross-Durow, P. L., McCabe, S. E., & Boyd, C. J. (2013). Adolescents' Access to Their Own Prescription Medications in the Home. *The Journal of Adolescent Health: Official Publication of the Society for Adolescent Medicine*. https://doi.org/10.1016/j.jadohealth.2013.02.012

Safe KidsNC. (n.d.). Drop Boxes by County. Retrieved May 24, 2017, from https://apps.ncdoi.net/f?p=102:24:::NO:::

SAMHSA. (2013a). *The CBHSQ Report: A Day in the Life of American Adolescents: Substance Use Facts Update* (The Center for Behavioral Health Statistics and Quality Report). Rockville,

MD: Center for Behavioral Health Statistics and Quality. Retrieved from http://www.samhsa.gov/data/sites/default/files/CBHSQ128_1/CBHSQ128/sr128-typical-day-adolescents-2013.htm#fn10

SAMHSA. (2013b). *The DAWN Report: Highlights of the 2011 Drug Abuse Warning Network (DAWN) Findings on Drug-Related Emergency Department Visits*. Rockville, MD. Retrieved from http://archive.samhsa.gov/data/2k13/DAWN127/sr127-DAWN-highlights.htm

SAMHSA. (2014). *Results from the 2013 National Survey on Drug Use and Health: Summary of National Findings* (NSDUH Series H-48 No. HHS Publication No. (SMA) 14-4863). Rockville, MD: Substance Abuse and Mental Health Services Administration.

SAMHSA. (2015). Prescription Drug Misuse and Abuse [Text]. Retrieved November 11, 2015, from http://www.samhsa.gov/prescription-drug-misuse-abuse

Seehusen, D. A., & Edwards, J. (2006). Patient Practices and Beliefs Concerning Disposal of Medications. *The Journal of the American Board of Family Medicine*, *19*(6), 542–547. https://doi.org/10.3122/jabfm.19.6.542

Slade, E. P., Stuart, E. A., Salkever, D. S., Karakus, M., Green, K. M., & Ialongo, N. (2008). Impacts of age of onset of substance use disorders on risk of adult incarceration among disadvantaged urban youth: A propensity score matching approach. *Drug and Alcohol Dependence*, *95*(1–2), 1–13. https://doi.org/10.1016/j.drugalcdep.2007.11.019

Smith, A. K., Ayanian, J. Z., Covinsky, K. E., Landon, B. E., McCarthy, E. P., Wee, C. C., & Steinman, M. A. (2011). Conducting High-Value Secondary Dataset Analysis: An Introductory Guide and Resources. *Journal of General Internal Medicine*, *26*(8), 920–929. https://doi.org/10.1007/s11606-010-1621-5

Song, E.-Y., Leichliter, J. S., Bloom, F. R., Vissman, A. T., O'Brien, M. C., & Rhodes, S. D. (2012). The Use of Prescription Medications Obtained from Non-medical Sources among Immigrant Latinos in the Rural Southeastern U.S. *Journal of Health Care for the Poor and Underserved*, *23*(2), 678–693. https://doi.org/10.1353/hpu.2012.0063

Stewart, H., Malinowski, A., Ochs, L., Jaramillo, J., McCall, K., & Sullivan, M. (2014). Inside Maine's Medicine Cabinet: Findings From the Drug Enforcement Administration's Medication Take-Back Events. *American Journal of Public Health*, *105*(1), e1–e7. https://doi.org/10.2105/AJPH.2014.302207

Therneau, T., Crowson, C., & Atkinson, E. (2017). Using Time Dependent Covariates and Time Dependent Coefficients in the Cox Model. *Mayo Clinic Proceedings*.

Ulan, S., Davison, C., & Perron, M. (2013, March 27). First Do No Harm: Responding to Canada's Prescription Drug Crisis. Retrieved December 30, 2013, from http://www.ccsa.ca/resource%20library/canada-strategy-prescription-drug-misuse-report-en.pdf

United States Census Bureau / American FactFinder. (2015). *2010-2015 American Community Survey*. Census Bureau's American Community Survey Office. Retrieved from http://factfinder2.census.gov

U.S.Census Bureau. (2010). *Census 2010*. Retrieved from http://2010.census.gov/2010census/

Vaughn, M. G., Nelson, E. J., Salas-Wright, C. P., Qian, Z., & Schootman, M. (2016). Racial and ethnic trends and correlates of non-medical use of prescription opioids among adolescents in the United States 2004–2013. *Journal of Psychiatric Research*, *73*, 17–24. https://doi.org/10.1016/j.jpsychires.2015.11.003

Warner, M., Hedegaard, H., & Chen, L.-H. (2014). *Trends in Drug-poisoning Deaths Involving Opioid Analgesics and Heroin: United States, 1999–2012*. Hyattsville, MD: National Center for Health Statistics. Retrieved from http://www.cdc.gov/nchs/data/hestat/drug_poisoning/drug_poisoning.htm

Yanovitzky, I. (2016). The American Medicine Chest Challenge: Evaluation of a Drug Take-Back and Disposal Campaign. *Journal of Studies on Alcohol and Drugs*, *77*(4), 549–555. https://doi.org/10.15288/jsad.2016.77.549

Zhang, L., Wieczorek, W. F., & Welte, J. W. (1997). The Impact of Age of Onset of Substance Use on Delinquency. *Journal of Research in Crime and Delinquency*, *34*(2), 253–268. https://doi.org/10.1177/0022427897034002005

Zibbell, J. E., Iqbal, K., Patel, R. C., Suryaprasad, A., Sanders, K. J., Moore-Moravian, L., … Centers for Disease Control and Prevention (CDC). (2015). Increases in hepatitis C virus infection related to injection drug use among persons aged ≤30 years - Kentucky, Tennessee, Virginia, and West Virginia, 2006-2012. *MMWR. Morbidity and Mortality Weekly Report*, *64*(17), 453–458.