

Copyright
by
Tawfik Rajab Rajab
2013

**The Thesis Committee for Tawfik Rajab Salem Rajab
Certifies that this is the approved version of the following thesis:**

**A Mail Survey to Assess the Incidence and Impact of Drug Shortages
within Texas Non - Government Acute Care Hospitals**

**APPROVED BY
SUPERVISING COMMITTEE:**

Supervisor:

Marvin D. Shepherd

James P. Wilson

Donna M. Burkett

**A Mail Survey to Assess the Incidence and Impact of Drug Shortages
within Texas Non - Government Acute Care Hospitals**

by

Tawfik Rajab Rajab, B.Pharm.; M.S.

Thesis

Presented to the Faculty of the Graduate School of

The University of Texas at Austin

in Partial Fulfillment

of the Requirements

for the Degree of

Master of Science in Pharmacy

The University of Texas at Austin

December, 2013

Dedication

To my mother and father, Thank you for your encouragement and support.

Acknowledgements

I am vary grateful to my supervisor Dr. Marvin Shepherd for his continuous support, guidance and patience during the course of this project. I would like to thank all my committee members, Dr. James Wilson and Dr. Donna Burkett for their valuable inputs and suggestions.

I am thankful to Ms. Stephanie Crouch and Ms. Iris Jenning for their support and assistance. My special thanks to the International Office staff, especially to Dr. Teri Albrecht, Ms. Darcy McGillicuddy and Ms. Elizabeth Smith for their continues help. My appreciation goes to fellow graduate students, Star Khoza and Busuyi Oluto, for their friendship.

Abstract

A Mail Survey to Assess the Incidence and Impact of Drug Shortages within Texas Non – Government Acute Care Hospitals

Tawfik Rajab Rajab, M.S.Phr.

The University of Texas at Austin, 2013

Supervisor: Marvin D. Shepherd

The objective of this study was to explore the incidence and impact of drug shortages within Texas Non-Government Acute Care Hospitals. A self-administered mail survey instrument was used to collect data. A convenience sample of 321 pharmacy directors of non-government acute care hospitals in the state of Texas was selected from the Texas Department of State Health Services (DSHS) Hospital List for 2012.

A total of 125 completed surveys were received by mail and 8 surveys were returned as undelivered, resulting in a response rate of 39.84% (125/313). A total of 56 (45.5%) respondents reported 11 or more drug shortages for the month of April 2013. There was a significant association between the number of drug shortages experienced and hospital size ($p = 0.003$), inpatient medication budget ($p = 0.001$) and hospital location ($p=0.015$). Of the 124 respondents, 78 (62.9%) spent four to 12 hours a week on managing drug shortage situations. There was a significant association between the number of hours spent per week by hospital pharmacy personnel when managing drug

shortages controlling for hospital size ($p < 0.001$), number of drug shortages experienced ($p < 0.001$), number of pharmacist FTEs ($p < 0.001$), and number of pharmacy technician FTEs ($p < 0.001$). A total of 107 (85.6%) reported that grey market vendors have contacted hospital pharmacy personnel in the month of April, 2013. A total of 96 (76.8%) ‘strongly agreed’ that grey market vendors are more likely to contact health care facility when drug shortage exists, 110 (88%) ‘strongly agreed’ that grey market vendors sell drugs in short supply at inflated prices and 70 (56%) ‘strongly agreed’ that the practice of buying drug products from grey market vendors should be eliminated.

In summary, all surveyed hospitals experienced at least one drug shortage for the month of April 2013, pharmacy personnel devoted a significant amount of time managing drug shortages and the majority of the hospitals were contacted by grey market vendors with the aim of selling drugs in short supply.

Table of Contents

List of Tables	xi
List of Figures	xv
Chapter One: Introduction and Literature Review.....	1
1.1 Introduction.....	1
1.1.1 Frequency of Drug Shortages	4
1.1.2 Characteristics of Drug Shortages	5
1.1.3 Issues Affecting the Supply and Distribution of Drug Products...8	
1.1.4 Information Resources for Managing Drug Shortages	9
1.2 Literature Review.....	12
1.2.1 Causes of Drug Shortages.....	12
1.2.1.1 Interruptions in the Supply of Raw Materials.....	14
1.2.1.2 Manufacturing and Regulatory Issues	15
1.2.1.3 Business Decisions.....	15
1.2.1.4 Changes in Clinical Practice	16
1.2.1.5 Industry Consolidation.....	16
1.2.1.6 Natural Disasters.....	16
1.2.2 The Impact of Drug Shortages.....	17
1.2.3 Grey Market.....	18
1.2.4. Summary of Literature Review.....	20
1.2.5 Objectives	21
1.2.6 Hypotheses.....	22
Chapter Two: Methodology.....	25
2.1 Phase One.....	25
2.1.1 Survey Instrument.....	25
2.1.2 Institutional Review Board Approval	34
2.1.3 Sample Selection.....	34
2.1.4 Pretest.....	35

2.2 Phase Two	36
2.2.1 Survey Administration	36
2.2.2 Data Collection	36
2.2.3 Data Analysis	36
2.2.3.1 Descriptive Analysis	37
2.2.3.2 Independent Variables	37
2.2.3.3 Dependent Variables	38
2.2.3.4 Hypothesis Testing.....	38
Chapter Three: Results.....	42
3.1 Survey Response Rate.....	42
3.2 Descriptive Analysis	42
3.2.1 Respondents’ Demographic and Practice Setting Characteristics.....	42
3.2.2 Incidence of Drug Shortages.....	47
3.2.3 Managing Drug Shortages	51
3.2.4 Impact of Drug Shortages	53
3.2.5 Drug Shortage Supply and Information Resources and Respondents’ Opinions on Drug Shortage Causes	56
3.2.6 Grey Market Vendors and Drug Shortages.....	61
3.2.7 Respondents’ Perceptions about Grey Market Vendors’ Activities Associated with Drug Shortages	67
3.3 Hypotheses Testing.....	71
3.3.1 Regrouped Variables.....	71
3.3.2 Chi-square Test	74
3.3.2.1 Chi-square Test for Dependent Variable ‘Number of Drug Shortages Experienced’	74
3.3.2.2 Chi-square Test for Dependent Variable ‘Number of Hours per Week Managing Drug Shortages’	79
3.3.2.3 Chi-square Test for Dependent Variable ‘Number of Times Hospital Pharmacy Personnel were Contacted by Grey Market Vendors’	84

3.3.3 Two-sample T-test	89
3.3.4 One-way ANOVA	91
3.3.5 Summary of Results of Hypotheses Testing.....	94
Chapter Four: Discussion.....	97
4.1 Review of Research Question.....	97
4.2 Study Findings	99
4.2.1 Demographic and Practice Setting Characteristics	99
4.2.2 Incidence of Drug Shortages.....	99
4.2.3 Managing Drug Shortages	100
4.2.4 Impact of Drug Shortages	102
4.2.5 Drug Shortage Supply, Information Resources and Causes	102
4.2.6 Grey Market Vendors	103
4.2.7 Respondents' Perceptions about Grey Market Vendors' Activities Associated with Drug Shortages.....	105
4.3 Study Limitations.....	106
4.4 Conclusion	107
4.5 Directions for Future Researches.....	108
Appendices.....	109
Appendix I	110
Appendix II	124
References.....	125

List of Tables

Table 1.1: Respondents’ Ratings of Existing Information Sources on Drug Shortages.....	11
Table 2.1: Operational Definitions of Variables Contained in the Survey Instrument.....	29
Table 2.1: Operational Definitions of Variables Contained in the Survey Instrument (<i>continued</i>)	30
Table 2.1: Operational Definitions of Variables Contained in the Survey Instrument (<i>continued</i>)	31
Table 2.1: Operational Definitions of Variables Contained in the Survey Instrument (<i>continued</i>)	32
Table 2.1: Operational Definitions of Variables Contained in the Survey Instrument (<i>continued</i>)	33
Table 2.2: Summary of Hypothesis, Variables and Statistical Tests	39
Table 2.2: Summary of Hypothesis, Variables and Statistical Tests (<i>Continued</i>).....	41
Table 3.1: Respondents’ Demographic and Practice Setting Characteristics (N=125) ^a	44
Table 3.1: Respondents’ Demographic and Practice Setting Characteristics (<i>continued</i>)	45
Table 3.1: Respondents’ Demographic and Practice Setting Characteristics (<i>continued</i>)	46
Table 3.2: Frequency Distribution of Pharmacists’ Positions within the Hospitals and their Licensure Status (N=123) ^a	47

Table 3.4: Respondents were Asked to Rate the Degree of the Drug Shortages’ Problem Regarding their Hospital Setting (N=125) ^a	49
Table 3.5: Percentage of Hospitals Affected by each of the 15 Drug Shortages Listed on the ASHP Web Site as of April, 2013 (N=124) ^{a, b}	50
Table 3.6: Frequency Distribution of Respondents’ Selection Regarding Activities Practiced when Managing Drug Shortages (N=125) ^a	52
Table 3.7: Frequency Distribution of Respondents’ Responses Regarding Number of Hours per Week spent when Managing Drug Shortages (N=124) ^a ..	53
Table 3.8: Respondents’ Ratings of the Extent to which Patients’ Care Activities have been Affected (N=37) ^a	55
Table 3.9: Respondents’ Ranking of the Most Widely Used Supply Resources when Obtaining Drugs in Short Supply (N=116) ^a	57
Table 3.10: Frequency Distribution of Respondents’ Responses Regarding Information Resources Used in Collecting Drug Shortages Information (N=125) ^a	59
Table 3.11: Respondents’ Ranking of the Most Common Reasons of Drug Shortages (N=118) ^a	60
Table 3.12: Frequency Distribution of the Number of Times Grey Market Vendors have contacted the Hospital Pharmacy Personnel in the Last Month (April, 2013), (N=73) ^a	63
Table 3.13: How Often Grey Market Vendors have Contacted Hospitals to Sell or Buy Drugs in Short Supply in the Last Month (April, 2013), (N=107) ^a	64

Table 3.14: Respondents' Ranking of the Most Widely Used Methods when Receiving Information on Drugs in Short Supply from Grey Market Vendors (N=100) ^a	66
Table 3.15: Frequency Distribution of Respondents' Main Concerns when Purchasing Drugs in Short Supply from Grey Market Vendors (N=107) ^a	67
Table 3.16: Frequencies and Descriptive Statistics of Respondents' Perceptions about Grey Market Vendors' Activities Associated with Drug Shortages (N = 125) ^a	70
Table 3.17: Original Variables and Regrouped Variables	72
Table 3.17: Original Variables and Regrouped Variables (<i>continued</i>).....	73
Table 3.18: Number of Drug Shortages for the Month of April 2013 Controlling for Hospital Size (N=123)	75
Table 3.19: Number of Drug Shortages Experienced Controlling for Hospital type for the Month of April 2013 (N=123)	76
Table 3.20: Number of Drug Shortages for the Month of April 2013 Controlling for Inpatient Medication Budget (N=123).....	77
Table 3.21: Number of Drug Shortages Experienced for the Month of April 2013 Controlling for Hospital Location (N=123).....	78
Table 3.22: Number of Reported Hours Spent Managing Drug Shortages Controlling for Hospital Size (N=124).....	80
Table 3.23: Number of Reported Hours Spent Managing Drug Shortages Controlling for the Number of Drug Shortages Experienced for the Month of April 2013 (N=122).....	81
Table 3.24: Number of Reported Hours Spent Managing Drug Shortages Controlling for the Number of Pharmacists FTEs (N=124).....	82

Table 3.25: Numbers of Reported Hours Spent Managing Drug Shortages Controlling for the Number of Pharmacy Technicians FTEs (N=124).....	83
Table 3.26: Numbers of Times Hospital Pharmacy Personnel were Contacted by Grey Market Vendors Controlling for Facility Size (N=73)	85
Table 3.27: Numbers of Times Hospital Pharmacy Personnel were Contacted by Grey Market Vendors Controlling for the Number of Drug Shortages Experienced for the Month of April 2013 (N=72).....	86
Table 3.28: Numbers of Times Hospital Pharmacy Personnel were Contacted by Grey Market Vendors Controlling for the Facility Type (N=73)	87
Table 3.29: Numbers of Times Hospital Pharmacy Personnel were Contacted by Grey Market Vendors Controlling for the Facility Location (N=73)	88
Table 3.30: Respondents' Perception Scores on Grey Market Activities Controlling for Managers and Staff Positions (N=125).....	90
Table 3.31: Respondents' Mean Perception Scores on Grey Market Activities Controlling for the Number of Drug Shortages Experienced by the Health Care Facility for the Month of April, 2013 (N=123)	92
Table 3.32: Respondents' Perception Scores on Grey Market Activities Controlling for the Number of Drug shortages Experienced by the Health Care Facility for the Month of April, 2013 (N=123).....	93
Table 3.33: Summary of Results of Hypotheses Testing.....	94
Table 3.33: Summary of Results of Hypotheses Testing (<i>continued</i>)	95
Table 3.33: Summary of Results of Hypotheses Testing (<i>continued</i>)	96

List of Figures

Figure 1.1: Number of U.S. New Drug Shortages, 2001-2012.....	2
Figure 1.2: Number of National Active Drug Shortages by Quarter, 2010-2012....	3
Figure 1.3: Drug Shortages by Route of Administration, January 2010-August 2011	6
Figure 1.4: Drug Shortages by Drug Class, January 2010-August 2011	7
Figure 1.5: Drug Shortages by Primary Reason for Disruption in Production and Supply, January 2010-August 2011	8
Figure 1.6: Reasons for Drug Shortages, 2010	13
Figure 1.7: Drug Supply Chain.....	14
Figure 3.1: Percentage of hospitals that have been contacted by grey market vendors in the last month (April, 2013).....	62

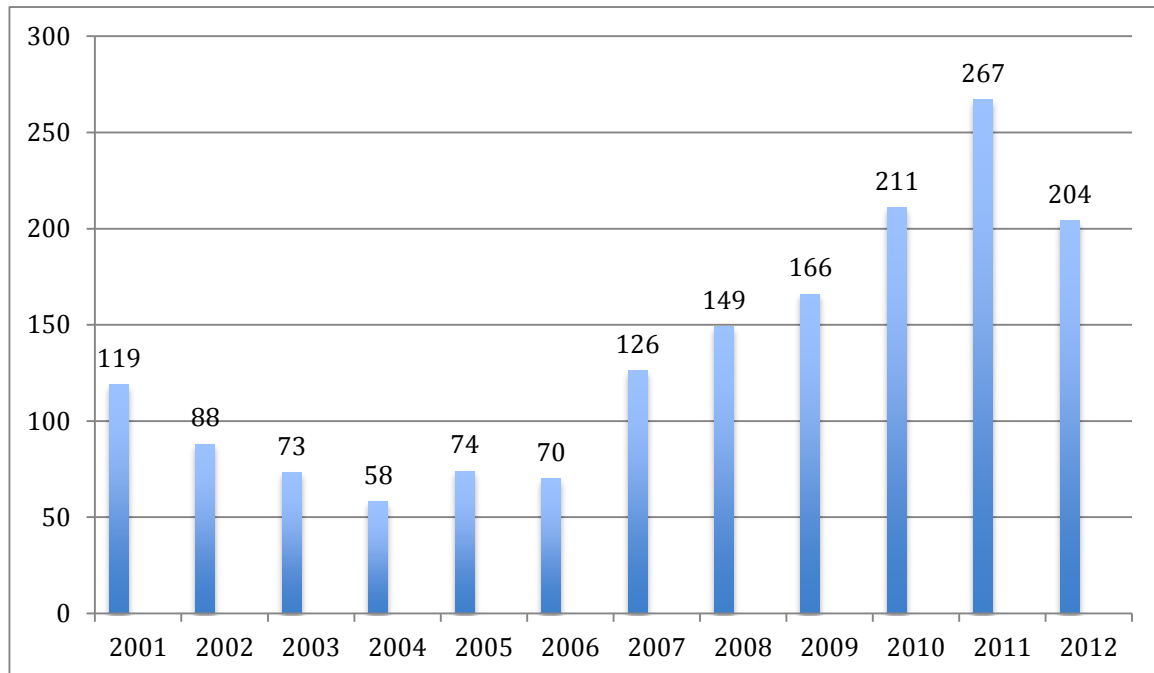
Chapter One: Introduction and Literature Review

1.1 INTRODUCTION

Drug shortages have been on the rise since 2001.¹ Beginning in 1996, the University of Utah Drug Information Service (UUDIS) started reporting drug shortages to practitioners at University of Utah Hospitals and Clinics (UUHSC). Later, in 2001, UUDIS initiated tracking drug shortages on a national level by providing information to the American Society of Health System Pharmacists (ASHP). According to UUDIS database, there was a considerable increase in the number of drug shortages from 3 in 1996 to 119 in 2001.² In 1999, the U.S. Food and Drug Administration (FDA) started the Drug Shortage Program (DSP) within the Center for Drug Evaluation and Research (CDER) reporting 61 drug product shortages in 2005 and 178 in 2010.³ Yet, ASHP/UUDIS reported 74 drug shortages in 2005 and 211 in 2010.⁴ These discrepancies in the numbers reported are due to the fact that FDA and ASHP define drug shortages differently. FDA defines drug shortage as “a situation in which the total supply of all clinically interchangeable versions of an FDA-regulated drug is inadequate to meet the current or projected demand at the user level.”⁵ ASHP’s definition of a drug shortage is “a supply issue that affects how the pharmacy prepares or dispenses a drug product or influences patient care when prescribers must use an alternative agent.”⁶ Despite these differences, the number of drug shortages has been increasing over the years; ASHP/UUDIS reported 70 in 2006, 126 in 2007, 149 in 2008, 166 in 2009, and 211 in 2010.⁷ As of the current month, March 2013, there are 121 drug shortages listed on the

FDA Web site and 235 drug shortages reported on the ASHP Web site.^{8,9} Figure 1.1 represents the number of national new drug shortages in the period between 2001 and 2012 as reported by UUDIS.

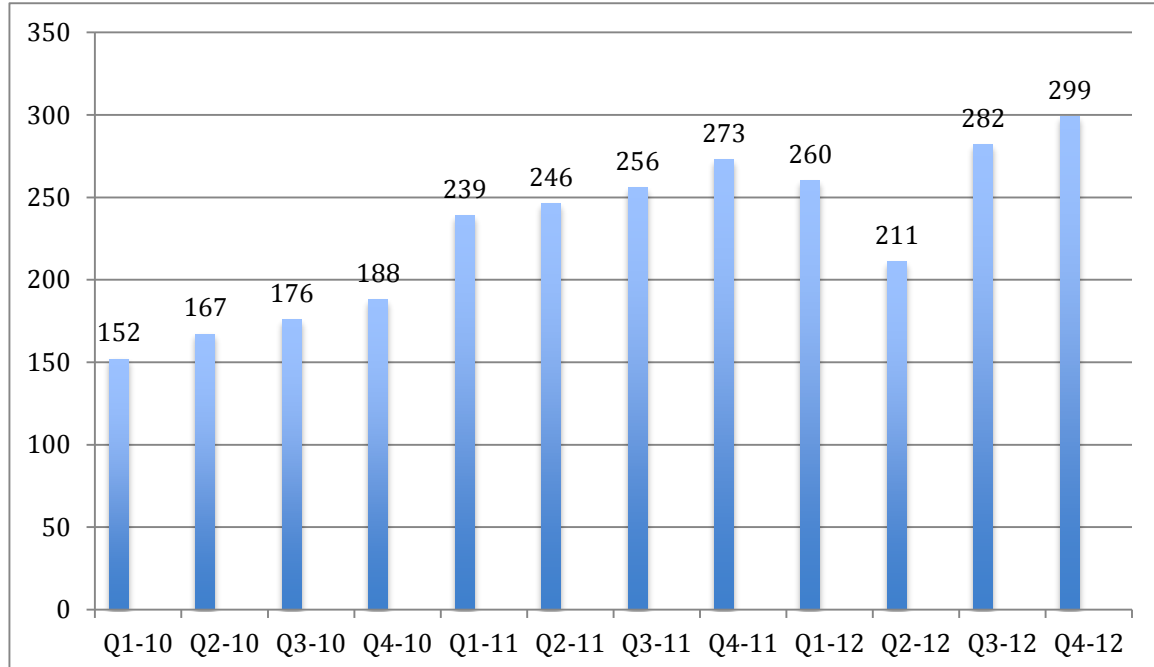
Figure 1.1: Number of U.S. New Drug Shortages, 2001-2012



Source: Fox E, Wheeler M. Drug Shortages in the US: Causes and What the FDA Is Doing to Prevent New Shortages. *AccessMedicine from McGraw-Hill*. March 2013. Available at: <http://www.medscape.com/viewarticle/780328>. Accessed June 15, 2013.

Despite the decrease in the number of new drug shortages tracked in 2012, the number of active and ongoing drug shortages was 299 as of December 31, 2012, the highest for the period between 2010 and 2012. Figure 1.2 illustrates the number of active and ongoing national drug shortages by quarter for the period between January 2010 and December 2012 as reported by UUDIS.

Figure 1.2: Number of National Active Drug Shortages by Quarter, 2010-2012



Source: Fox E, Wheeler M. Drug Shortages in the US: Causes and What the FDA Is Doing to Prevent New Shortages. *AccessMedicine from McGraw-Hill*. March 2013. Available at: <http://www.medscape.com/viewarticle/780328>. Accessed June 15, 2013.

The issue of drug shortages has grabbed the attention of mass media, health professionals, patients, and politicians. As a result, President Obama issued an Executive Order in October, 2011 urging FDA to encourage early reporting of potential shortages by manufacturers, expedite reviews of applications regarding start or alter production of medicines, and work in collaboration with the United States Department of Justice in controlling price escalation of existing drug shortages.¹⁰ This was followed by the FDA Safety and Innovation Act (FDASIA), which was passed by the Congress in June 2012, requiring drug manufacturers to notify FDA when discontinuation or interruption in the manufacturing process of a drug occurs that could result in a shortage of that drug in the United States.¹¹

The following sections provide information on frequency of drug shortages, characteristics of drug shortages, issues affecting the supply and distribution of drug products, and resources available when obtaining information on drug shortages. This will be followed by literature review detailing the causes of drug shortages, impact of drug shortages on patient care, and grey market activities associated with drug shortages.

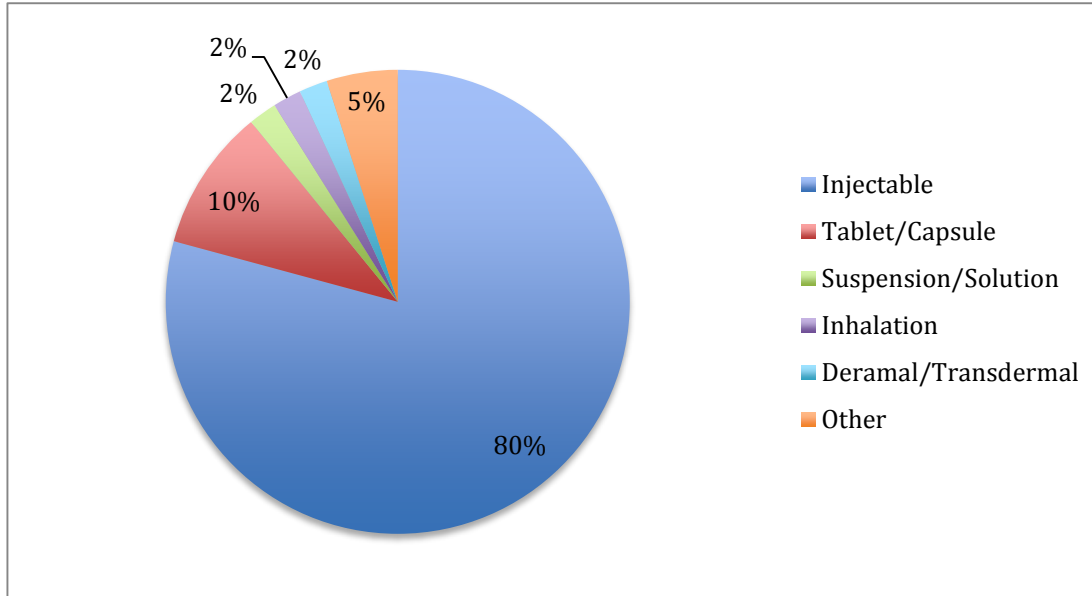
1.1.1 Frequency of Drug Shortages

Only a limited number of studies, in particular surveys, exist with the objective of collecting data on the frequency of drug shortages as experienced by health systems. The American Hospital Association (AHA) conducted one such survey in June 2011, collecting data from 820 non-federal, short-term acute care hospitals. The survey revealed that 99.5% of the hospitals experienced one or more drug shortage in the last six months, and 44% reported encountering 21 or more shortages for the same time period.¹² A survey of 1373 anesthesiologists administered by the American Society of Anesthesiologists (ASA) in April 2011, reported that more than 90% of the respondents were experiencing at least one anesthesia drug shortage currently and more than 98% had an incidence of anesthetic shortage in the last year.¹³ In 2011, ASHP performed a national survey of 1322 pharmacy directors looking at the impact of drug shortages on U.S. health systems. The study found that 47% of the institutions with 400 or more beds encountered more than 30 drug shortages in the year of 2010.¹⁴ Premier Healthcare Alliance analyzed a survey of 311 hospital pharmacists from 228 hospitals in March 2011 claiming that 90% had experienced a drug shortage for the period between July and December 2010. In addition it was reported that there were more than 240 drug shortages and more than 400 generics that were back-ordered for five or more days.¹⁵

1.1.2 Characteristics of Drug Shortages

The vast majority of drug shortages reported to FDA are prescription drugs, where the highest proportion involves injectable generic products. According to FDA, for the year of 2010 injectables accounted for 74% of all recorded drug shortages.¹⁶ Moreover, UUDIS announced that as of September 2011, parenteral drug shortages contributed to 60% of the drug shortages.¹⁷ Data analysis of 127 drug shortages collected by the DSP for the period between January 1, 2010 and August 26, 2011, revealed that 80% of drugs in short supply concerned injectables, 10% oral tablets/capsules and 2% for each of the dermal, inhalation and oral liquid preparations.¹⁸ Figure 1.3 shows the percentages of drug shortages according to route of administration based on data of 127 drug shortages for the period between January 2010 and August 2011.

Figure 1.3: Drug Shortages by Route of Administration, January 2010-August 2011^a

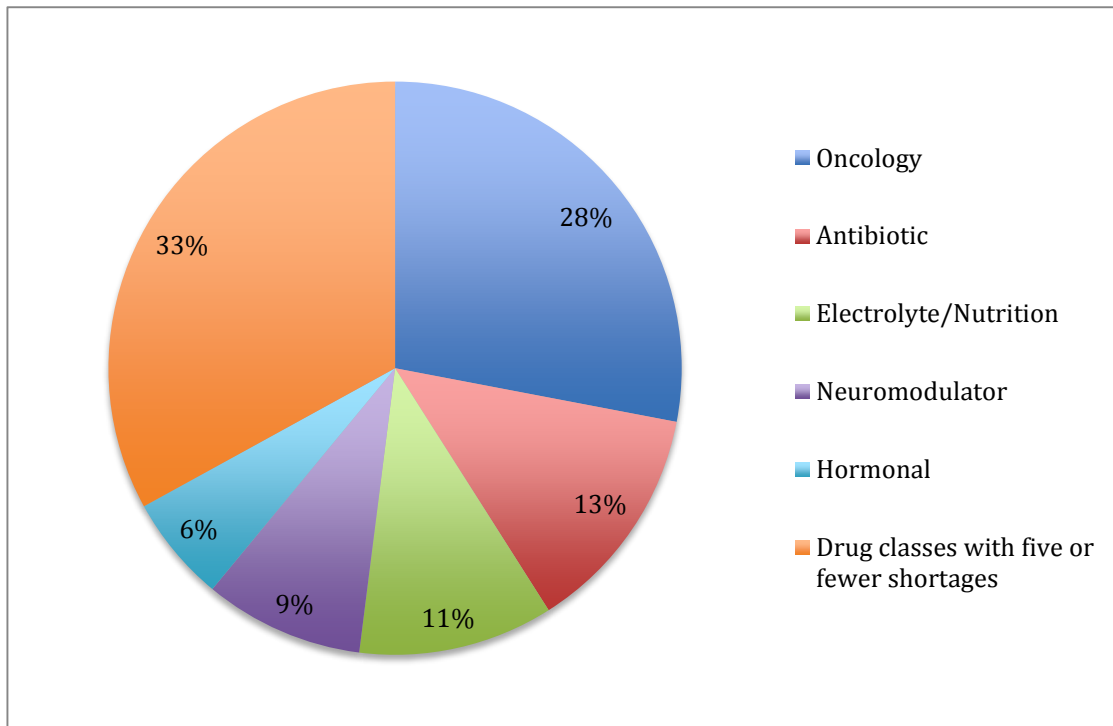


Source: Food and Drug Administration. A review of FDA's approach to medical product shortages. 2011 October 31. Available at: www.fda.gov/AboutFDA/ReportsManualsForms/Reports/ucm277745.htm. Accessed November 10, 2011.

^a Percentages total to 101% due to rounding.

In addition, the examination of 127 drug shortages showed that oncology medicines accounted for 28% of all shortages, followed by antibiotics (13%), electrolyte/nutrition products (11%), neuromodulators (9%), hormones (6%), and drug classes with five or fewer shortages (33%).¹⁹ Figure 1.4 presents the percentages of drug shortages by drug class based on data of 127 drug shortages for the period between January 2010 and August 2011.

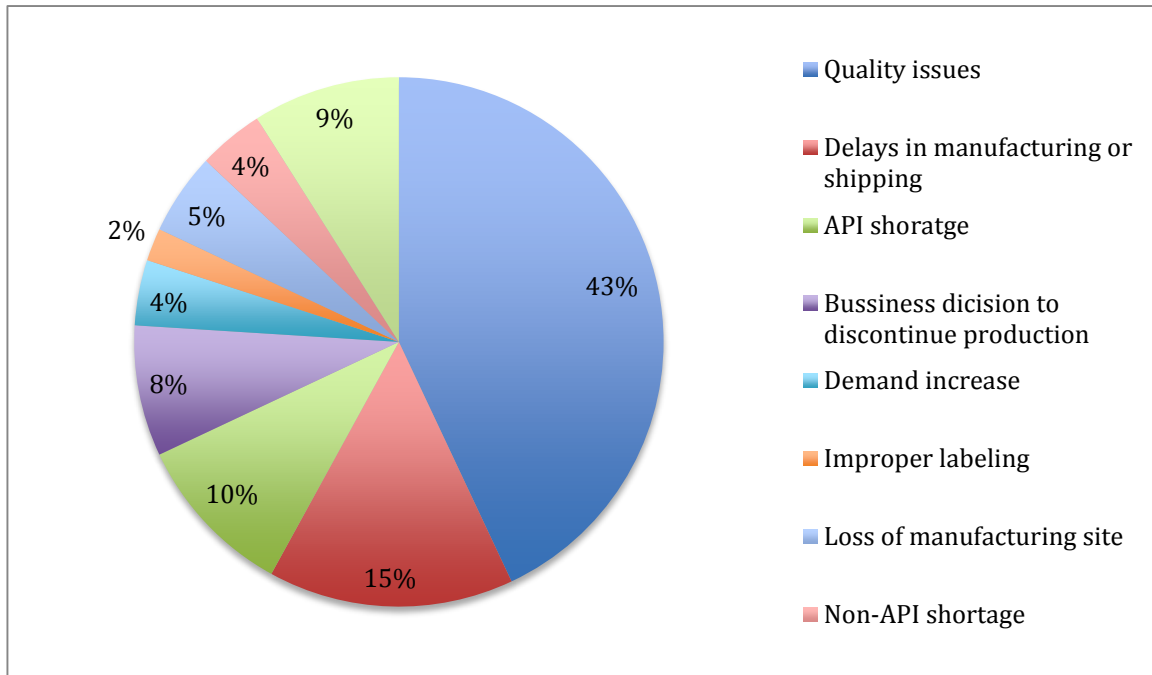
Figure 1.4: Drug Shortages by Drug Class, January 2010-August 2011



Source: Food and Drug Administration. A review of FDA's approach to medical product shortages. 2011 October 31. Available at: www.fda.gov/AboutFDA/ReportsManualsForms/Reports/ucm277745.htm. Accessed November 10, 2011.

Further study of the data demonstrated that 43% of all shortages were due to quality issues within the manufacturing facility, 15% due to delays in manufacturing or shipping, 10% due to shortage of Active Pharmaceutical Ingredient (API), and 8% due to business decision to discontinue production.²⁰ Figure 1.5 represents the percentages of drug shortages by primary reason for disruption in production and supply based on data of 127 drug shortages for the period between January 2010 and August 2011.

Figure 1.5: Drug Shortages by Primary Reason for Disruption in Production and Supply, January 2010-August 2011



Source: Food and Drug Administration. A review of FDA's approach to medical product shortages. 2011 October 31. Available at: www.fda.gov/AboutFDA/ReportsManualsForms/Reports/ucm277745.htm. Accessed November 10, 2011.

1.1.3 Issues Affecting the Supply and Distribution of Drug Products

Prior to FDASIA of 2012, manufacturers were required to provide a six months' advance notice to FDA regarding discontinuation of the production of a single-source, medically necessary drug. All other manufacturers provided early notifications of potential shortages of other drug on voluntary basis. According to FDA early warnings from manufacturers for potential interruptions in product supply have been critical to preventing drug shortages. In fact, FDA was able to prevent 195 shortages in 2011 and 100 shortages during the first half of 2012 using its authority and the early notifications from manufacturers.²¹

Another issue that might contribute to disruption within the supply chain of drug products is the practice of stockpiling. Stockpiling is the practice of the accumulation of drug products by purchasing more products than would be necessary to fulfill an institution's monthly needs. In fact, stockpiling could extend the period within which the drug is in short supply because it creates an artificial depletion of a drug product in the supply chain.²² Therefore, ASHP recommended that health care organizations avoid stockpiling of drug products for the sole purpose of preventing artificial drug shortage and costly inventories.²³

Distributors of drug products have also contributed to the overall problem of drug shortage in terms of the lack of providing information to health facilities regarding drug shortages in a timely manner. Being unaware of existing drug shortage makes the development of a strategy for managing drugs in short supply hard to achieve. In addition, hospitals in rural areas are further challenged by the unavailability of distribution centers near them and other hospitals from which they could borrow a drug product. Therefore, it is extremely important for health professionals to have access to reliable information resources in order to be able to successfully manage drug shortages.²⁴

1.1.4 Information Resources for Managing Drug Shortages

Managing drug shortages has become a routine practice within health care facilities where health care professionals dedicate personnel time and resources to identify, track, and resolve existing drug shortages. This process involves obtaining the necessary information regarding reasons for product's unavailability, time period for the product's shortage (i.e. when the product's supply will be available), alternative supply

resource, alternative therapies, and cost related to alternative suppliers or therapies.²⁵ Gathering information and maintaining an excellent network of communication are crucial in minimizing the impact of a drug shortage. The main information resources providing assistance with current drug shortages are the Food and Drug Administration, the American Society of Health-System Pharmacists, and the Centers for Disease Control and Prevention (CDC).²⁶ The FDA's web site (www.fda.gov/Drugs/DrugSafety/DrugShortages/default.htm) provides a list of current drug shortages, reasons for drug shortages, availability and estimated shortage duration, updates on resolved shortages, and information about drugs that are going to be discontinued. The site does not present any clinical information with regard to alternative therapies and possible implications for patient care that could help health professionals deal with a particular shortage.^{27, 28} In addition, the FDA's web site instructs users on how to report a drug shortage or supply issue, sign up for drug shortage e-mail notifications, and contact manufacturers.²⁹ ASHP in collaboration with UUDIS and Novation, LLC have created Drug Shortage Bulletins available on ASHP web site (www.ashp.org/shortages) in which information is provided detailing current drug shortages, reasons for drug shortages, estimated re-supply dates, implications for patient care, safety issues, and alternative agents.^{30,31} The CDC's web site (www.cdc.gov/vaccines/vac-gen/shortages/default.htm) informs about existing vaccine shortages and provides recommendations regarding modifications of immunization schedules.³² In addition, the FDA's Center for Biological Evaluation Research (CBER) web site (www.fda.gov/BiologicsBloodVaccines/SafetyAvailability/Shortages/default.htm)

provides information about current blood, vaccines and biologics shortages.³³ Moreover, ASHP recommends contacting manufacturers and distributors in order to get information on causes and duration of current drug shortages.³⁴

In an online survey conducted by ASHP in 2010, 1322 members of ASHP were asked to rate the quality of various sources of information currently available to health professionals. In particular, they were asked to rate the usefulness of ASHP drug shortage web site, FDA drug shortage web site, wholesalers and group purchasing organizations, and direct communication with manufacturers using a 5-point Likert scale. Overall, the results showed that 70% of the respondents rated the information available on all specified sources as less than good.³⁵ Table 1.1 shows participants' ratings of the usefulness of selected information sources.

Table 1.1: Respondents' Ratings of Existing Information Sources on Drug Shortages

Rated Characteristic ^s	ASHP Web Site	FDA Web Site	Wholesaler Web Site or Communication	GPO Web Site or Communication	Direct Communication With Manufacturer
Timeliness	3.93	3.40	3.38	3.42	3.02
Reason for and duration of shortage provided	3.80	3.23	2.66	3.23	2.78
Suggested alternatives provided	3.97	2.74	1.81	3.04	1.92

ASHP = American Society of Health-System Pharmacists; GPO = group-purchasing organization.
^aMean rating, based on a 5-point Likert scale, where 1 = very poor, 2 = poor, 3 = neutral, 4 = good, and 5 = very good.
 Source: Kaakeh R, Sweet BV, Reilly C, Bush C, DeLoach S, Higgins B, et al. Impact of drug shortages on U.S. health systems. *Am J Health Syst Pharm.* 2011; 68: e13-17.

1.2 LITERATURE REVIEW

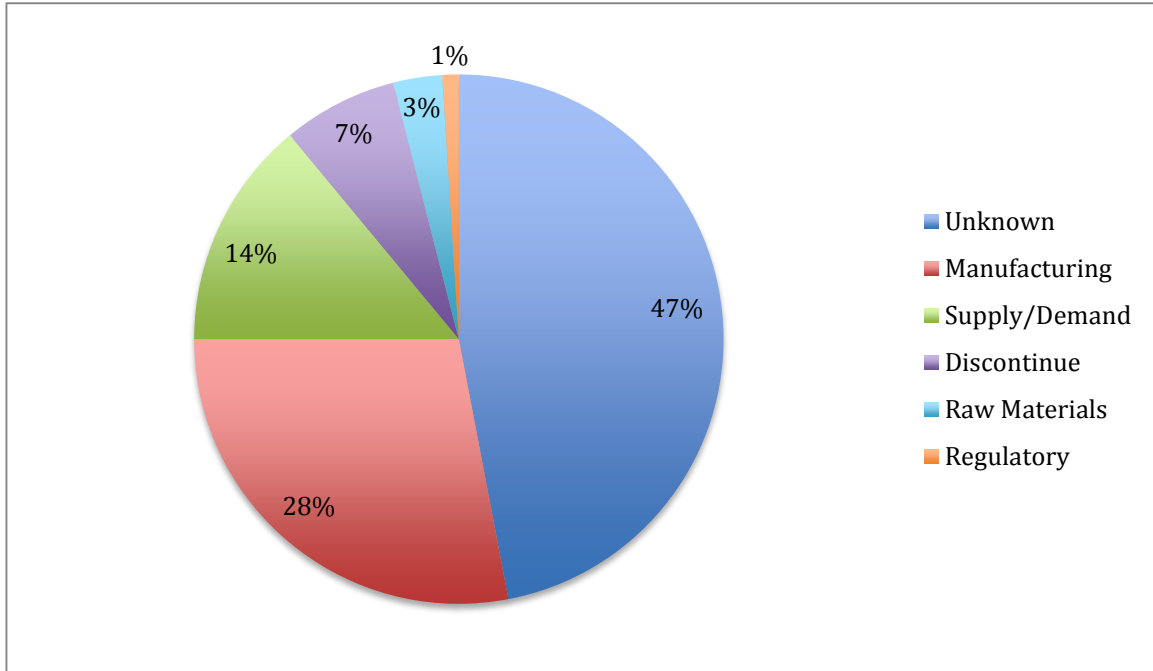
This section will cover causes of drug shortages, impact of drug shortages on patient care, and grey market activities associated with drug shortages.

1.2.1 Causes of Drug Shortages

Drug shortages exist for variety of reasons. Quoting FDA, the primary cause of shortages is production shutdowns because of manufacturing problems, such as contamination and metal particles that get into medicine.³⁶ Yet, according to UUDIS the reason for 47% of the drug shortages tracked in 2010, is unknown.³⁷ Figure 1.6 illustrates the reasons for drug shortages in 2010.

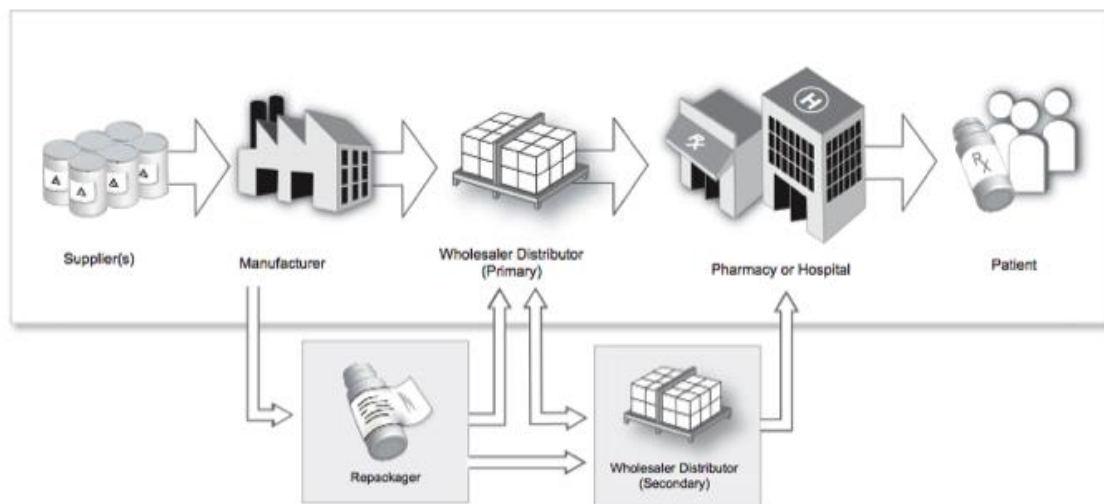
However, there are other factors throughout the supply chain that are equally important in their contribution to the drug shortage crisis. These factors include interruptions in the supply of raw materials, manufacturing and regulatory issues, business decisions, changes in clinical practice, industry consolidation, and natural disasters.^{38,39} Figure 1.7 depicts the parties involved in the drug supply distribution chain.

Figure 1.6: Reasons for Drug Shortages, 2010



Source: American Society of Health-System Pharmacists. Drug Shortages Summit Report. Available at: <http://www.ashp.org/drugshortages/summitreport>. Accessed June 20, 2012.

Figure 1.7: Drug Supply Chain



Source: Food and Drug Administration. A Drug Supply Chain Example. From Supplier to Patient. Available at: www.fda.gov/Drugs/DrugSafety/DrugShortages/ucm277626.htm. Accessed December 12, 2011.

1.2.1.1 Interruptions in the Supply of Raw Materials

Interruptions in the supply of raw or bulk materials often lead to a drug shortage particularly in situations when the primary or sole supplier of raw materials experiences delays or discontinues production and thus affecting all manufacturers of a particular drug product.⁴⁰ In fact, drug manufacturers are increasingly relying on a global supply chain for the raw materials.⁴¹ It has been estimated that 80% of the raw materials used in the manufacture of drug products in the United States are imported from other countries.⁴² Armed conflicts, trade disruptions, animal diseases, environmental conditions, or degradation of raw materials during harvesting, storage, or transportation, are all factors that may contribute to the disruption of the supply of raw materials.⁴³

1.2.1.2 Manufacturing and Regulatory Issues

Once the primary or sole manufacturer of a drug product experiences noncompliance with current good manufacturing practices (cGMP) a drug shortage could result as a consequence of halts or delays in drug production.⁴⁴ The main factors that might contribute to regulatory issues within a drug manufacturing company include antiquated manufacturing equipment, a shift of resources from maintenance of equipment and facilities to research and development, loss of manufacturer personnel, cGMP-related problems with subcontractors who supply products, and limited FDA resources for timely inspections of manufacturing sites.⁴⁵ In addition, the resolution of such issues may require inspection for recertification, issuance of an injunction against the manufacturer, or seizure of products. Moreover, in some instances a manufacturer might decide to close a specific facility and thus contribute to unintended drug shortages.⁴⁶

1.2.1.3 Business Decisions

Availability of generic products, market size, patent expiration, drug-approval status, regulatory compliance requirements, and anticipated clinical demand are all factors that influence drug manufacturers' business decisions. Yet, in many instances the main factor that influences a manufacturer's decision to discontinue production of a specific drug product is the insufficient financial return or the high cost to correct manufacturing issues. This could lead to an unanticipated serious drug shortage especially if the manufacturer is a sole-source.⁴⁷ For example, a manufacturer of diphtheria and tetanus toxoids and acellular pertussis vaccine announced in 2000 the discontinuation of its products due to low revenues resulting in a vaccine shortage.⁴⁸

1.2.1.4 Changes in Clinical Practice

Changes in clinical practice, such as a new indication of an existing drug product, new therapeutic guidelines, or disease outbreak, could lead to an unexpected increase in the demand for a specific drug product, which exceeds production capacity. One such drug shortage occurred, in 2006, when CDC changed its guidelines for pediatric flu vaccine to include children 6 to 59 months of age resulting in an increased demand for the only product approved by FDA in children 6-23 months of age.⁴⁹

1.2.1.5 Industry Consolidation

Industry consolidation, in the form of manufacturer mergers or acquisition could result in discontinuation or delayed availability of drug products. In many instances manufacturer mergers narrow the focus of production lines or result in single-source products, especially when two companies producing similar product merge. As a result there is fewer number of manufacturers of a particular drug product, which in turn makes the product supplies more vulnerable to any disruptions in the supply chain.⁵⁰

1.2.1.6 Natural Disasters

Natural disasters, such as fires, hurricanes, tornadoes, and floods, could have devastating effects on drug product availability. Moreover, a long-term drug shortage could occur if a manufacturing facility has been damaged especially in instances of sole-source product. An example is the damage caused by hurricane George in 1998 to manufacturing facilities in Puerto Rico resulting in several drug product shortages.⁵¹

1.2.2 The Impact of Drug Shortages

The most important implications of drug shortage include the hampering of patient care, increased drug costs, and an increased burden on health professionals in managing drug shortages. With regard to patient care, drug shortages may adversely affect patient's drug therapy, compromise or delay medical treatment procedures, or result in medication errors or adverse patient outcomes. In addition, drug shortages have financial and emotional effects. Costly alternative medications might be needed to continue patient treatments, and health care professionals might need a significant amount of time and resources to manage shortages. Patients and professionals might become frustrated, angry, and develop mistrust. Professional relationships might also become strained.⁵² A national survey of more than 1,800 health care practitioners conducted by the Institute for Safe Medication Practices (ISMP), in the period between July and September 2010, revealed that 64% of the respondents were concerned with risk of adverse patient outcomes as a result of drug shortages, 70% expressed anger toward pharmacists, nurses and hospitals in response to a drug shortage, 80% indicated facing difficulties when trying to obtain a suitable alternative, and 35% reported a near miss due to a drug shortage.⁵³ ISMP defines near miss as a situation in which an error has occurred yet it was captured by a health professional before it could reach and harm the patient.⁵⁴ Another survey of 311 pharmacy experts performed by Premier Healthcare Alliance in the period between July and December 2010 reported similar results. Of the surveyed respondents, 89% experienced shortages that may have caused a medication safety issue or error in patient care, 80% experienced shortages that resulted in a delay or cancellation of a patient care intervention, 98% experienced shortages that resulted in an increase in

costs.⁵⁵ One of the first national surveys conducted across acute care hospitals by ASHP in 2004 revealed that almost all pharmacy directors surveyed agreed that drugs shortages changed practice and compromised patient care. In addition, it was found that hospital pharmacy personnel spent a considerable amount of time managing drug shortages and the acquisition cost of pharmaceuticals increased by over \$99 million annually as a consequence of drug shortages.⁵⁶ In 2011, ASHP performed another national survey looking at the impact of drug shortages on U.S. health systems, and it was found that pharmacists and pharmacy technicians devoted more time managing drug shortages than other healthcare professionals, like physicians and nurses, and that the labor cost associated with managing drug shortages was estimated to be \$216 million annually. In addition, it was reported that there was a significant association between the number of drug shortages experienced and the hospital size as well as between the time spent managing drug shortages and the size of the facility, and the number of shortages experienced.⁵⁷ The American Hospital Association (AHA) released the results of its survey of 820 hospitals in July 2011 revealing that 82% of the hospitals delayed patient treatment, more than half (63%) were not always able to provide the recommended treatment to the patients, and 92% reported increased drug costs.⁵⁸

1.2.3 Grey Market

The drug shortages issue is further complicated by the practices of grey market vendors who take advantage of the situation. The grey market vendors are sellers who might not be licensed or authorized secondary distributors. They buy scarce drugs from small regional wholesalers, pharmacies or other sources and then market them to

hospitals at inflated prices.⁵⁹ These distributors market drug products in short supply to hospitals, specialty health systems, home care agencies, and physician practices, at substantially inflated prices. The main concerns of these activities come from the inability to determine the product's pedigree or ensure the reliability of the product's source, proper handling and storage throughout the chain of ownership.⁶⁰

For example, at Christus Santa Rosa Health Care, Texas, Cytarabine, an injectable cancer drug for treatment of leukemia costs on average \$15.76 for a 2-gm vial, but with the drug in short supply, suppliers have offered 17 vials for \$995 each, a markup of 6213%. The same problem exists at many healthcare systems across Texas. Baptist Health System is spending \$125,000 per month extra in premiums for Cytarabine and other drugs in short supply.⁶¹ Texas Medical Center hospital pharmacists managed the crisis by getting rare FDA exemptions for the importation of drugs from Europe.⁶² A 2011 survey, conducted by ISMP, examined grey market activities associated with drug shortages among hospital purchasing agents and pharmacists. Of 549 respondents, 56% reported receiving daily solicitations from grey market vendors and 52% reported purchasing drugs from grey market vendors in the last two years. Many respondents provided examples of inflated prices, including Propofol that was marked up by over 1567%.⁶³ Similar results were reported by Premier Healthcare Alliance in their survey of pharmacists regarding the incidence of grey market offers. They reported 1,745 examples of grey market offers over a two-week period among 42 acute care hospitals with an average markup of 650%.⁶⁴

1.2.4. Summary of Literature Review

Hospitals have been combating the increasing number of drug shortages since 2001.⁶⁵ The main factors contributing to the drug shortage crisis include interruptions in the supply of raw materials, manufacturing and regulatory issues, business decisions, changes in clinical practice, industry consolidation, and natural disasters.^{66,67} Drug shortages have had a significant impact on patient care. The most important implications of drug shortage include hampering patient care, increased drugs' costs, and an increased burden on health professionals in managing drug shortages and obtaining needed drug products. With regard to patient care, drug shortages might adversely affect drug therapy, compromise or delay medical treatment procedures, fail to treat diseases, result in medication errors and adverse patient outcomes. In addition, drug shortages have financial and emotional effects on both health care practitioners and patients. Costly alternative medications might be needed to continue patient's treatments, and health care professionals might need significant amount of time and resources to manage shortages. Patients as well as professionals may become frustrated, angry, and develop mistrust.⁶⁸ The drug shortage issue is further complicated by the practices of "grey market" vendors who take advantage of the shortage situation and thus significantly contribute to the difficulties in obtaining drugs in short supply.⁶⁹ These vendors promote drug products in short supply to health care facilities at dearly inflated prices. Health professionals are mainly concerned about the quality of the drug products marketed by grey market vendors because product's pedigree, source, handling, and storage are difficult to be determined.⁷⁰

This study explores the incidence and impact of drug shortages across Texas Acute Care Hospitals. The study determines if the number of drug shortages experienced by a hospital is related to the size in terms of number of beds of a hospital, its type, location, and medication budget. In addition, the study finds out whether hospital pharmacy personnel dedicate more time in managing drug shortages as the number of drug in short supply increases. Furthermore, the study will examine if hospital pharmacy personnel believe grey market vendors contribute toward the drug shortages crises. Previous study has reported a significant association between the number of drug shortages experienced and the hospital size as well as between the time spent managing drug shortages and the size of the facility, and the number of shortages experienced.⁷¹

The project gives an in depth picture of the existing drug shortage problem within Texas acute care hospitals and will contribute to further understanding of the nationwide problem of drug shortages and its implications.

1.2.5 Objectives

The purpose of this study is to explore the incidence and impact of drug shortages across Texas Non-Government Acute Care Hospitals. The specific objectives of this study are as follows:

1. To assess the proportion of Texas Non-Government Acute Care Hospitals experiencing a drug shortage and the number of shortages experienced in the last month (April, 2013);

2. To determine the percentage of Texas Non-Government Acute Care Hospitals affected by each of the 15 most recent drug shortages as of April 2013 (according to ASHP) for the last month;
3. To estimate the average number of hours per week spent by hospital pharmacy staff managing drug shortages and the activities associated with managing drug shortages;
4. To examine whether additional hospital pharmacy personnel were hired as a result of increased workload due to drug shortages;
5. To determine whether hospital pharmacy personnel were shifted from patient care activities toward managing drug shortages and which activities have been affected the most;
6. To describe the various supply and informational resources used to obtain drugs in short supply and information on drug shortages, as well as respondents' opinions with regard to the most common causes of drug shortages;
7. To assess the number of acute care hospitals contacted by grey market vendors in the last month (April, 2013), frequency and mode of contact, concerns and opinions of hospital pharmacy personnel regarding grey market activities associated with current drug shortages;

1.2.6 Hypotheses

Based on the study objectives the following hypotheses will be tested:

H_{A1}: There is an association between the number of drug shortages experienced by a health system in the last month (April, 2013) and facility size in terms of number of beds.

H₀₂: There is no association between the number of drug shortages experienced by a health system in the last month (April, 2013) and facility type (Chain and Non-Chain hospitals).

H₀₃: There is no association between the number of drug shortages experienced by a health system in the last month (April, 2013) and hospital inpatient medication budget.

H₀₄: There is no association between the number of drug shortages experienced by a health system in the last month (April, 2013) and facility location (Rural/Semi-Urban, Small/Medium Metropolitan and Large Metropolitan).

H_{A5}: There is an association between the numbers of hours spent per week by hospital pharmacy personnel when managing drug shortages and facility size in terms of number of beds.

H_{A6}: There is an association between the numbers of hours spent per week by hospital pharmacy personnel when managing drug shortages and number of drug shortages experienced by the health system in the last month (April, 2013).

H_{A7}: There is an association between the numbers of hours spent per week by hospital pharmacy personnel when managing drug shortages and number of pharmacist FTEs.

H_{A8}: There is an association between the numbers of hours spent per week by hospital pharmacy personnel when managing drug shortages and number of pharmacy technicians FTEs.

H₀₉: There is no association between the numbers of times hospital pharmacy personnel were contacted by grey market vendors across facility sizes in terms of number of beds.

H₀₁₀: There is no association between the numbers of times hospital pharmacy personnel were contacted by grey market vendors by number of shortages experienced by the health system in the last month (April, 2013).

H₀₁₁: There is no association between the numbers of times hospital pharmacy personnel were contacted by grey market vendors by facility type (Chain and Non-Chain hospitals).

H₀₁₂: There is no association between the numbers of times hospital pharmacy personnel were contacted by grey market vendors by and facility location (Rural/Semi-Urban, Small/Medium Metropolitan and Large Metropolitan).

H₀₁₃: There is no difference in the mean opinion score of hospital pharmacy personnel whether grey market vendors contribute toward the drug shortages crises by buying whatever supplies they can find on the market controlling for position within the facility (Managers and Staff) and number of drug shortages experienced by the health system in the last month (April, 2013).

H₀₁₄: There is no difference in the mean perception score of hospital pharmacy personnel in regard to grey market vendors' practice of selling drugs in short supply at inflated prices by their position within the facility (Managers and Staff) and number of drug shortages experienced by the health system in the last month (April, 2013).

H₀₁₅: There is no difference in the mean opinion score of hospital pharmacy personnel toward elimination of the practice of buying drugs in short supply from grey market vendors by their position within the facility (Managers and Staff) and number of drug shortages experienced by the health system in the last month (April, 2013).

Chapter Two: Methodology

This chapter describes the methods used in conducting the study. It details the instrument, instrument development, selection of study respondents, survey administration, data collection, and analyses. The study was divided into two phases. The first phase included development of the survey questionnaire, selection of survey participants, completion of IRB approval, and pretest of the questionnaire. The second phase involved survey administration, data collection, and data analysis.

The study design employed a self-reported questionnaire of hospital pharmacy directors of non-government acute care hospitals located in Texas. A total of 321 acute non-government care hospitals were identified via the Texas Department of State Health Services (DSHS) directory and 321 were mailed a packet, which contained a cover letter, questionnaire, and return envelope.

2.1 PHASE ONE

2.1.1 Survey Instrument

A survey questionnaire was comprised of 26 items (Appendix 1). The survey questionnaire was divided into three sections and had 18 close-ended items, 1 open-ended and 7 partially close-ended questions.

The following presents descriptions of the items by section and Table 2.1 presents the operational definitions and measurement levels of each questionnaire item (variable), as well as each variable location in the survey instrument.

The first section explored hospital pharmacy personnel experience with regard to drug shortages. It consisted of closed-ended and partially close-ended questions with the objective of collecting the following information from respondents:

1. Number of drug shortages experienced in the last month (April, 2013) (question 1);
2. Perception of the degree of the drug shortage problem (question 2);
3. Drug shortages experienced for specified medicines (question 3);
4. Activities in managing drug shortages (question 4);
5. Number of hours per week spent managing drug shortages (question 5);
6. Whether or not additional personnel were hired as a result of increased workload due to drug shortages (question 6 and 7);
7. The degree to which patients' care activities were affected as a result of shifting hospital staff personnel toward managing drug shortages (question 8 and 9);
8. Drug supply sources commonly used for obtaining drugs in short supply (question 10);
9. Information resources commonly used to obtain additional information on drugs in short supply (question 11); and
10. Ranking of the top three reasons for drug shortages (question 12).

The second section examined respondents' practice and their opinions in regard to grey market vendor activities associated with drug shortages. For the purpose of getting the same perspective, "grey market" was defined as a supply channel that is unofficial, unauthorized or unintended by the original manufacturer for distribution of medicines.

This section contained 12 questions including an open-ended question, closed-ended and partially closed-ended questions with the objective of collecting the following information from respondents:

1. Number of times contacted by grey market vendors in the last month (question 13);
2. Number of times solicited by grey market vendors to buy drug products (question 14);
3. Number of times grey market vendors solicited the hospitals to purchase products from the hospital (question 15);
4. The most widely used methods hospital pharmacists hear about products available from the grey market vendors (question 16);
5. Collect hospital pharmacists perceptions as to the main concerns regarding the purchasing of drug products from grey market vendors (question 17); and
6. Hospital pharmacy personnel perceptions with regard to grey market vendors' activities associated with drug shortages (question 18).

The third section used eight questions to gather information about respondents' demographics and practice setting characteristics. The following information was collected using closed-ended and partially closed-ended questions:

1. Type of facility (question 19);
2. Position within facility (question 20);
3. Whether or not the person who completed the questionnaire was licensed pharmacist (question 21);

4. Number of pharmacist full-time-equivalents at the facility (question 22);
5. Number of pharmacy technician full-time-equivalents (question 23);
6. Facility size in terms of number of beds (question 24);
7. Inpatient medication budget (question 25); and
8. Facility geographic location (question 26).

Table 2.1: Operational Definitions of Variables Contained in the Survey Instrument

Variable Name	Operational Definition	Measurement level/ Variable labels	Survey Section (Number)
Number Drug Shortages	Number of drug shortages each hospital experienced in the last month	Ordinal: 0 = None, 1= 1-2, 3= 3-4, 4=5-6, 5=9-10, 6= \geq 11	I (1)
Degree of Problem	Degree of the of drug shortages' problem regarding each hospital setting	Ordinal: 1= No problem, 2= Not much of a problem, 3 = Some kind of a problem	I (2)
Drug Shortages	List of 15 drug shortages	Dichotomous: 1= No, 2= Yes	I (3)
Activities	Activities associated with drug shortages	Dichotomous: 1= No, 2= Yes	I (4)
Week hours	Number of hours per week (h/w) hospital pharmacy staff spend managing drug shortages	Ordinal: 1= 1-3 h/w, 2= 4-6 h/w, 3= 7-9 h/w, 4= 10-12 h/w, 5= 13-15 h/w, 6= \geq 16 h/w	I (5)
Additional Staff	Additional staff hired as a result of increased workload due to drug shortages	Dichotomous: 1= No, 2= Yes	I (6)
Number of additional staff	Number of additional staff hired as a result of increased workload due to drug shortages	Interval	I (7)
Personnel Shifted	Hospital pharmacy personnel shifted from patients' care activities toward managing drug shortages	Dichotomous: 1= No, 2= Yes	I (8)
Activities affected	Activities that have been affected as a result of shifting hospital pharmacy personnel toward managing drug shortages	Categorical: 0 = Not Selected, 1= Highly Affected, 2= Some What Affected, 3= Not Affected	I (9)

Table 2.1: Operational Definitions of Variables Contained in the Survey Instrument (*continued*)

Variable Name	Operational Definition	Measurement level/ Variable labels	Survey Section (Number)
Supply Resources	Resources commonly used while obtaining drugs in short supply	Categorical: 0 = Not Selected, 1= Most Widely Used, 2= Second Most Widely Used, 3= Third Most Widely Used	I (10)
Information Resources	Information resources used to obtain information on drugs in short supply	Dichotomous: 1= No, 2= Yes	I (11)
Reasons	Reasons of drug shortages	Categorical: 0 = Not Selected, 1= Most Common Reason, 2= Second Most Common Reason, 3= Third Most Common Reason	I (12)
Grey Market Contact	Hospital pharmacy staff personnel contacted by a grey market vendor	Categorical: 1= No, 2= Yes, 3= Don't know	II (13)
Number of grey market contact	Number of times contacted by grey market vendors	Interval	II (13)
Incidence of grey market to sell	Incidence of grey market vendors contacts with hospital staff personnel to sell their products	Categorical: 0 = None 1= Monthly, 2= Less than monthly, 3= Weekly, 4= Daily	II (14)
Incidence of grey market to buy	Incidence of grey market vendors contacts with hospital staff personnel to buy products	Categorical: 0 = None 1= Monthly, 2= Less than monthly, 3= Weekly, 4= Daily	II (15)

Table 2.1: Operational Definitions of Variables Contained in the Survey Instrument (continued)

Variable Name	Operational Definition	Measurement level/ Variable labels	Survey Section (Number)
Contact methods	Methods by which hospital pharmacy staff personnel hear about products available from the gray market vendors	Categorical: 0 = Not Selected, 1= Most Widely Used, 2= Second Most Widely Used, 3= Third Most Widely Used	II (16)
Concerns	Concerns regarding purchasing products from grey market vendors	Dichotomous: 1= No, 2= Yes	II (17)
Grey market Likelihood	Grey market vendors' likelihood to contact facility when drug shortage exists	Interval (Likert Scale): 1= Strongly Disagree, 2= Disagree, 3= Neutral, 4= Agree, 5= Strongly Agree	II (18a)
Grey Market Ability	Grey market vendors' ability to identify and obtain drugs in short supply	Interval (Likert Scale): 1= Strongly Disagree, 2= Disagree, 3= Neutral, 4= Agree, 5= Strongly Agree	II (18b)
Grey Market Contribution	Grey market vendors' contribution to the drug shortage crises	Interval (Likert Scale): 1= Strongly Disagree, 2= Disagree, 3= Neutral, 4= Agree, 5= Strongly Agree	II (18c)
Grey Market Contribution	Grey market vendors' contribution to the drug shortage crises	Interval (Likert Scale): 1= Strongly Disagree, 2= Disagree, 3= Neutral, 4= Agree, 5= Strongly Agree	II (18c)
Grey Market Price	Grey market vendors sell drugs in short supply at inflated prices	Interval (Likert Scale): 1= Strongly Disagree, 2= Disagree, 3= Neutral, 4= Agree, 5= Strongly Agree	II (18d)

Table 2.1: Operational Definitions of Variables Contained in the Survey Instrument (continued)

Variable Name	Operational Definition	Measurement level/ Variable labels	Survey Section (Number)
Grey Market Markups	Grey market vendors offer drugs in short supply needed to treat critically ill patients at largest markups	Interval (Likert-Like Scale): 1= Strongly Disagree, 2= Disagree, 3= Neutral, 4= Agree, 5= Strongly Agree	II (18e)
Grey Market Source	Grey market vendors as the only source available for obtaining a drug in shortage	Interval (Likert-Like Scale): 1= Strongly Disagree, 2= Disagree, 3= Neutral, 4= Agree, 5= Strongly Agree	II (18f)
Grey Market Elimination	Eliminating the practice of buying products from grey market vendors	Interval (Likert-Like Scale): 1= Strongly Disagree, 2= Disagree, 3= Neutral, 4= Agree, 5= Strongly Agree	II (18g)
Facility type	Hospital type	Categorical: 1= Community Hospital, 2= Chain Hospital, 3= Children’s Hospital, 4= Health Care Group Hospital, 5=Health Care System Hospital, 6= University Hospital, 7= Other (please, specify)	III (19)
Position	Pharmacist position within the hospital	Categorical: 1= Director of pharmacy, 2= Pharmacy manager, 3= Pharmaceutical purchasing agent, 4= Staff pharmacist, 5= Pharmacy technician, 6= Pharmacy clerk, 7= Other (please, specify)	III (20)
License	Pharmacist license	Dichotomous: 1= No, 2= Yes	III (21)
Pharmacist (FTEs)	Number of Pharmacist Full Time Equivalents (FTEs)	Categorical: 1= ≤ 10, 2= 11- 25, 3= 26- 50, 4= > 50	III (22)

Table 2.1: Operational Definitions of Variables Contained in the Survey Instrument (continued)

Variable Name	Operational Definition	Measurement level/ Variable labels	Survey Section (Number)
Pharmacy Technician (FTEs)	Number of Pharmacist Technician Full Time Equivalents (FTEs)	Categorical: 1= ≤ 10, 2= 11- 25, 3= 26- 50, 4= > 50	III (23)
Hospital Size	Hospital size in terms of number of beds	Categorical: 1= < 100, 2= 100 – 150 beds, 3= 151 – 250 beds, 4= 251 - 350 beds, 5= 351 – 450 beds, 6= > 451	III (24)
Budget	Hospital inpatient medication budget per year	Categorical: 1= < \$1.5 million, 2= \$1.5-5.0 million, 3= \$5.0-10 million, 4= > \$10 million	III (25)
Hospital Location	Hospital location	Categorical: 6= Large Metropolitan, 5= Medium Metropolitan, 4=Small Metropolitan, 3= Semi- Urban, 2= Semi- Rural, 1= Rural	III (26)

2.1.2 Institutional Review Board Approval

This study received an expedited approval from the University of Texas Institutional Review Board (IRB Protocol # 2012-07-0010) on April 2, 2013.

2.1.3 Sample Selection

The study population of interest was Texas non-government acute care hospitals, identified through the Texas Hospital List for 2012, which is available on the Texas Department of State Health Services (DSHS) website (<http://wwwprod.dshs.state.tx.us/default.shtm>). Texas DSHS is a state agency, which provides state-operated health care services, including hospitals, health centers, and health agencies. The Center for Health Statistics, within the Texas DSHS, conducts annual survey of Texas hospitals in collaboration with the American Hospital Association and releases a comprehensive list of all Texas hospitals each year. The 2012 Texas Hospital List had an alphabetical listing of Texas hospitals and the city where each hospital is located. It also had the complete hospital name, address, county, zip code, number of beds, and type of ownership. All non-federal government acute care hospitals, irrespective of their ownership (i.e., for-profit, not-for-profit), with 50 or greater beds were selected and surveyed. A total sample of 321 hospitals was selected from the Texas Hospital List for 2012 that included every non-government acute care hospital with 50 or greater beds.

2.1.4 Pretest

The survey questionnaire was pretested on a convenience sample of seven Texas hospital pharmacists working at non-government acute care hospitals. The survey questionnaire, a cover letter and a questionnaire evaluation form were sent electronically by email to selected hospital pharmacists. The hospital pharmacists were asked to provide feedback on the clarity and completeness of the questionnaire by identifying unclear or confusing items and offering suggestions. In addition, the pretest individuals were asked to record the time needed to complete the survey instrument.

After receipt of all pretest evaluation forms and based on reviewers' recommendations some items were reworded and two new items were added to the survey instrument. For example, the list representing recent drug shortages (Question 3) was updated in order to reflect the current drug shortages as recommended by the reviewers. In addition, the answer choices in Question 4 "*Preparing written communications for health care providers*" and "*Communicating information to other health care providers*" were viewed as repetitive and therefore the first answer choice was removed, yet a new answer choice was added "*Communicating drug shortage information to hospital administration*" to better reflect current practices within hospitals. A new question (Question 9) was added to capture the patient care activities that have been affected as a result of shifting hospital pharmacy personnel toward managing drug shortages. Furthermore, a new question (Question 12) was included to assess hospital pharmacy staff considerations in regard to most common reasons for the current drug shortages. The reviewers reported that the time needed to complete the survey was between 10 and 15 minutes.

2.2 PHASE TWO

2.2.1 Survey Administration

The questionnaire and a cover letter (see Appendix I and Appendix II) were mailed to the pharmacy directors for each of the 321 selected hospitals. The cover letter provided explanation of the purpose of the study, voluntary participation, respondents' confidentiality, security, anonymity of responses, IRB approval, and approximates time for completion of the questionnaire. It was stated that completing and returning the questionnaire would serve as consent for study participation. In addition, the cover letter included contact information of the Office of Research Support and the researchers involved in the study so that participants could direct any questions about the research. Responders were offered an aggregate summary of the study as an incentive to participate. A follow-up reminder mail was not sent due to budget constraints.

2.2.2 Data Collection

The data were collected in the period between May 09, 2013 and June 10, 2013, a one-month time period.

2.2.3 Data Analysis

Data from the questionnaire were entered into the Predictive Analytics Software (PASW)® version 18.0 for analysis. The data were cleaned and descriptive analysis was performed on all variables.

2.2.3.1 Descriptive Analysis

Descriptive analysis (means, standard deviations, frequency distribution) will be reported for all variables derived from the instrument. Means will be reported for continuous variables such as *'number of times hospital pharmacy personnel got contacted by grey market vendors'* (item 13), *'perceptions regarding grey market vendors contribution toward the drug shortages crises'* (item 18b), *'perceptions toward grey market vendors practice of selling drugs in short supply at inflated prices'* (item 18d), and *'perceptions toward elimination of the practice of buying drugs in short supply from grey market vendors'* (item 18g).

Counts and percentages will be reported for categorical variables such as *'number of drug shortages experienced'* (item 1), *'number of hours per week managing drug shortages'* (item 5), *'facility type'* (item 19), *'position within facility'* (item 20), *'pharmacy licensure'* (item 21), *'number of pharmacist FTEs'* (item 22), *'number of pharmacy technician FTEs'* (item 23), *'facility size'* (item 24), *'inpatient medication budget'* (item 25), and *'facility location'* (item 26).

2.2.3.2 Independent Variables

The independent variables for this project are *'facility type'* (item 19), *'position within facility'* (item 20), *'pharmacy licensure'* (item 21), *'number of pharmacist FTEs'* (item 22), *'number of pharmacy technician FTEs'* (item 23), *'facility size'* (item 24), *'inpatient medication budget'* (item 25), and *'facility location'* (item 26).

2.2.3.3 Dependent Variables

Based on the study objectives the dependent variables are: ‘ *number of drug shortages experienced*’ (item 1), ‘ *number of hours per week managing drug shortages*’ (item 5), ‘ *number of additional staff hired as a result of increased workload due to drug shortages*’ (item 7), ‘ *number of times hospital pharmacy personnel got contacted by grey market vendors*’ (item 13), and perceptions toward whether grey market vendors ‘ *contribute toward the drug shortages crises*’ (item 18b), ‘ *sell drugs in short supply at inflated prices*’ (item 18d), and ‘ *practice of selling drugs in short supply need to be eliminated*’ (item 18g).

2.2.3.4 Hypotheses Testing

All statistical analysis will be performed using Predictive Analytics Software[®] (PASW[®]) Statistics 18. An a priori significance level of $p < 0.05$ will be used for all statistical tests. Table 2.2 summarizes the study hypothesis, variables, and statistical tests employed.

Table 2.2: Summary of Hypothesis, Variables and Statistical Tests

Hypothesis	Dependent Variable (DV)	Independent Variable (IV)	Statistical Test
H_{A1}	Number of drug shortages experienced by a health system: <i>Categorical</i>	Facility size: <i>Categorical</i>	Chi-square
H₀₂	Number of drug shortages experienced by a health system: <i>Categorical</i>	Facility type: <i>Categorical</i>	Chi-square
H₀₃	Number of drug shortages experienced by a health system: <i>Categorical</i>	Inpatient medication budget: <i>Categorical</i>	Chi-square
H₀₄	Number of drug shortages experienced by a health system: <i>Categorical</i>	Location: <i>Categorical</i>	Chi-square
H_{A5}	Number of hours spent per week by hospital pharmacy personnel when managing drug shortages: <i>Categorical</i>	Facility size: <i>Categorical</i>	Chi-square
H_{A6}	Number of hours spent per week by hospital pharmacy personnel when managing drug shortages: <i>Categorical</i>	Number of drug shortages: <i>Categorical</i>	Chi-square
H_{A7}	Number of hours spent per week by hospital pharmacy personnel when managing drug shortages: <i>Categorical</i>	Number of pharmacist FTEs: <i>Categorical</i>	Chi-square

Table 2.2: Summary of Hypothesis, Variables and Statistical Tests (Continued)

Hypothesis	Dependent Variable (DV)	Independent Variable (IV)	Statistical Test
H_{A8}	Number of hours spent per week by hospital pharmacy personnel when managing drug shortages: <i>Categorical</i>	Number of pharmacy technicians FTEs: <i>Categorical</i>	Chi-square
H₀₉	Number of times hospital pharmacy personnel were contacted by grey market vendors: <i>Categorical</i>	Facility size: <i>Categorical</i>	Chi-square
H₀₁₀	Number of times hospital pharmacy personnel were contacted by grey market vendors: <i>Categorical</i>	Number of drug shortages: <i>Categorical</i>	Chi-square
H₀₁₁	Number of times hospital pharmacy personnel were contacted by grey market vendors: <i>Categorical</i>	Facility type: <i>Categorical</i>	Chi-square
H₀₁₂	Number of times hospital pharmacy personnel were contacted by grey market vendors: <i>Categorical</i>	Location: <i>Categorical</i>	Chi-square
H₀₁₃	Grey market vendors contribute toward the drug shortages crises by buying whatever supplies they can find on the market: <i>Interval</i>	Position (IV ₁): <i>Categorical</i> Number of drug shortages (IV ₂): <i>Categorical</i>	Two sample T-test One-way ANOVA

Table 2.2: Summary of Hypothesis, Variables and Statistical Tests (*Continued*)

Hypothesis	Dependent Variable (DV)	Independent Variable (IV)	Statistical Test
H₀₁₄	Grey market vendors' practice of selling drugs in short supply at inflated prices: <i>Interval</i>	Position (IV ₁): <i>Categorical</i> Number of drug shortages (IV ₂): <i>Categorical</i>	Two sample T-test One-way ANOVA
H₀₁₅	Elimination of the practice of buying drugs in short supply from grey market vendors: <i>Interval</i>	Position (IV ₁): <i>Categorical</i> Number of drug shortages (IV ₂): <i>Categorical</i>	Two sample T-test One-way ANOVA

Chapter Three: Results

This chapter presents the results of the survey data analysis. In particular, it details respondents' demographic and practice setting characteristics, in addition to descriptive analysis and hypothesis testing.

3.1 SURVEY RESPONSE RATE

A total of 321 self-administered mail surveys and cover letters were sent to hospital directors of non-government acute care hospitals in the State of Texas. Data collection period was set beginning on May 09, 2013 and ending on June 10, 2013. By the end of the data collection period, 125 completed surveys were received by mail and 8 surveys were returned as undelivered. Thus, 313 surveys were considered delivered resulting in a response rate of 39.84% (125/313). Only one mailing was used to collect the data.

3.2 DESCRIPTIVE ANALYSIS

3.2.1 Respondents' Demographic and Practice Setting Characteristics

Table 3.1 illustrates the demographics and practice setting characteristics of the respondents. A total of 76.0% (n = 95) of the respondents were pharmacy directors and 8.8% (n = 11) were purchasing agents of the hospitals. Approximately half of the respondents (47.2%, n = 59) indicated community hospital as their practice setting whereas 26.4% (n = 33) worked in a health care system hospital. A majority of the respondents, 105 (84.0%), were licensed pharmacists. Regarding the number of

pharmacist full-time equivalents (FTEs) employed at each hospital, the majority of the respondents (61.6%, n = 77) indicated 10 or less pharmacist FTEs, 28.0% (n = 35) listed between 11 and 25 pharmacist FTEs. A total of 78 (62.4%) respondents reported 10 or less full-time equivalent pharmacy technicians and 34 (27.2%) listed between 11 and 25 FTE pharmacy technicians employed. In terms of facility size, reported as number of beds, approximately half of the respondents (42.4%, n = 53) listed 100 or less, whereas 16.0% (n = 20) indicated between 100 and 150 beds. Of the total 125 respondents, 43 (34.4%) had less than \$1.5 million annual inpatient budget, 48 (38.4%) reported between \$1.5 and \$5.0 million and 34 (27.2%) had more than \$5.0 million. A total of 52 (41.6%) hospitals were located in large metropolitan areas whereas 29 (23.3%) were set in medium metropolitan areas.

Table 3.2 depicts respondents' position controlling for pharmacist licensure status. A total of 123 respondents answered the item on licensure and from this total 105 (85.4%) were licensed pharmacists. Out of the 11 who indicated being purchasing agents, only 2 respondents were licensed pharmacists.

Table 3.1: Respondents' Demographic and Practice Setting Characteristics (N=125)^a

Variable	Measure	Frequency N (%)
Position	Director of Pharmacy	95 (76.0%)
	Pharmacy Manager	10 (8.0%)
	Pharmaceutical Purchasing Agent	11 (8.8%)
	Staff Pharmacist	2 (1.6%)
	Pharmacy Technician	6 (4.8%)
	Other ^c	1 (0.8%)
	Total (N)	125
Facility Type	Community Hospital	59 (47.2%)
	Chain Hospital	14 (11.2%)
	Children's Hospital	5 (4.0%)
	Health Care Group Hospital	9 (7.2%)
	Health Care System Hospital	33 (26.4%)
	University Hospital	1 (0.8%)
	Other ^d	4 (3.2%)
	Total (N)	125
Pharmacy Licensure	Licensure	105 (85.4%)
	No Licensure	18 (14.6%)
	Total (N)	123^b

^aTotal number of respondents (N) = 125.

^bTwo respondents did not answer this item.

^c'Other' position specified by respondent as clinical coordinator.

^d'Other' facility type indicated by respondents included long term acute care hospitals, rehabilitation hospital and privately owned hospital.

^eFTEs – Full-Time Equivalents.

^fNumber of beds.

Table 3.1: Respondents' Demographic and Practice Setting Characteristics
(continued)

Variable	Measure	Frequency N (%)
Pharmacist FTEs ^e	Less or equal 10 FTEs	77 (61.6%)
	11-25 FTEs	35 (28.0%)
	26-50 FTEs	6 (4.8%)
	More than 50 FTEs	7 (5.6%)
	Total (N)	125
Pharmacy Technician FTEs ^e	Less or equal 10 FTEs	78 (62.4%)
	11-25 FTEs	34 (27.2%)
	26-50 FTEs	8 (6.4%)
	More than 50 FTEs	5 (4.0%)
	Total (N)	125
Facility Size ^f	Less than 100 beds	53 (42.4%)
	100-150 beds	20 (16.0%)
	151-250 beds	17 (13.6%)
	251-350 beds	16 (12.8%)
	351-450 beds	10 (8.0%)
	More than 450 beds	9 (7.2%)
	Total (N)	125

^aTotal number of respondents (N) = 125.

^bTwo respondents did not answer this item.

^c'Other' position specified by respondent as clinical coordinator.

^d'Other' facility type indicated by respondents included long term acute care hospitals, rehabilitation hospital and privately owned hospital.

^eFTEs – Full-Time Equivalents.

^fNumber of beds.

Table 3.1: Respondents' Demographic and Practice Setting Characteristics
(continued)

Variable	Measure	Frequency N (%)
Inpatient Medication Budget	Less than \$1.5 million	43 (34.4%)
	\$1.5-\$5.0 million	48 (38.4%)
	\$5.0-\$10 million	18 (14.4%)
	More than \$10 million	16 (12.8%)
	Total (N)	125
Facility Location	Rural	6 (4.8%)
	Semi-Rural	6 (4.8%)
	Semi-Urban	15 (12.0%)
	Small Metropolitan	17 (13.6%)
	Medium Metropolitan	29 (23.2%)
	Large Metropolitan	52 (41.6%)
	Total (N)	125

^aTotal number of respondents (N) = 125.

^bTwo respondents did not answer this item.

^c'Other' position specified by respondent as clinical coordinator.

^d'Other' facility type indicated by respondents included long term acute care hospitals, rehabilitation hospital and privately owned hospital.

^eFTEs – Full-Time Equivalents.

^fNumber of beds.

Table 3.2: Frequency Distribution of Pharmacists' Positions within the Hospitals and their Licensure Status (N=123)^a

Positions	Pharmacist Licensure		Total N (%)
	No N (%)	Yes N (%)	
Director of Pharmacy	1 (5.6%)	92 (87.6%)	93 (75.6%)
Pharmacy Manager	3 (16.7%)	7 (6.7%)	10 (8.1%)
Pharmaceutical Purchasing Agent	9 (50.0%)	2 (1.9%)	11 (8.9%)
Staff Pharmacist	0 (0.0%)	2 (1.9%)	2 (1.6%)
Pharmacy Technician	5 (27.8%)	1 (1.0%)	6 (4.9%)
Other	0 (0.0%)	1 (1.0%)	1 (0.8%)
Total^a N (%)	18 (100%)	105 (100%)	123 (100%)

^aTotal number of respondents (N) = 123, two respondents did not answer the pharmacy licensure item.

3.2.2 Incidence of Drug Shortages

In a closed ended question, respondents were asked to report the number of drug shortages encountered within their health facility for the month of April 2013. The answer choices provided and the results are depicted in Table 3.3. A majority of the respondents 56 (45.5%) reported 11 or more drug shortages for the month of April 2013, followed by 23 (18.7%) indicating between 5 and 6 drug shortages. Thus 64.2% (n = 79) of the respondents reported five or more drug shortages in April 2013.

In a related item respondents were asked to give their opinion as to the extent of the drug shortages' problem. The rating scale used was 'significant problem', 'moderate problem', 'some kind of a problem', and 'not much of a problem'. Table 3.4 represents the

respondents' ratings of the degree of the drug shortages' problem. A majority of the respondents, 85 (68.0%) rated the existing drug shortages' problem as 'significant' whereas 32 (25.6%) indicated drug shortages to be a 'moderate problem'. Only one respondent (0.8%) thought drug shortages were 'not much of a problem'.

In addition, respondents were given a list of the 15 most recent drugs which had a shortage as reported by the ASHP web site and were asked to report whether their hospital experienced a shortage for each of the 15 recent drug shortages for April 2013. Table 3.5 lists the 15 drug products and shows the percentage of hospitals affected by each of the products. At least 40% (n = 50) of the respondents indicated that their hospital was affected by nine of the drugs listed; four drugs which included atropine sulfate injection, calcium chloride injection, dextrose injection, and sodium bicarbonate injection affected over 80% (n = 105) of the hospitals and one drug (Dextrose 50% injection) affected more than 90% (n = 118) of the hospitals.

Table 3.3: Frequency Distribution of the Reported Number of Drug Shortages Experienced in the Month of April 2013 (N=123)^a

Number of Drug Shortages	Frequency N (%)
1 to 2	1 (0.8%)
3 to 4	13 (10.6%)
5 to 6	23 (18.7%)
7 to 8	13 (10.6%)
9 to 10	17 (13.8%)
11 or more	56 (45.5%)

^aTotal number of respondents (N) =123, two respondents did not answer the item.

Table 3.4: Respondents were Asked to Rate the Degree of the Drug Shortages' Problem Regarding their Hospital Setting (N=125)^a

Degree of the Drug Shortages' Problem	Frequency N (%)
Not much of a problem	1 (0.8%)
Some kind of a problem	7 (5.6%)
Moderate problem	32 (25.6%)
Significant problem	85 (68%)

^aTotal number of respondents (N) =125.

Table 3.5: Percentage of Hospitals Affected by each of the 15 Drug Shortages Listed on the ASHP Web Site as of April, 2013 (N=124)^{a, b}

Drug Name	Frequency N (%)
Amiodarone HCl Injection	50 (40.3%)
Amikacin Injection	62 (50%)
Aminophylline Injection	54 (43.5%)
Atropine Sulfate Injection	106 (85.5%)
Calcium Chloride Injection	105 (84.7%)
Cytarabine Injection	17 (13.7%)
Dextrose 50% Injection	118 (95.2%)
Dopamine Injection	65 (52.4%)
Diltiazem Injection	40 (32.3%)
Methotrexate Injection	25 (20.2%)
Midazolam Injection	49 (39.5%)
Norepinephrine Injection	46 (37.1%)
Oxymorphone Hydrochloride	10 (8.1%)
Odanserton Injection	57 (46%)
Sodium Bicarbonate Injection	112 (90.3%)

^aTotal number of respondents (N) =124, one respondent did not answer the item.

^bTotal percentage is more than 100% because of multiple responses.

3.2.3 Managing Drug Shortages

A list of management activities was provided to respondents and they were asked to indicate if their practice used the listed activities in managing their drug shortages. The activities listed in the item were as follows:

- ‘tracking drug shortages/gathering information’,
- ‘identifying therapeutic alternatives’,
- ‘contacting vendors, manufacturers, and group purchasing organizations’,
- ‘manage inventory/rationing available supplies/prioritizing’,
- ‘communicating drug information to other health care providers’, and
- ‘communicating drug shortage information to hospital administration’.

Respondents also had the opportunity to select “other” as a category and provide explanation. “Trading and borrowing” was listed. Table 3.6 presents frequency distribution of respondents’ responses regarding the activities applied within their practice settings when managing drug shortages. More than 90% of the respondents selected all of the listed activities that were applicable to their practice setting when managing drug shortages. The activity ‘identifying therapeutic alternatives’ was selected by majority of the respondents (n = 122, 97.6%), followed by both ‘manage inventory/rationing available supplies/prioritizing’ and ‘communicating drug information to other health care providers’ activities (n = 121, 96.8%), ‘contacting vendors, manufacturers, and group purchasing organizations’ (n = 117, 93.6%), and ‘communicating drug shortage information to hospital administration’ (n = 113, 90.4%). Two of the respondents (2.4%) specified ‘trading/borrowing’ as an activity practiced at their hospital when managing drugs in short supply.

Table 3.6: Frequency Distribution of Respondents' Selection Regarding Activities Practiced when Managing Drug Shortages (N=125)^a

Activity	Frequency N (%)^b
Tracking drug shortages/Gathering information	116 (92.8%)
Identifying therapeutic alternatives	122 (97.6%)
Contacting vendors, manufacturers, and group purchasing organizations	117 (93.6%)
Manage inventory/Rationing available supplies/Prioritizing	121 (96.8%)
Communicating drug information to other health care providers	121 (96.8%)
Communicating drug shortage information to hospital administration	113 (90.4%)
Trading/Borrowing	2 (2.4%)

^aTotal number of respondents (N) = 125.

^bTotal frequency is more than 125 and percentage total is more than 100% because of multiple responses.

Respondents were asked to estimate the number of hours per week hospital pharmacy personnel spend on managing drug shortages. Table 3.7 shows the frequency distributions of respondents' responses. A total of 62.9% (n = 78) of the respondents spent anywhere from a half day to one and a half days a week (four to 12 hours) on managing drug shortage situations. Eighteen respondents (14.5%) indicated that they spend 2 or more days a week managing drug shortages.

Table 3.7: Frequency Distribution of Respondents' Responses Regarding Number of Hours per Week spent when Managing Drug Shortages (N=124)^a

Number of Hours per Week (hrs/week)	Frequency N (%)
1 to 3 hrs/week	17 (13.7%)
4 to 6 hrs/week	31 (25.0%)
7 to 9 hrs/week	24 (19.4%)
10 to 12 hrs/week	23 (18.5%)
13-15 hrs/week	11 (8.9%)
16 hrs/week or more	18 (14.5%)

^aTotal number of respondents (N) =124, one respondent did not answer the item.

3.2.4 Impact of Drug Shortages

To explore the impact drug shortages has had on hospital pharmacy personnel, respondents were asked to report whether additional staff were hired as a result of increased workload and whether or not hospital pharmacy personnel were shifted from patients' care activities toward managing drug shortages. Only three respondents (2.4%) indicated that they had hired more people because of drug shortage situations. The remaining 121 (97.6%) reported that there were no hires as a result of increased workload due to drug shortages. Of those who reported hiring additional staff, 2 (1.6%) indicated hiring 1 additional personnel and 1 (0.8%) respondent reported hiring 2 additional personnel. Controlling for hospital size showed that the two respondents who reported hiring one additional personnel each split equally between hospitals with less than 100 beds and hospitals with greater than 100 beds. On the other hand, the respondent who

indicated hiring two additional personnel was representative of hospitals with greater than 100 beds.

Of the 124 respondents, 76 (61.3%) reported that hospital pharmacy personnel have not been shifted from patients' care activities toward managing drug shortages, while 48 (38.7%) confirmed shifting hospital pharmacy personnel from patients' care activities. Twenty (41.7%) of the respondents who reported shifting hospital personnel were representatives of hospitals with less than 100 beds whereas twenty-eight (58.3%) respondents were representatives of hospitals with greater than 100 beds.

Respondents who reported shifting hospital pharmacy personnel from patients' care activities toward managing drug shortages within their facility settings were asked to select from a list of nine patients' care activities three patients' care activities and to rate the degree to which these areas were affected. The rating scale used was "1" being highly affected, "2" being somewhat affected, and "3" not being affected. The listed patients' care activities included:

- practice management
- medication-use policy development
- optimizing medication therapy
- drug product procurement and inventory management
- preparing, packaging and labeling medications
- medication delivery
- monitoring medication use
- evaluating the effectiveness of the medication-use system and
- research.

Table 3.8 depicts the patients' care activities and the responses. A majority of the respondents, 20 (54.1%), indicated 'drug product procurement and inventory management' as highly affected, this was followed by 'preparing, packaging and labeling medications' (N=12, 32.4%) rated as somewhat affected, and 'medication delivery' (N=7, 18.9%) as being not affected.

Table 3.8: Respondents' Ratings of the Extent to which Patients' Care Activities have been Affected (N=37)^a

Patients' Care Activities	Highly Affected N (%)	Somewhat Affected N (%)	Not Affected N (%)
Drug product procurement and inventory management	20 (54.1%)	5 (13.5%)	5 (13.5%)
Preparing, packaging and labeling medications	5 (13.5%)	12 (32.4%)	2 (5.4%)
Monitoring medication use	4 (10.8%)	3 (8.1%)	0 (0.0%)
Practice management	3 (8.1%)	4 (10.8%)	3 (8.1%)
Optimizing medication therapy	2 (5.4%)	3 (8.1%)	4 (10.8%)
Medication delivery	2 (5.4%)	6 (16.2%)	7 (18.9%)
Medication-use policy development	0 (0.0%)	4 (10.8%)	2 (5.4%)
Research	0 (0.0%)	0 (0.0%)	5 (13.5%)
Evaluating the effectiveness of the medication-use system	0 (0.0%)	0 (0.0%)	0 (0.0%)
Total N (%)	36^b (97.3%)	37 (100.0%)	28^c (56.7%)

^aTotal number of respondents (N) = 37, eleven respondents did not answer the item.

^bOne respondent did not indicate 'Highly Affected' patients' care activity.

^cNine respondents did not indicate 'Not Affected' patients' care activity.

3.2.5 Drug Shortage Supply and Information Resources and Respondents' Opinions on Drug Shortage Causes

Respondents were asked to rank the top three supply resources used when obtaining drugs in short supply using numbers 1 through 3 with “1” being the most widely used supply resource, “2” being the second most widely used supply resource, and “3” being the third most widely used supply resource. The list of supply resources included:

- purchasing off-contract from current vendor
- purchase from alternative/secondary vendor
- borrow from another institution
- obtain services from group purchasing organization
- purchase-compounded replacement pharmaceuticals and
- purchase raw materials to compound replacement pharmaceuticals.

A total of 116 respondents answered the question and the results are depicted in Table 3.9. Forty-eight (41.4%) out of 116 respondents reported purchasing off-contract from current vendor as the most widely used supply resource. This was followed by purchasing from alternative/secondary vendor (n = 28, 24.1%) and borrowing from another institution (n = 25, 21.6%). As of total selections, both purchasing off-contract from current vendor and purchasing from alternative/secondary vendor were each selected by 90 (77.6%) of the respondents among the first three most widely used supply resources, followed by borrowing from another institution 84 (72.4%), purchasing compounded replacement pharmaceuticals 57 (49.1%), obtaining services from group purchasing organization 19 (16.4%), and purchasing raw materials to compound replacement pharmaceuticals 3 (2.6%). Controlling for hospital size showed that among

the 90 respondents who selected purchasing from alternative/secondary vendor as one the three most widely used supply resource 39 (43.3%) respondents were representatives of hospitals with less than 100 beds, and 51 (56.7%) respondents were representatives of hospitals with greater than 100 beds. In addition, controlling for hospital type showed that among the 90 respondents who selected purchasing from alternative/secondary vendor as one of the three most widely used supply resource 48 (53.3%) respondents were representatives of non-chain hospitals whereas 42 (46.7%) respondents were representatives of chain hospitals.

Table 3.9: Respondents’ Ranking of the Most Widely Used Supply Resources when Obtaining Drugs in Short Supply (N=116)^a

Supply Resource	Most Widely Used N (%)	2nd Most Widely Used N (%)	3rd Most Widely Used N (%)	N^b (%)
Purchase off-contract from current vendor	48 (41.4%)	27 (23.3%)	15 (12.9%)	90 (77.6%)
Purchase from alternative/secondary vendor	28 (24.1%)	39 (33.6%)	23 (19.8%)	90 (77.6%)
Borrow from another institution	25 (21.6%)	28 (24.1%)	31 (26.7%)	84 (72.4%)
Purchase compounded replacement pharmaceuticals	11 (9.5%)	15 (12.9%)	31 (26.7%)	57 (49.1%)
Obtain services from group purchasing organization	3 (2.6%)	6 (5.2%)	10 (8.6%)	19 (16.4%)
Purchase raw materials to compound replacement pharmaceuticals	1 (0.9%)	1 (0.9%)	1 (0.9%)	3 (2.6%)
Total N (%)	116 (100%)	116 (100%)	111 ^c (95.6%)	

^aTotal number of respondents (N) = 116, nine respondents did not answer the item.

^bIndicates total frequency of respondents who ranked each supply resource.

^cFive respondents did not indicate ‘3rd Most Widely Used’ supply resource.

Respondents were asked to report the information resources used when gathering information about drug shortages. A list of seven answer choices included: American Society of Health-System Pharmacists (ASHP); Food and Drug Administration (FDA); Centers for Disease Control and Prevention (CDC); Wholesalers; Manufacturers; Group purchasing organizations (GPOs); and other. Table 3.10 presents the frequency distribution of respondents' choices. A majority of the respondents, 110 (88.0%), reported gathering drug shortages information from wholesalers, followed by ASHP (n = 107, 85.6%) . Seventy-nine (63.2%) used manufacturers as an information resource, 76 (60.8%) reported GPOs, 69 (55.2%) stated FDA, 14 (11.2%) indicated CDC, and 10 (8.8%) selected 'other' as an answer choice. Of those selecting 'other', 5 (4.0%), specified the Risk and Safety Management Alert System (RASMAS) as an information resource currently used when seeking information about drug shortages.

Table 3.10: Frequency Distribution of Respondents’ Responses Regarding Information Resources Used in Collecting Drug Shortages Information (N=125)^a

Information Resource	Frequency N (%)^b
Wholesalers	110 (88.0%)
ASHP ^c	107 (85.6%)
Manufacturers	79 (63.2%)
GPOs ^d	76 (60.8%)
FDA ^e	69 (55.2%)
CDC ^f	14 (11.2%)
Other	10 (8.0%)
RASMAS ^g	5 (4.0%)

^aTotal number of respondents (N) = 125.

^bTotal frequency is more than 125 and total percentage is more than 100% because of multiple responses.

^cASHP-American Society of Health-System Pharmacists.

^dGPOs-Group purchasing organizations.

^eFDA-Food and Drug Administration.

^fCDC-Centers for Disease Control and Prevention.

^gRASMAS-Risk and Safety Management Alert System.

Respondents were asked to rank order the top three common reason for drug shortages. A list of reasons were generated from the literature and respondents were asked to rate the top three reasons using the following rating scale: “1” being the most common reason, “2” being the second most common reason, and “3” being the third most common reason. The seven answer choices provided were: consolidation in the industry; raw materials; supply chain issues; manufacturing/regulatory issues, changes in clinical practice, business decisions; and unknown. Table 3.11 depicts the results.

Sixty-one (51.7%) out of 118 respondents indicated manufacturing/regulatory issues as the most common reason of drug shortages, this was followed by business decision (n = 39, 33.1%) and consolidation in the industry (n = 10, 8.5%). In terms of total mentions, 101 (85.6%) respondents indicated manufacturing/regulatory issues among the most common reasons of drug shortages, followed by business decisions 96 (81.4%), consolidation in the industry 73 (61.9%), raw materials 47 (39.8%), supply chain issues 30 (25.4%), unknown 5 (4.2%), and changes in clinical practice 1 (0.8%).

Table 3.11: Respondents' Ranking of the Most Common Reasons of Drug Shortages (N=118)^a

Reasons	Most Common Reason N (%)	2nd Most Common Reason N (%)	3rd Most Common Reason N (%)	N^b (%)
Manufacturing/regulatory issues	61 (51.7%)	27 (22.9%)	13 (11.0%)	101 (85.6%)
Business Decisions	39 (33.1%)	30 (25.4%)	27 (22.9%)	96 (81.4%)
Consolidation in the industry	10 (8.5%)	31 (26.3%)	32 (27.1%)	73 (61.9%)
Raw materials	5 (4.2%)	16 (13.6%)	26 (22.0%)	47 (39.8%)
Supply chain issues	2 (1.7%)	13 (11.0%)	15 (12.7%)	30 (25.4%)
Unknown	1 (0.8%)	0 (0.0%)	4 (3.4%)	5 (4.2%)
Changes in clinical practice	0 (0.0%)	1 (0.8%)	0 (0.0%)	1 (0.8%)
Total N (%)	118 (100%)	118 (100%)	117 ^c (99.1%)	

^aTotal number of respondents (N) =118, seven respondents did not answer the item.

^bIndicates total frequency of respondents who ranked each reason of drug shortages.

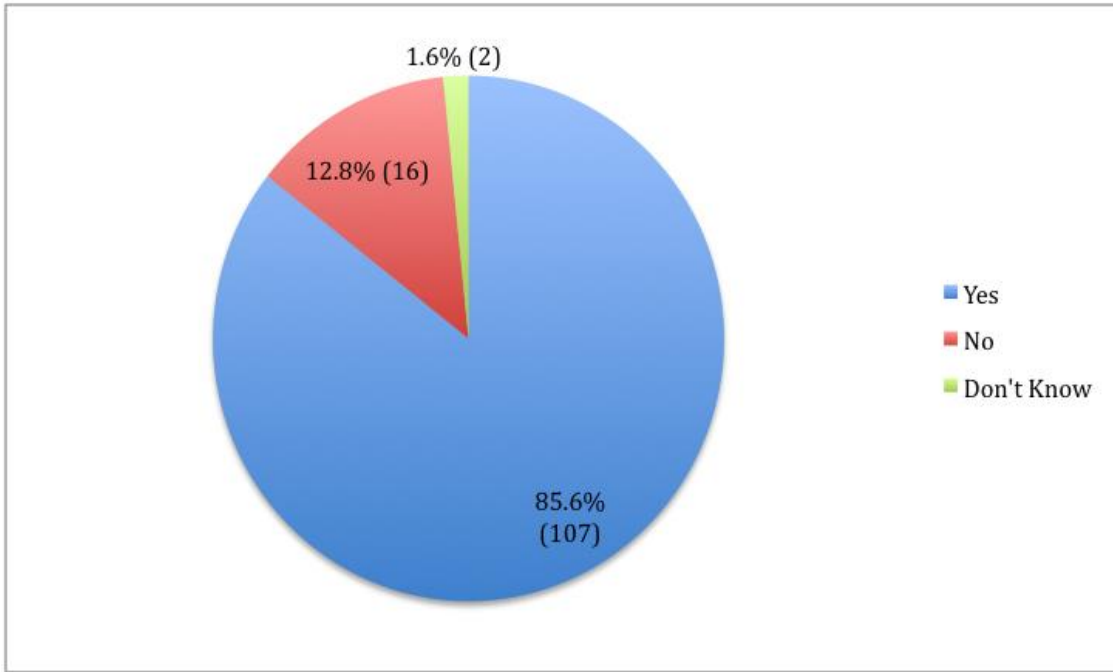
^cOne respondent did not indicate '3rd Most Common Reason'.

3.2.6 Grey Market Vendors and Drug Shortages

Respondents were asked to report whether a grey market vendor had contacted hospital pharmacy personnel in the last month (April, 2013). Grey market vendors were defined as secondary supply channels that are unofficial, unauthorized or unintended by the original manufacturer for distribution of medicines. A total of 107, (85.6%), reported that grey market vendors have contacted hospital pharmacy personnel in the last month (April, 2013), whereas 16 (12.8%) respondents indicated that they were not contacted and two (1.6%) answered 'Don't know'. Figure 3.1 shows the percentage of hospitals that have been contacted by grey market vendors in the last month (April, 2013).

Moreover, respondents who confirmed such contact were asked to estimate the number of times they were contacted by grey market vendors in the last month (April 2013). Table 3.12 represents the frequency distribution of the number of times grey market vendors have contacted the hospital pharmacy personnel in the last month (April, 2013). Seventy-three (68.2%) who reported being contacted by grey market vendors gave an estimate of the number of times such contact took place. A total of 34 (31.8%) did not answer the question. The reported number of grey market vendors' contacts ranged between 1 and 200 contacts, where the average number was 20.4 (SD = 32.035) contacts, the median was 10 (Interquartile Range = 5-20) contacts, and the mode was 10 contacts for the last month (April, 2013).

Figure 3.1: Percentage of Hospitals that have been Contacted by Grey Market Vendors in the Last Month (April, 2013), (N=125)^a



^aTotal number of respondents (N) = 125.

Table 3.12: Frequency Distribution of the Number of Times Grey Market Vendors have contacted the Hospital Pharmacy Personnel in the Last Month (April, 2013), (N=73)^a

Number of times contacted by gray market vendor	Frequency (%)
1	1 (1.4%)
2	1 (1.4%)
3	7 (9.6%)
4	7 (9.6%)
5	8 (11.0%)
6	5 (6.8%)
7	1 (1.4%)
8	2 (2.7%)
9	2 (2.7%)
10	11 (15.1%)
11	1 (1.4%)
12	2 (2.7%)
14	1 (1.4%)
15	2 (2.7%)
20	6 (8.2%)
22	1 (1.4%)
25	3 (4.1%)
30	2 (2.7%)
35	1 (1.4%)
45	1 (1.4%)
50	2 (2.7%)
80	1 (1.4%)
100	4 (5.5%)
200	1 (1.4%)
Total	73 (100%)

^aTotal number of respondents (N) = 73, thirty-four respondents did not answer the item.

In addition, respondents were asked to indicate both how often hospital pharmacy personnel have been solicited by grey market vendors to buy drugs in short supply and how often hospital pharmacy personnel have been solicited by grey market vendors to sell drugs in short supply. Table 3.13 depicts the frequencies and percentages of how often grey market vendors have contacted hospitals to sell or buy drugs in short supply in

the last month (April, 2013). In terms of how often grey market vendors have contacted hospital pharmacy personnel to sell drugs in short supply, 57 (53.3%) reported receiving contacts on a daily basis, 43 (40.2%) weekly, 5 (4.7%) monthly, and 2 (1.9%) respondents indicated getting contacts less than monthly. However, a majority of respondents, 82 (76.6%), noted not receiving any contacts from grey market vendors with the aim of buying drugs in short supply from their hospital pharmacies, this was followed by 9 (8.4%) respondents indicating getting such contacts less than monthly, 8 (7.5%) daily, 5 (4.7%) weekly, and 3 (2.8%) respondents reporting receiving contacts monthly.

Table 3.13: How Often Grey Market Vendors have Contacted Hospitals to Sell or Buy Drugs in Short Supply in the Last Month (April, 2013), (N=107)^a

Frequency	To sell drugs in short supply N (%)	To buy drugs in short supply N (%)
Daily	57 (53.3%)	8 (7.5%)
Weekly	43 (40.2%)	5 (4.7%)
Monthly	5 (4.7%)	3 (2.8%)
Less than monthly	2 (1.9%)	9 (8.4%)
None	0 (0.0%)	82 (76.6%)
Total N (%)	107 (100%)	107 (100%)

^aTotal number of respondents (N) = 107, total percentage more than 100% due to rounding.

Furthermore, 107 respondents who confirmed being contacted by grey market vendor in the last month (April, 2013) were asked to rank the three most widely used methods by which hospital pharmacy personnel hear about drug products availability from the grey market vendors using numbers 1 through 3 with “1” being most widely used, “2” being the second most widely used, and “3” being the third most widely used method. There were six answer choices: email; fax; telephone; US mail, personal visits; and other. Table 3.14 illustrates the respondents’ ranking of the most widely used methods when receiving information on drugs in short supply from grey market vendors. Sixty-two (62.0%) out of 107 respondents selected telephone as the most widely used method followed by email (n = 27, 27.0%) and fax (n = 10, 10.0%). In terms of total mentions, 95 (95.0%) respondents indicated telephone among the most common methods to hear about availability of drug products in short supply from grey market vendors, followed by fax (n = 82, 82.0%) and email (n = 82, 82.0%), US mail (n = 18, 18.0%), and personal visits (n = 4, 4.0%).

Table 3.14: Respondents’ Ranking of the Most Widely Used Methods when Receiving Information on Drugs in Short Supply from Grey Market Vendors (N=100)^a

Methods	Most Widely Used N (%)	2nd Most Widely Used N (%)	3rd Most Widely Used N (%)	N^b (%)
Telephone	62 (62.0%)	29 (29.0%)	4 (4.0%)	95 (95.0%)
Fax	10 (10.0%)	20 (20.0%)	52 (52.0%)	82 (82.0%)
Email	27 (27.0%)	40 (40.0%)	15 (15.0%)	82 (82.0%)
US Mail	0 (0.0%)	4 (4.0%)	14 (14.0%)	18 (18.0%)
Personal Visits	1 (1.0%)	0 (0.0%)	3 (3.0%)	4 (4.0%)
Total (%)	100 (100%)	93 ^c (93.0%)	88 ^d (88.0%)	

^aTotal number of respondents (N) = 100, seven respondents did not answer the item.

^bIndicates total frequency of respondents who ranked each method.

^cSeven respondents did not indicate ‘2nd Most Widely Used’ method.

^dTwelve respondents did not indicate ‘3rd Most Widely Used’ method.

Finally, respondents were asked to indicate all of their main concerns regarding purchasing drug products in short supply from grey market vendors. There were eight answer choices: cost; authenticity; reliability; ethical concerns; reputation of vendors; storage conditions prior to purchase; institutional policy; and other. Table 3.15 presents the frequency distribution of respondents’ main concerns when purchasing drugs in short supply from grey market vendors. A majority of the respondents, 98 (91.6%) reported cost as their main concern, this was followed by authenticity (n = 79, 73.8%), storage conditions prior to purchase (n = 76, 71.0%), ethical concerns (n = 75, 70.1%), reliability (n = 60, 56.1%), reputation of vendors (n = 59, 55.1%), and institutional policy (n = 41, 38.3%).

Table 3.15: Frequency Distribution of Respondents' Main Concerns when Purchasing Drugs in Short Supply from Grey Market Vendors (N=107)^a

Concerns	Frequency ^b N (%)
Cost	98 (91.6%)
Authenticity	79 (73.8%)
Storage conditions prior to purchase	76 (71.0%)
Ethical concerns	75 (70.1%)
Reliability	60 (56.1%)
Reputation of vendor	59 (55.1%)
Institutional Policy	41 (38.3%)

^aTotal number of respondents (N) = 107.

^bTotal frequency is more than 107 and total percentage is more than 100% because of multiple responses.

3.2.7 Respondents' Perceptions about Grey Market Vendors' Activities Associated with Drug Shortages

Respondents were asked about their perceptions towards grey market vendors' activities associated with drug shortages. Grey market was defined as a secondary supply channel that is unauthorized or unintended by the original manufacturer for distribution of medicines. Table 3.16 represents the items and the descriptive statistics on respondents' perceptions about grey market vendor activities associated with drug shortages. Respondents were asked to rate 7 items using a five-point Likert-like scale, where the following ratings were used: 1 = 'Strongly Disagree', 2 = 'Disagree', 3 = 'Neutral', 4 = 'Agree', and 5 = 'Strongly Agree'.

Of the 125 respondents, 96 (76.8%) 'strongly agreed' while 24 (19.2%) 'agreed' that grey market vendors are more likely to contact health care facility when drug shortage exists. The mean (\pm SD) perception score of the respondents on this item was 4.69 (\pm 0.70). When asked whether grey market vendors have the ability to identify and obtain drugs in short supply, 57 (45.6%) 'agreed' whereas 49 (39.2%) 'strongly agreed'. The mean perception score on the item was 4.16 (\pm 0.902). A majority of the respondents 72 (57.6%) out of 125 'strongly agreed' while 43 (34.4%) 'agreed' that grey market vendors contribute to the drug shortage crises by buying whatever drug supplies they can find on the market. The mean (\pm SD) was 4.43 (\pm 0.836).

Once respondents were inquired whether grey market vendors sell drugs in short supply at inflated prices, 110 (88.0%) 'strongly agreed' while 12 (9.6%) 'agreed'. The mean (\pm SD) perception score for this item was 4.82 (\pm 0.597). Respondents indicated that grey market vendors offer drugs in short supply needed to treat critically ill patients at largest markups with 83 (66.4%) choosing 'strongly agree' and 28 (22.4%) 'agree'. The mean (\pm SD) perception score of the respondents on this item was 4.52 (\pm 0.799).

Out of 125 respondents, 58 (46.4%) 'strongly agreed', 43 (34.4%) 'agreed' while 12 (9.6%) indicated 'neutral' when asked whether grey market vendors are sometimes the only source available for obtaining a drug in shortage. The mean (\pm SD) perception score of the respondents on this item was 4.14 (\pm 1.045). In addition, respondents were requested to indicate their level of agreement on whether the practice of buying drug products from grey market vendors should be eliminated. Seventy (56.0%) respondents 'strongly agreed' with this statement, 25 (20.0%) 'agreed' while 19 (15.2%) reported

‘neutral’. The mean (\pm SD) perception score of the respondents on this item was 4.20 (\pm 1.092).

Table 3.16: Frequencies and Descriptive Statistics of Respondents' Perceptions about Grey Market Vendors' Activities Associated with Drug Shortages (N = 125)^a

Item (Question Number)	Scale Range ^b						
	SD 1 N (%)	D 2 N (%)	N 3 N (%)	A 4 N (%)	SA 5 N (%)	Total N (%)	Mean (S.D.)
Grey market vendors are more likely to contact your facility when drug shortage exists (18a).	2 (1.6%)	1 (0.8%)	2 (1.6%)	24 (19.2%)	96 (76.8%)	125 (100.0%)	4.69 (0.70)
Grey market vendors have the ability to identify and obtain drugs in short supply (18b).	3 (2.4%)	4 (3.2%)	12 (9.6%)	57 (45.6%)	49 (39.2%)	125 (100.0%)	4.16 (0.90)
Grey market vendors contribute to the drug shortage crises by buying whatever supplies they can find on the market (18c).	2 (1.6%)	4 (3.2%)	4 (3.2%)	43 (34.4%)	72 (57.6%)	125 (100.0%)	4.43 (0.84)
Grey market vendors sell drugs in short supply at inflated prices (18d).	2 (1.6%)	0 (0.0%)	1 (0.8%)	12 (9.6%)	110 (88.0%)	125 (100.0%)	4.82 (0.60)
Grey market vendors offer drugs in short supply needed to treat critically ill patients at largest markups (18e).	2 (1.6%)	0 (0.0%)	12 (9.6%)	28 (22.4%)	83 (66.4%)	125 (100.0%)	4.52 (0.799)
Grey market vendors are sometimes the only source available for obtaining a drug in shortage (18f).	4 (3.2%)	8 (6.4%)	12 (9.6%)	43 (34.4%)	58 (46.4%)	125 (100.0%)	4.14 (1.05)
The practice of buying products from grey market vendors should be eliminated (18g).	4 (3.2%)	7 (5.6%)	19 (15.2%)	25 (20.0%)	70 (56.0%)	125 (100.0%)	4.20 (1.09)

^aTotal number of respondents (N) = 125

^bSD – Strongly Disagree, D – Disagree, N – Neutral, A – Agree, SA – Strongly Agree (coded 1 to 5)

3.3 HYPOTHESES TESTING

The study's hypotheses and the statistical test that addresses each hypothesis were presented in Table 2.2. Data analyses were conducted using Chi-square test, two sample t-test and One-way ANOVA.

3.3.1 Regrouped Variables

For the purpose of conducting valid chi-square test all variables were regrouped in order to achieve an adequate number of respondents in each category. According to Cochran the smallest expected number in any group should be 5 or 10 and if this condition is not met then neighboring groups should be merged together.⁷² Table 3.17 presents the values of the original variables and the regrouped variables.

The variable '*number of times hospital pharmacy personnel were contacted by grey market vendors*' was collected as a continuous data, yet the normal distribution was skewed due to extreme outliers. A sensitivity analysis in which the data were analyzed with and without the outliers revealed that the outliers had effect on the median values and therefore two categories were created.

Table 3.17: Original Variables and Regrouped Variables

Variable Name	Regrouped Values (Original Values)
Number of drug shortages experienced	1-4 (1-2 and 3-4) 5-8 (5-6 and 7-8) 9 or more (9-10 and 11 or more)
Number of hours per week managing drug shortages	1-6 (1-3 and 4-6) 7-12 (7-9 and 10-12) 13 or more (13-15 and 16 or more)
Number of times hospital pharmacy personnel were contacted by grey market vendors	1-10 (Continues) Greater than 10 (Continues)
Facility size in terms of number of beds	Less than 100 (less than 100) 100-250 (100-150 and 151-250) Greater than 250 (251-350, 351-450, and greater than 450)
Facility type	Chain Hospital (Chain Hospital, Health Care Group Hospital and Health Care System Hospital) Non Chain Hospital (Community Hospital, Children’s Hospital, University Hospital, and Other)

Table 3.17: Original Variables and Regrouped Variables (*continued*)

Variable Name	Regrouped Values (Original Values)
Position within facility	Managers (director of pharmacy and pharmacy manager) Staff (pharmaceutical purchasing agent, staff pharmacist, pharmacy technician, pharmacy clerk, and other)
Inpatient medication budget	Less than \$1.5 million (less than \$1.5 million) \$1.5-5.0 million (\$1.5-5.0 million) Greater than \$5.0 million (\$5.0-10 million and greater than \$10 million)
Pharmacist FTEs	10 or less (10 or less) 11 or more (11-25, 26-50 and greater than 50)
Pharmacy technician FTEs	10 or less (10 or less) 11 or more (11-25, 26-50 and greater than 50)
Facility location	Rural/Semi-Urban (Rural, Semi-Rural and Semi-Urban) Small/Medium Metropolitan (Small Metropolitan and Medium Metropolitan) Large Metropolitan (Large Metropolitan)

3.3.2 Chi-square Test

3.3.2.1 Chi-square Test for Dependent Variable 'Number of Drug Shortages Experienced'

A chi-square test was used to assess the relationship between the number of drug shortages experienced in the last month (April, 2013) controlling for health facility size in terms of number of beds, facility type, inpatient medication budget, and facility location. Despite regrouping, the chi-square test assessing whether a relationship existed between the number of drug shortages experienced by a health care system in the last month (April, 2013) and health facility size in terms of number of beds and inpatient medication budget could not be utilized because 22.2% of the cells had expected counts less than 5. According to Yates et al in order to achieve a good chi-square approximation large contingency tables should not have more than 20% of the cells with expected counts less than 5 and all individual expected counts should be 1 or greater.⁷³ Therefore the independent variables '*facility size*' and '*inpatient medication budget*' were regrouped again creating two categories for each of the variables. In particular, the new categories for the '*facility size*' variable were 'less than 100 beds' and '100 beds or more'. The categories '100-250 beds' and 'greater than 250 beds' were merged. The new categories for the '*inpatient medication budget*' variable were 'less than \$1.5 million' and '\$1.5 million or more'. The categories '\$1.5-5.0 million' and 'greater than \$5.0 million' were merged.

Interpretation of Results:

This section summarizes the hypothesis and the results of chi-square analyses for each hypothesis.

Hypothesis 1

H₀₁: There is an association between the number of drug shortages experienced by a health system in the last month (April, 2013) and facility size in terms of number of beds.

The chi-square analysis (Table 3.18) showed significant relationship between the number of drug shortages experienced controlling for facility size ($\chi^2 = 11.907$, $n = 123$, $df = 2$, $p = 0.003$). Examination of the cell frequencies showed that 70.4% of the hospitals with 100 or more beds have experienced nine or more drug shortages for the month of April 2013. Thus the hypothesis was supported.

Table 3.18: Number of Drug Shortages for the Month of April 2013 Controlling for Hospital Size (N=123)

Facility Size		Number of Drug Shortages			Total (%)
		1-4	5-8	9 or more	
Less than 100 beds	n	11	18	23	52
	Row %	21.2%	34.6%	44.2%	(100%)
100 or more beds	n	3	18	50	71
	Row %	4.2%	25.4%	70.4%	(100%)
Total (%)		14 (11.4%)	36 (29.3%)	73 (59.3%)	123 (100%)

Chi-Square Test: $\chi^2 = 11.907$, $n = 123$, $df = 2$, $p = 0.003$

Hypothesis 2

H₀₂: There is no association between the number of drug shortages experienced by a health system in the last month (April, 2013) and facility type (Chain and Non - Chain hospitals).

The chi-square analysis (Table 3.19) showed no significant relationship between the number of drug shortages experienced controlling for facility type ($\chi^2 = 3.770$, n = 123, df = 2, p = 0.152). The majority of both Chain (50.9%) and Non-Chain (66.2%) hospitals have reported nine or more drug shortages for the month of April 2013. Thus the hypothesis was not rejected.

Table 3.19: Number of Drug Shortages Experienced Controlling for Hospital type for the Month of April 2013 (N=123)

Facility Type		Number of Drug Shortages			Total (%)
		1-4	5-8	9 or more	
Non - Chain Hospital	n	5	18	45	68
	Row %	7.4%	26.5%	66.2%	(100%)
Chain Hospital	n	9	18	28	55
	Row %	16.4%	32.7%	50.9%	(100%)
Total (%)		14 (11.4%)	36 (29.3%)	73 (59.3%)	123 (100%)

Chi-Square Test: $\chi^2 = 3.770$, n = 123, df = 2, p = 0.152

Hypothesis 3

H₀₃: There is no association between the number of drug shortages experienced by a health system in the last month (April, 2013) and hospital inpatient medication budget.

The chi-square analysis (Table 3.20) showed significant relationship between the number of drug shortages experienced controlling for inpatient medication budget ($\chi^2 = 13.249$, $n = 123$, $df = 2$, $p = 0.001$). Examination of the cell frequencies showed that 65% of the hospitals with inpatient medication budget greater than \$1.5 million have experienced nine or more drug shortages for the month of April 2013. Thus the hypothesis was rejected.

Table 3.20: Number of Drug Shortages for the Month of April 2013 Controlling for Inpatient Medication Budget (N=123)

Inpatient Medication Budget		Number of Drug Shortages			Total (%)
		1-4	5-8	9 or more	
Less than \$1.5 million	n	11	11	21	43
	Row %	25.6%	25.6%	48.8%	(100%)
\$1.5 million or more	n	3	25	52	80
	Row %	3.8%	31.3%	65.0%	(100%)
Total (%)		14 (11.4%)	36 (29.3%)	73 (59.3%)	123 (100%)

Chi-Square Test: $\chi^2 = 13.249$, $n = 123$, $df = 2$, $p = 0.001$

Hypothesis 4

H₀₄: There is no association between the number of drug shortages experienced by a health system in the last month (April, 2013) and facility location (Rural/Semi-Urban, Small/Medium Metropolitan and Large Metropolitan).

Table 3.21 shows that there is a significant association between the number of drug shortages experienced and facility location ($\chi^2 = 12.353$, $n = 123$, $df = 4$, $p = 0.015$). Examination of the cell frequencies showed that 77.8% of the hospitals located in Rural/Semi-Urban areas have experienced nine or more shortages for the month of April 2013. Drug shortages in hospitals located in large metropolitan areas have split in the number of drug shortages compared to the rural area hospitals. Therefore the hypothesis was rejected.

Table 3.21: Number of Drug Shortages Experienced for the Month of April 2013 Controlling for Hospital Location (N=123)

Facility Location		Number of Drug Shortages			Total (%)
		1-4	5-8	9 or more	
Rural/Semi-Urban	n	1	5	21	27
	Row %	3.7%	18.5%	77.8%	(100%)
Small/Medium Metropolitan	n	2	17	26	45
	Row %	4.4%	37.8%	57.8%	(100%)
Large Metropolitan	n	11	14	26	51
	Row %	21.6%	27.5%	51.0%	(100%)
Total (%)		14 (11.4%)	36 (29.3%)	73 (59.3%)	123 (100%)

Chi-Square Test: $\chi^2 = 12.353$, $n = 123$, $df = 4$, $p = 0.015$

3.3.2.2 Chi-square Test for Dependent Variable ‘Number of Hours per Week Managing Drug Shortages’

A chi-square test was used to assess the relationship between the numbers of hours spent per week by hospital pharmacy personnel for the management of drug shortages controlling for facility size, number of drug shortages experienced in the last month (April, 2013), number of pharmacists FTEs, and pharmacy technicians FTEs.

Interpretation of Results:

The following section will present the results of chi-square analyses for each hypothesis.

Hypothesis 5

H_{A5}: There is an association between the numbers of hours spent per week by hospital pharmacy personnel when managing drug shortages controlling for facility size in terms of number of beds.

Table 3.22 shows the Chi-square analysis of the number of hours spent per week controlling for hospital size. The results show a significant association between the numbers of hours spent by hospital pharmacy personnel when managing drug shortages controlling for facility size ($\chi^2 = 21.340$, $n = 124$, $df = 4$, $p < 0.001$). Examination of the cell frequencies showed that 60.4% of the hospitals with beds less than 100 have their hospital pharmacy personnel spend between one and six hours per week managing drug shortages. The result shows that the hypothesis was supported.

Table 3.22: Number of Reported Hours Spent Managing Drug Shortages Controlling for Hospital Size (N=124)

Facility Size		Number of Hours (hrs/week)			Total (%)
		1-6	7-12	13 or more	
Less than 100 beds	n	32	16	5	53
	Row %	60.4%	30.2%	9.4%	(100%)
100 – 250 beds	n	10	16	11	37
	Row %	27.0%	43.2%	29.7%	(100%)
Greater than 250 beds	n	6	15	13	34
	Row %	17.6%	44.1%	38.2%	(100%)
Total (%)		48 (38.7%)	47 (37.9%)	29 (23.4%)	123 (100%)

Chi-Square Test: $\chi^2 = 21.340$, n = 124, df = 4, p < 0.001

Hypothesis 6

H_{A6}: There is an association between the numbers of hours spend per week by hospital pharmacy personnel when managing drug shortages and number of drug shortages experienced by the health system in the last month (April, 2013).

Table 3.23 depicts the chi-square analysis which shows a significant association between the numbers of hours spent by hospital pharmacy personnel when managing drug shortages and the number of drug shortages encountered by the health system for the month of April, 2013 ($\chi^2 = 28.345$, n = 122, df = 4, p < 0.001). Examination of the cell frequencies showed that the majority (85.7%) of the hospitals indicating between one and four drug shortages for the month of April, 2013 had their hospital pharmacy personnel spent between one and six hours per week managing drug shortages. As the total number

of drug shortages increased more time was spent on managing drug shortages. Hypothesis H_{A6} was supported.

Table 3.23: Number of Reported Hours Spent Managing Drug Shortages Controlling for the Number of Drug Shortages Experienced for the Month of April 2013 (N=122)

Number of Drug Shortages		Number of Hours (hrs/week)			Total (%)
		1-6	7-12	13 or more	
1 - 4	n	12	2	0	14
	Row %	85.7%	14.3%	0.0%	(100%)
5 - 8	n	18	16	2	36
	Row %	50.0%	44.4%	5.6%	(100%)
9 or more	n	18	28	28	72
	Row %	25.0%	38.9%	36.1%	(100%)
Total (%)		48 (39.3%)	46 (37.7%)	28 (23%)	122 (100%)

Chi-Square Test: $\chi^2 = 28.345$, n = 122, df = 4, p < 0.001

Hypothesis 7

H_{A7}: There is an association between the numbers of hours spent per week by hospital pharmacy personnel when managing drug shortages and number of pharmacist FTEs.

Table 3.24 depicts the relationship between hours spent by hospital pharmacy personnel managing drug shortages controlling for number for pharmacist FTEs. The Chi-square analysis showed a significant association between the numbers of hours spent by hospital pharmacy personnel when managing drug shortages and the number of pharmacists FTEs ($\chi^2 = 16.069$, n = 124, df = 2, p < 0.001). Examination of the cell

frequencies showed that the majority (51.9%) of the hospitals with ten or less pharmacy technicians FTEs reported that their hospital pharmacy personnel spent between one and six hours per week managing drug shortages while the majority (46.8%) of the hospitals with eleven or more pharmacists FTEs indicated that that their hospital pharmacy personnel spent between seven and twelve hours per week managing drug shortages. Hypothesis H_{A7} was supported.

Table 3.24: Number of Reported Hours Spent Managing Drug Shortages Controlling for the Number of Pharmacists FTEs (N=124)

Pharmacists FTEs		Number of Hours (hrs/week)			Total (%)
		1-6	7-12	13 or more	
10 or less	n	40	25	12	77
	Row %	51.9%	32.5%	15.6%	(100%)
11 or more	n	8	22	17	47
	Row%	18.2%	46.8%	36.3%	(100%)
Total (%)		48 (38.7%)	47 (37.9%)	29 (23.4%)	124 (100%)

Chi-Square Test: $\chi^2 = 16.069$, n = 124, df = 2, p < 0.001

Hypothesis 8

H_{A8}: There is an association between the numbers of hours spent per week by hospital pharmacy personnel when managing drug shortages and number of pharmacy technicians FTEs.

Table 3.25 depicts the relationship between reported number of hours spent managing drug shortages and number of full-time-equivalent (FTE) pharmacy technician

employees. Chi-square analysis showed a significant association between the numbers of hours spent by hospital pharmacy personnel when managing drug shortages and the number of pharmacy technicians FTEs ($\chi^2 = 16.935$, $n = 124$, $df = 2$, $p < 0.001$). Examination of the cell frequencies showed that 51.3% of the hospitals with ten or less pharmacy technicians FTEs reported that their hospital pharmacy personnel spent between one and six hours per week managing drug shortages while 47.0% of the hospitals with eleven or more pharmacy technician FTEs indicated that that their hospital pharmacy personnel spent between seven and twelve hours per week managing drug shortages. Hypothesis H_{A8} was supported.

Table 3.25: Numbers of Reported Hours Spent Managing Drug Shortages Controlling for the Number of Pharmacy Technicians FTEs (N=124)

Pharmacy Technicians FTEs		Number of Hours (hrs/week)			Total (%)
		1-6	7-12	13 or more	
10 or less	n	40	27	11	78
	Row %	51.3%	34.6%	14.1%	(100%)
11 or more	n	8	20	18	46
	Row%	17.4%	47.0%	39.1%	(100%)
Total (%)		48 (38.7%)	47 (37.9%)	29 (23.4%)	124 (100%)

Chi-Square Test: $\chi^2 = 16.935$, $n = 124$, $df = 2$, $p < 0.001$

3.3.2.3 Chi-square Test for Dependent Variable ‘Number of Times Hospital Pharmacy Personnel were Contacted by Grey Market Vendors’

A chi-square test was used to assess the relationship between the numbers of times hospital pharmacist personnel were contacted by grey market vendors across facility sizes in terms of number of beds, number of drug shortages experienced by a health care systems in the last month (April, 2013), facility types, and facility locations.

Interpretation of Results:

The following section will present the results of chi-square analyses for each hypothesis.

Hypothesis 9

H₀₉: There is no association between the numbers of times hospital pharmacy personnel were contacted by grey market vendors across facility sizes in terms of number of beds.

Table 3.26 depicts the relationship between the numbers of times hospital pharmacy personnel were contacted by grey market vendors controlling for hospital size. The chi-square analysis showed no significant relationship ($\chi^2 = 1.963$, $n = 73$, $df = 2$, $p = 0.375$). Examination of cell frequencies showed that more than 50% of the hospitals regardless of their facility size were contacted between one and ten times by grey market vendors in the month of April, 2013. However, size of the hospital was not related to the number of contacts thus hypothesis H₀₉ was not rejected.

Table 3.26: Numbers of Times Hospital Pharmacy Personnel were Contacted by Grey Market Vendors Controlling for Facility Size (N=73)

Facility Size		Number of Grey Market Contacts		Total (%)
		1 - 10	Greater than 10	
Less than 100 beds	N	22	10	32
	Row %	68.8%	31.3%	(100%)
100 – 250 beds	N	12	7	19
	Row %	63.2%	36.8%	(100%)
Greater than 250 beds	N	11	11	22
	Row %	50.0%	50.0%	(100%)
Total (%)		45 (61.6%)	28 (38.4%)	73 (100%)

Chi-Square Test: $\chi^2 = 1.963$, n = 73, df = 2, p = 0.375

Hypothesis 10

H₀₁₀: There is no association between the numbers of times hospital pharmacist personnel were contacted by grey market vendors controlling for the number of shortages experienced by the health system in the last month (April, 2013).

Table 3.27 depicts the relationship between the numbers of times hospital pharmacy personnel were contacted by grey market vendors and the number of drug shortages experienced for the month of April, 2013. The chi-square analysis showed no significant relationship ($\chi^2 = 4.340$, n = 72, df = 2, p = 0.114). The number of drug shortages was not related to the number of contacts by grey market vendors. In

examining Table 3.27 more than 50% of the hospitals regardless of the number of drug shortages they have experienced for the month of April, 2013 they had been contacted between one and ten times by grey market vendors during the month of April, 2013. Thus H_{010} was not rejected.

Table 3.27: Numbers of Times Hospital Pharmacy Personnel were Contacted by Grey Market Vendors Controlling for the Number of Drug Shortages Experienced for the Month of April 2013 (N=72)

Number of Drug Shortages		Number of Grey Market Contacts		Total (%)
		1 - 10	Greater than 10	
1 - 4	N	6	2	8
	Row %	75.0%	25.0%	(100%)
5 - 8	N	15	4	19
	Row %	78.9%	21.1%	(100%)
9 or more	N	24	21	45
	Row %	53.3%	46.7%	(100%)
Total (%)		45 (62.5%)	27 (37.5%)	72 (100%)

Chi-Square Test: $\chi^2 = 4.340$, $n = 72$, $df = 2$, $p = 0.114$

Hypothesis 11

H_{011} : *There is no association between the numbers of times hospital pharmacist personnel were contacted by grey market vendors and the facility type (Chain and Non-Chain hospitals).*

Table 3.28 depicts the relationship between the numbers of times hospital pharmacy personnel were contacted by grey market vendors and the facility type. The chi-square analysis showed no significant relationship between the two variables ($\chi^2 = 1.652$, $n = 73$, $df = 1$, $p = 0.199$). Thus, hypothesis H_{011} was not rejected. The majority of both Chain (69.7%) and Non - Chain (55.0%) hospitals reported being contacted between one and ten times by grey market vendors for the month of April 2013.

Table 3.28: Numbers of Times Hospital Pharmacy Personnel were Contacted by Grey Market Vendors Controlling for the Facility Type (N=73)

Facility Type		Number of Grey Market Contacts		Total (%)
		1 - 10	Greater than 10	
Non – Chain Hospitals	N	22	18	40
	Row %	55.0%	45.0%	(100%)
Chain Hospitals	N	23	10	33
	Row %	69.7%	30.3%	(100%)
Total (%)		45 (61.6%)	28 (38.4%)	73 (100%)

Chi-Square Test: $\chi^2 = 1.652$, $n = 73$, $df = 1$, $p = 0.199$

Hypothesis 12

H₀₁₂: There is no association between the numbers of times hospital pharmacist personnel got contacted by grey market vendors by and facility location (Rural/Semi-Urban, Small/Medium Metropolitan and Large Metropolitan).

Table 3.29 shows the results of the numbers of times hospital pharmacy personnel were contacted by grey market vendors controlling for hospital location. The chi-square analysis showed no significant relationship between the numbers of times hospital pharmacy personnel were contacted by grey market vendors and facility location ($\chi^2 = 3.442$, $n = 73$, $df = 2$, $p = 0.179$). Examination of cell frequencies showed that more than 50% of the hospitals regardless of their facility location had been contacted between one and ten times by grey market vendors for the month of April, 2013. Hypothesis H_{012} was not rejected.

Table 3.29: Numbers of Times Hospital Pharmacy Personnel were Contacted by Grey Market Vendors Controlling for the Facility Location (N=73)

Facility Location		Number of Grey Market Contacts		Total (%)
		1 - 10	Greater than 10	
Rural/Semi-Urban	N	11	10	22
	Row %	52.4%	47.6%	(100%)
Small/Medium Metropolitan	N	21	7	28
	Row %	75.0%	25.0%	(100%)
Large Metropolitan	N	13	11	24
	Row %	54.2%	45.8%	(100%)
Total (%)		45 (61.6%)	28 (38.4%)	73 (100%)

Chi-Square Test: $\chi^2 = 3.442$, $n = 73$, $df = 2$, $p = 0.179$

3.3.3 Two-sample T-test

A two-sample T-test was used to test the following set of hypotheses.

H₀₁₃: There is no difference in the mean opinion score of hospital pharmacy personnel whatever supplies they can find on the market controlling for position within the facility (Managers and Staff).

H₀₁₄: There is no difference in the mean perception score of hospital pharmacy personnel in regard to grey market vendors' practice of selling drugs in short supply at inflated prices by their position within the facility (Managers and Staff).

H₀₁₅: There is no difference in the mean opinion score of hospital pharmacy personnel toward elimination of the practice of buying drugs in short supply from grey market vendors by their position within the facility (Managers and Staff).

Table 3.30 shows the perception items, the descriptive statistics and the t-test results in comparing the mean perception scores of respondents toward grey market activities associated with drug shortages controlling for respondent position within the healthcare facility. As mentioned earlier, respondents' positions were re-categorized into two categories, managers and staff, due to inadequate cell size numbers when controlling for other variables. For each of the three perception measures no statistical significant differences were found controlling for manager and staff position. Thus hypotheses H₀₁₃, H₀₁₄ and H₀₁₅ were not rejected.

Table 3.30: Respondents' Perception Scores on Grey Market Activities Controlling for Managers and Staff Positions (N=125)

Dependent Variables	Position				df	t	Sig.
	Managers (N = 105)		Staff (N = 20)				
	Mean	SD	Mean	SD			
Grey market vendors contribute to the drug shortage crises by buying whatever supplies they can find on the market	4.47	0.79	4.25	1.07	123	1.06	0.29
Grey market vendors sell drugs in short supply at inflated prices ^a	4.86	0.49	4.65	0.99	20.81	0.92	0.37
The practice of buying products from grey market vendors should be eliminated	4.19	1.13	4.25	0.91	123	-0.22	0.82

Dependent variables were measured on 5-point Likert scale ranging 1 to 5 (1 = 'Strongly Disagree' and 5 = 'Strongly Agree')

^aEqual variances not assumed

SD – Standard Deviation

3.3.4 One-way ANOVA

A one-way analysis of variance was employed to test the following set of hypothesis.

H₀₁₃: There is no difference in the mean opinion score of hospital pharmacy personnel whether grey market vendors contribute toward the drug shortages crises by buying whatever supplies they can find on the market controlling for the number of drug shortages experienced by the health system in the last month (April, 2013).

H₀₁₄: There is no difference in the mean perception score of hospital pharmacy personnel in regard to grey market vendors' practice of selling drugs in short supply at inflated prices by number of drug shortages experienced by the health system in the last month (April, 2013).

H₀₁₅: There is no difference in the mean opinion score of hospital pharmacy personnel toward elimination of the practice of buying products from grey market vendors controlling for the number of drug shortages experienced by the health system in the last month (April, 2013).

Table 3.31 provides the descriptive statistics of the perception scores controlling for the three groups of drug shortages ('1-4', '5-8' and '9 or more' drug shortages). This is followed by Table 3.32, which shows the results of ANOVA.

Table 3.31: Respondents' Mean Perception Scores on Grey Market Activities Controlling for the Number of Drug Shortages Experienced by the Health Care Facility for the Month of April, 2013 (N=123)

Dependent Variable	Number of Drug Shortages						Total	
	1 – 4 N = 14		5 – 8 N = 36		9 or more N = 73		N = 123	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Grey market vendors contribute to the drug shortage crises by buying whatever supplies they can find on the market	4.36	0.50	4.58	0.77	4.37	0.92	4.43	0.84
Grey market vendors sell drugs in short supply at inflated prices	4.71	0.47	4.89	0.32	4.84	0.69	4.84	0.58
The practice of buying products from grey market vendors should be eliminated	4.14	0.95	4.25	1.05	4.19	1.15	4.20	1.09

Dependent variables were measured on 5-point Likert scale ranging 1 to 5 (1 = 'Strongly Disagree' and 5 = 'Strongly Agree')

Table 3.32: Respondents' Perception Scores on Grey Market Activities Controlling for the Number of Drug shortages Experienced by the Health Care Facility for the Month of April, 2013 (N=123)

Dependent Variables		Sum of Squares	df	Mean Square	F	Sig.
Grey market vendors contribute to the drug shortage crises by buying whatever supplies they can find on the market	Between	1.19	2	0.59	0.84	0.44
	Within	84.98	120	0.71		
	Total	86.16	122			
Grey market vendors sell drugs in short supply at inflated prices	Between	0.31	2	0.15	0.46	0.63
	Within	40.44	120	0.34		
	Total	40.75	122			
The practice of buying products from grey market vendors should be eliminated	Between	0.14	2	0.07	0.06	0.99
	Within	145.78	120	1.22		
	Total	145.92	122			

One-way ANOVA tests showed that there were no statistically significant differences in the mean perception scores for each of the three perception items when controlling for the number of drug shortages. Thus hypotheses H_{013} , H_{014} and H_{015} were supported.

3.3.5 Summary of Results of Hypotheses Testing

Table 3.33 presents a summary of the results of the hypotheses testing.

Table 3.33: Summary of Results of Hypotheses Testing

Hypothesis	Results
H ₀₁ : There is an association between the number of drug shortages experienced by a health system in the last month (April, 2013) and facility size in terms of number of beds.	Supported
H ₀₂ : There is no association between the number of drug shortages experienced by a health system in the last month (April, 2013) and facility type (Chain and Non - Chain hospitals).	Not Rejected
H ₀₃ : There is no association between the number of drug shortages experienced by a health system in the last month (April, 2013) and hospital inpatient medication budget.	Rejected
H ₀₄ : There is no association between the number of drug shortages experienced by a health system in the last month (April, 2013) and facility location (Urban, Small/Medium Metropolitan and Large Metropolitan).	Rejected
H _{A5} : There is an association between the numbers of hours spend per week by hospital pharmacy personnel when managing drug shortages and facility size in terms of number of beds.	Supported
H _{A6} : There is an association between the numbers of hours spend per week by hospital pharmacy personnel when managing drug shortages and number of drug shortages experienced by the health system in the last month (April, 2013).	Supported

Table 3.33: Summary of Results of Hypotheses Testing (continued)

Hypothesis	Results
H _{A7} : There is an association between the numbers of hours spend per week by hospital pharmacy personnel when managing drug shortages and number of pharmacist FTEs.	Supported
H _{A8} : There is an association between the numbers of hours spend per week by hospital pharmacy personnel when managing drug shortages and number of pharmacy technicians FTEs.	Supported
H ₀₉ : There is no association between the numbers of times hospital pharmacy personnel got contacted by grey market vendors across facility sizes in terms of number of beds.	Not Rejected
H ₀₁₀ : There is no association between the numbers of times hospital pharmacist personnel got contacted by grey market vendors by number of shortages experienced by the health system in the last month (April, 2013).	Not Rejected
H ₀₁₁ : There is no association between the numbers of times hospital pharmacist personnel got contacted by grey market vendors by facility type (Chain and Non-Chain hospitals).	Not Rejected
H ₀₁₂ : There is no association between the numbers of times hospital pharmacist personnel got contacted by grey market vendors by and facility location (Urban, Small/Medium Metropolitan and Large Metropolitan).	Not Rejected

Table 3.33: Summary of Results of Hypotheses Testing (continued)

Hypothesis	Results
H ₀₁₃ : There is no difference in the mean opinion score of hospital pharmacy personnel whether grey market vendors contribute toward the drug shortages crises by buying whatever supplies they can find on the market controlling by position within the facility (Managers and Staff) and number of drug shortages experienced by the health system in the last month (April, 2013).	Not Rejected
H ₀₁₄ : There is no difference in the mean perception score of hospital pharmacy personnel in regard to grey market vendors' practice of selling drugs in short supply at inflated prices by their position within the facility (Managers and Staff) and number of drug shortages experienced by the health system in the last month (April, 2013).	Not Rejected
H ₀₁₅ : There is no difference in the mean opinion score of hospital pharmacy personnel toward elimination of the practice of buying drugs in short supply from grey market vendors by their position within the facility (Managers and Staff) and number of drug shortages experienced by the health system in the last month (April, 2013).	Not Rejected

Chapter Four: Discussion

This chapter provides a summary of the study results and discussion of the significance of these findings with regard to the literature. In addition, the chapter will assess the study limitations and provide directions for future research.

4.1 REVIEW OF RESEARCH QUESTION

The U.S. hospitals have been combating the problem of drug shortages over the past decade. The rapidly increasing frequency of drug shortages has caused difficulties in the delivery of optimum health care. Health care facilities, clinicians, patients, and federal agencies have tried to tackle the issue, yet drug shortages continue to significantly burden all parties involved. The most important implications of drug shortage include delayed patient care, adverse outcomes, higher drug costs, and an increased strain on health professionals in terms of time and money spent on managing drug shortages. The drug shortage issue is further complicated by the practices of “grey market” or opportunistic vendors who take advantage of the shortage situation and thus significantly contribute to the overall problem of drugs in short supply.

The issue of increased number of drug shortages has grabbed the national attention of the mass media, health professionals, federal and state regulators, health care and pharmacy associations, patients and patient groups/associations, and politicians. The growing public concern is also evident by the increasing number of published journal articles, newspaper articles, and news reports. Yet, more research is needed and the results communicated to policy makers, manufacturers, public agencies, wholesaler, and

the public in order to improve communication among different parties and to present an in depth picture of the problem and its implications. Despite all the publicity, there has been no study examining the effect of drug shortages across Texas Hospitals.

This study was conducted on a sample of pharmacy directors of non-government acute care hospitals in the state of Texas. The purpose was to explore the incidence and impact of drug shortages across Texas Non-Government Acute Care Hospitals. The specific objectives were to assess: the proportion of Texas Non-Government Acute Care Hospitals experiencing a drug shortage and the number of shortages experienced in the last month (April, 2013); the percentage of Texas Non-Government Acute Care Hospitals affected by each of the 15 most recent drug shortages as of March 2013 (according to ASHP) for the last month; the average number of hours per week spent by hospital pharmacy staff managing drug shortages and the activities associated with managing drug shortages; whether additional hospital pharmacy personnel were hired as a result of increased workload due to drug shortages; whether hospital pharmacy personnel were shifted from patient care activities toward managing drug shortages and which activities have been affected the most; and the various supply and informational resources used to obtain drugs in short supply and information on drug shortages, as well as respondents' opinions with regard to the most common causes of drug shortages. In addition, the study estimated the number of acute care hospitals contacted by grey market vendors in the last month (April, 2013), the frequency and the mode of contact, and the concerns and the opinions of hospital pharmacy personnel toward grey market activities associated with current drug shortages.

4.2 STUDY FINDINGS

4.2.1 Demographic and Practice Setting Characteristics

Of the 125 respondents who answered the survey, 95 (76.0%) were pharmacy directors, 11 (8.8%) were pharmaceutical purchasing agents and 10 (8.0%) were pharmacy managers. A majority of the respondents, 105 (84.0%), were licensed pharmacists. In addition, the majority (42.4%) of acute care hospitals in Texas were with less than 100 beds, had 10 or fewer pharmacist full-time equivalents (61.6%) and 10 or fewer pharmacy technician full-time equivalents (62.4%). The practice setting characteristics of our sample are consistent with the characteristics reported in the 2010 national survey of U.S. health systems conducted by the American Society of Health-System Pharmacists (ASHP). Their results indicated that 29% of the hospitals were with less than 100 beds, had 10 or fewer pharmacist full-time equivalents (53%) and 10 or fewer pharmacy technician full-time equivalents (49%).⁷⁴

4.2.2 Incidence of Drug Shortages

This study found that all surveyed hospitals have experienced at least one drug shortage for the month of April 2013. The majority of the hospitals, (45.5%), reported 11 or more drug shortages, followed by 18.7% indicating between 5 and 6 drug shortages. Thus, 64.2% of the respondents reported five or more drug shortages for April 2013. These findings are consistent with American Hospital Association (AHA) survey in which over a period of six months, 99.5% of hospitals experienced at least one drug shortage and 95% of the hospitals reported more than five drug shortages.⁷⁵ Moreover, our results indicated that there is a significant association between the number of drug

shortages experienced and the increasing in hospital size ($p = 0.003$), inpatient medication budget ($p = 0.001$) and hospital location ($p = 0.015$) with more shortages occurring in hospitals with 100 or more beds, with inpatient medication budget of \$1.5 million or more, and located in rural/semi urban areas. One previous study assessed the relationship between the number of drug shortages experienced by a health system and its size or geographic location and found that a significant association existed between the number of drug shortages and hospital size in term of number of beds ($p = 0.001$).⁷⁶

In addition, respondents were given a list of the 15 most recent drug shortages as reported by the ASHP web site and were asked to report whether their hospital experienced a shortage for April 2013. At least 50% of the respondents indicated that their hospital was affected by six of the drugs listed; four drugs affected over 80% of the hospitals. These findings are consistent with the results reported by Kaakeh et al. where 50% of respondents reported that their facilities had experienced a shortage of seven of the thirty drugs listed and 80% were affected by three of the drugs.⁷⁷ In addition, a national survey of the impact of drug shortages in acute care hospitals conducted by Baumer et al. indicated that almost half, 49%, of the respondents reported encountering a shortage for seven of the nine drugs listed.⁷⁸

4.2.3 Managing Drug Shortages

Respondents were asked to indicate whether they use activities such as ‘tracking drug shortages/gathering information’, ‘identifying therapeutic alternatives’, ‘contacting vendors, manufacturers, and group purchasing organizations’, ‘manage inventory/rationing available supplies/prioritizing’, ‘communicating drug information to

other health care providers', and 'communicating drug shortage information to hospital administration' when managing their drug shortages. A majority, 97.6%, of the respondents selected 'identifying therapeutic alternatives' as the activity practiced when managing drug shortages. This was followed by both 'manage inventory/rationing available supplies/prioritizing' and 'communicating drug information to other health care providers' activities (96.8%). These results are consistent with the Baumer et al. survey that notes 'identifying therapeutic alternatives' as the activity reported by the majority, 84.6%, of the respondents.⁷⁹

Additionally, respondents were asked to estimate the number of hours per week hospital pharmacy personnel spend on managing drug shortages considering the activities mentioned earlier. A majority, 62.9%, of the respondents spent anywhere from a half day to one and a half days a week (four to 12 hours) on managing drug shortage situations whereas 14.5% indicated spending 2 or more days a week managing drug shortages. Furthermore, the study found a significant association between the number of hours spent per week by hospital pharmacy personnel when managing drug shortages controlling for hospital size ($p < 0.001$), number of drug shortages experienced ($p < 0.001$), number of pharmacist FTEs ($p < 0.001$), and number of pharmacy technician FTEs ($p < 0.001$). Kaakeh et al. reported similar results where pharmacists indicated spending between 5 and 20 hours per week and pharmacy technicians between 3 and 17 hours per week managing drug shortages. In addition, a significant relationship was found between the amount of time spent managing shortages controlling for hospital size and the total number of drug shortages experienced.⁸⁰

4.2.4 Impact of Drug Shortages

Respondents were asked to report whether additional staff were hired as a result of increased workload and whether or not hospital pharmacy personnel were shifted from patients' care activities toward managing drug shortages. Only 2.4% of the respondents indicated that they had hired additional staff of which 1.6% reported hiring one additional person and 0.8% indicated hiring two additional people. These results are consistent with the findings of Baumer et al. and Kaakeh et al. where 2% indicated creating one or more new pharmacist positions and 5% reported adding staff to manage drug shortages respectively.^{81, 82}

In addition, only 38.7% of the respondents confirmed shifting hospital pharmacy personnel from patients' care activities toward managing drug shortages, which is consistent with the estimates of Kaakeh et al. where 32% of the respondents reported relocation of existence staff.⁸³ Furthermore, our study found that a majority, 54.1%, of the respondents, who reported shifting of personnel, indicated 'drug product procurement and inventory management' as the major patient care activity affected as the result of the staff relocation.

4.2.5 Drug Shortage Supply, Information Resources and Causes

When asked to rank the top three supply resources used when obtaining drugs in short supply, 41.4% of respondents reported purchasing off-contract from current vendor followed by 24.1% purchasing from alternative/secondary vendor. These results are consistent with the finding of the ASHP 2003 national survey in which the two most widely used supply resources were purchasing off-contract from their current vendor and

purchasing from alternative vendor as reported by 75% and 74% of the respondents respectively.⁸⁴

Additionally, a majority, 88%, of the respondents indicated wholesalers as their main resource when gathering drug shortages information, followed by ASHP (85.6%) and manufacturers (63.2%). The 2010 ASHP national survey claimed that the ASHP website was the most widely used information source as selected by 89% of the respondents, followed by wholesalers websites (84%) and group purchasing website (74%).⁸⁵ A possible explanation for the difference was that hospital pharmacy personnel are in constant contact with wholesalers thus receiving information on current drug shortages could be a part of the established relationship.

Respondents were asked to rank order the three most common reasons for drug shortages. More than half, 51.7%, of the respondents indicated manufacturing/regulatory issues as the most common reason of drug shortages, followed by business decision (33.1%) and consolidation in the industry (8.5%). These results are consistent with the findings in a previous study that tracked 224 drug shortages and found that the most common reason was manufacturing difficulties (28%), followed by business decision (20%), and a supply-and-demand imbalance (10%).⁸⁶

4.2.6 Grey Market Vendors

One of the study objectives was to estimate the number of acute care hospitals contacted by grey market vendors, defined as secondary supply channels that are unofficial, unauthorized or unintended by the original manufacturer for distribution of medicines, in the last month (April, 2013), the frequency and the mode of contact, and the

concerns and opinions of hospital pharmacy personnel toward grey market activities associated with current drug shortages. The majority, 85.6%, of the respondents reported that grey market vendors have contacted hospital pharmacy personnel in the last month (April, 2013). The reported number of grey market vendors' contacts ranged between 1 and 200 contacts, with an average number of 20.4 contacts, median of 10 contacts, and mode of 10 contacts. On the question, "*With regard to your practice, how often has hospital staff personnel been solicited by grey market vendors to buy their products?*" more than half, 53.3%, of the respondents reported receiving contacts on a daily basis, followed by 40.2% indicating weekly. However, when asked "*With regard to your practice, how often has hospital staff personnel been solicited by grey market vendors who want to purchase products from your pharmacy?*" only 23.4% of the respondents reported receiving such contacts and requests. Furthermore, respondents ranked the three most widely used methods by which hospital pharmacy personnel hear about drug products availability from the grey market vendors. A majority, 62%, selected telephone as the most widely used method, followed by email (27%) and fax (10%). Finally, respondents were asked what their main concerns were with purchasing drug products in short supply from grey market vendors. A majority of the respondents, 91.6%, reported that cost is their main concern, followed by authenticity (73.8%) and storage conditions of the drug products prior to purchase (71.0%). A previous study conducted by the Institute for Safe Medication Practices (ISMP) found that more than half, 56%, of the respondents reported receiving solicitations on a daily basis from up to 10 different grey market vendors who sell drugs in short supply. The study found that 90% were contacts

made via phone, 76% by email, and 68% by fax. In addition, the ISMP study found that more than 13% of the respondents received proposals from grey market vendors who wanted to purchase drugs in short supply from their pharmacy. Furthermore, respondents' main concerns regarding products offered by grey market vendors were authenticity (74%), cost (69%), ethical concerns (66%), and storage conditions prior to purchase (58%).⁸⁷

Additionally, our study aimed to explore whether a relationship existed between the numbers of times hospital pharmacist personnel were contacted by grey market vendors across facility sizes in terms of number of beds, number of drug shortages experienced by a health care systems in the last month (April, 2013), facility types, and facility locations. The results showed no such associations making it evident that the frequency of grey market vendors' contacts are not selective with regard to hospital size, type, location, and number of drug shortages experienced.

4.2.7 Respondents' Perceptions about Grey Market Vendors' Activities Associated with Drug Shortages

Using a five-point Likert-like scale, respondents were asked to indicate their level of agreement as to whether or not grey market vendors' contribute toward the drug shortages crises by buying whatever supplies they can find on the market, grey market vendors' practice of selling drugs in short supply at inflated prices, and whether the practice of buying drug products from grey market vendors should be eliminated. More than half, 57.6%, of the respondents 'strongly agreed' while 34.4% 'agreed' that grey market vendors contribute to the drug shortage crises by buying whatever drug supplies they can find on the market. Furthermore, a majority, 88%, of the respondents 'strongly

agreed' while 9.6% 'agreed' that grey market vendors sell drugs in short supply at inflated prices. These perceptions are consistent with findings in the 2011 Premier survey in which over a two-week period 1,745 grey market offers were collected with an average markup of 650%.⁸⁸ Similar results were reported in the ISMP survey on drug shortages, which found that 31% of respondents from small, critical access hospitals and 35% of the respondents from community hospitals had purchased products from grey market vendors with markups of 10 times or more the contract price.⁸⁹ Additionally, more than half, 56%, of the respondents expressed their strong agreement toward eliminating the practice of buying drug products from grey market vendors, while 20% 'agreed' and 15.2% reported being 'neutral' on the issue. Respondents' perceptions are in agreement with current calls for more stringent federal legislations in which rigid penalties are applied toward price gouging and diversion of products.⁹⁰

Finally, our study examined whether respondents' perceptions toward grey market activities associated with drug shortages differ while controlling for respondents' positions and the number of drug shortages experienced by the hospital. The results indicated no relationship thus concluding that hospital pharmacy personnel of Texas non-government acute care hospitals share common perceptions toward grey market vendors and the part they play in the drug shortages crises.

4.3 STUDY LIMITATIONS

The interpretation of the study findings should be considered in the light of several limitations. First, the study had a cross-sectional design and therefore any relationships found among variables might change over time. Second, a sample of Texas

non-government acute care hospitals was used, which was relatively small in size and thus any generalizations should be done with caution, especially to different types of hospitals and hospitals located outside of Texas. Third, the survey was self-administered and anonymous and as such verification of the responses was impracticable. In addition, respondents provided estimates of time based on recall, which is prone to both underestimation and overestimation.

As a part of the study, perceptions of hospital pharmacy personnel toward grey market vendors' activities associated with drug shortages were assessed. Hence, we cannot be assured that respondents will hold the same views over the time and as with all questionnaires questions are susceptible to different interpretations.

The study response rate was low (i.e., 39.84%) and non-response bias was not accounted for in the study. Thus, selection bias might be a problem since only hospitals that are interested in the drug shortages issue might have responded to the survey.

4.4 CONCLUSION

A survey of Texas non-government acute care hospitals revealed that the majority of the hospitals experienced five or more drug shortages in April 2013 and directors acknowledged the significance of the problem. The results showed that hospital pharmacy personnel devote a significant amount of time managing drug shortages, which in some instances might lead to relocation of personnel and thus compromising some patient care activities. In addition, the majority of respondents accounted for receiving solicitations from grey market vendors on a daily basis with the main purpose to sell drugs in short supply at inflated prices. These results are in line with the ongoing alarms

of drug shortages' price gouging calling for immediate actions by all stakeholders. Furthermore, the majority of the respondents expressed their strong agreement toward eliminating the practice of buying drugs in short supply from grey market vendors and thus advocating for stronger regulations regarding distribution of pharmaceutical products.

4.5 DIRECTIONS FOR FUTURE RESEARCHES

This study focused only on non-government acute care facilities. Future research should examine the impact of drug shortages in non-acute-care settings, including home care, long-term care, and community pharmacy settings and other types of hospitals such as psychiatric and oncology hospitals. In addition, it would be necessary to assess the financial burden health systems would anticipate when applying alternative therapies once a drug shortage is encountered. Another unexplored area is the impact of the Medicare Prescription Drug, Improvement, and Modernization Act of 2003 on drug shortages. Lastly, a study is needed to determine to what extent hospitals buy drugs from grey market vendor and sell drugs to grey market vendors.

Appendices

Appendix I

Assess the Incidence and Impact of Drug Shortages within

Texas Non - Government Acute Care Hospitals

SECTION I: DRUG SHORTAGES EXPERIENCE

In this section we would like to know more about your experience regarding drug shortages.

Please check the appropriate box that corresponds with your answer to the questions below.

1. Using the following scale, please estimate the number of drug shortages your hospital experienced in the last month.

None (Please, skip to Section III, page 10)

1-2

3-4

5-6

7-8

9-10

11 or more

2. In your opinion, please rate the degree of the of drug shortages' problem regarding your hospital setting

Significant problem

Moderate Problem

Some kind of a problem

Not much of a problem

No problem

3. Listed below are 15 of the recent drug shortages as listed on ASHP website as of March 2013. Please, check all the medicines that apply to your hospital for which shortage has been experienced.

- Amiodarone HCl Injection
- Amikacin Injection
- Aminophylline Injection
- Atropine Sulfate Injection
- Calcium Chloride Injection
- Cytarabine Injection
- Dextrose 50% Injection
- Dopamine Injection
- Diltiazem Injection
- Methotrexate Injection
- Midazolam Injection
- Norepinephrine Injection
- Oxymorphone Hydrochloride
- Odanserton Injection
- Sodium Bicarbonate Injection
- None

4. Which of the following activities apply to your practice when managing drug shortages? Please, check all that apply.

- Tracking drug shortages/Gathering information
- Identifying therapeutic alternatives
- Contacting vendors, manufacturers, and group purchasing organizations
- Manage inventory/Rationing available supplies/Prioritizing
- Communicating drug shortage information to other health care providers
- Communicating drug shortage information to hospital administration
- Other (please, specify)_____

5. Regarding your practice, on average, please estimate the number of hours per week hospital pharmacy staff spend managing drug shortages considering all the activities mentioned above?

- 1-3 hrs/week
- 4-6 hrs/week
- 7-9 hrs/week
- 10-12 hrs/week
- 13-15 hrs/week
- More than 16 hrs/week

6. With regard to your practice, have you hired additional staff as a result of increased workload due to drug shortages?

- Yes (please continue with Question 7)
- No (please skip to Question 8)

7. How many additional staff have you hired as a result of increased workload due to drug shortages?

- 1
- 2
- 3
- 4
- Other (please, specify)_____

8. With regard to your practice, have you shifted hospital pharmacy personnel from patients' care activities toward managing drug shortages?

- Yes (Please continue with Question 9)
- No (Please skip to Question 10)

9. Listed below are some of the hospital pharmacy personnel patients' care activities. With regard to your practice, please rate the degree of **only three** care activities that have been affected as a result of shifting hospital pharmacy personnel toward managing drug shortages using numbers 1 through 3 with "1" being highly affected, "2" being somewhat affected and "3" being not affected.

- _____ practice management
- _____ medication-use policy development
- _____ optimizing medication therapy
- _____ drug product procurement and inventory management
- _____ preparing, packaging, and labeling medications
- _____ medication delivery
- _____ monitoring medication use
- _____ evaluating the effectiveness of the medication-use system
- _____ research

10. Listed below are various resources commonly used while obtaining drugs in short supply. In your opinion, please rank **only three** of the most widely used resources using numbers 1 through 3 with “1” being most widely used, “2” second most widely used, and “3” third most widely used.

- _____ Purchase off-contract from current vendor
- _____ Purchase from alternative/secondary vendor
- _____ Borrow from another institution
- _____ Obtain services from group purchasing organization
- _____ Purchase-compounded replacement pharmaceuticals
- _____ Purchase raw materials to compound replacement pharmaceuticals

11. Listed below are various information resources commonly used to obtain information on drugs in short supply. Please, check all that apply to your practice when gathering information on drug shortages.

- ASHP (American Society of Health System Pharmacists)
- FDA (Food and Drug Administration)
- CDC (Centers for Disease Control and Prevention)
- Wholesalers
- Manufacturers
- Group purchasing organizations
- Other (please, specify)_____

12. Various reasons have been mentioned for the drug shortage problem.

In your opinion, please indicate the top **three reasons** you think are the causes of the drug shortage problem using numbers 1 through 3 with “1” being the most common reason, “2” being the second most common reason and “3” being the third most common reason.

- _____ Consolidation in the industry
- _____ Raw Materials
- _____ Supply Chain Issues
- _____ Manufacturing/Regulatory Issues
- _____ Changes in Clinical Practice
- _____ Business Decisions (Low Profitability)
- _____ Unknown

SECTION II: “GREY MARKET” VENDORS AND DRUG SHORTAGES

In this section, we would like to know more about your practice and opinion regarding “grey market” vendors’ activities associated with drug shortages. For the purpose of getting same perspective we define “grey market” as a secondary supply channel that is unofficial, unauthorized or unintended by the original manufacturer for distribution of medicines

Please check the appropriate box that corresponds with your answer to the questions below.

13. With regard to your facility, have hospital pharmacy staff personnel been contacted by a grey market vendor in the last month?

Yes (please continue with Question 14)

If ‘Yes’, please estimate the number of times contacted by grey market vendors in the last month

_____ times contacted by grey market vendors in the last month.

No (please skip to question 18, page 9)

I don’t know (please skip to question 18, page 9)

14. With regard to your practice, how often has hospital pharmacy staff personnel been solicited by grey market vendors to buy their products?

Daily

Weekly

Monthly

Less than monthly

None

15. With regard to your practice, how often has hospital pharmacy staff personnel been solicited by grey market vendors who want to purchase products from your pharmacy?

- Daily
- Weekly
- Monthly
- Less than monthly
- None

16. With regard to your practice, please rank **only three** of the most widely used methods by which hospital pharmacy staff personnel hear about products available from the gray market vendors using numbers 1 through 3 with “1” being most widely used, “2” second widely used, and “3” third widely used.

- _____ Email
- _____ Fax
- _____ Telephone
- _____ US mail
- _____ Personal visits
- _____ Other (please specify)_____

17. With regard to your practice, what are the main concerns regarding purchasing products from grey market vendors? Please, check all that apply.

- Cost
- Authenticity
- Reliability
- Ethical concerns
- Reputation of vendors
- Storage conditions prior to purchase
- Institutional policy
- Other (please specify)_____

18. We are interested in knowing your perceptions of grey market vendors' activities associated with drug shortages.

Please, check the appropriate circle indicating your level of agreement with each of the following statements by choosing one of the following responses:

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
a. Grey market vendors are more likely to contact your facility when drug shortage exists.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
b. Grey market vendors have the ability to identify and obtain drugs in short supply.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
c. Grey market vendors contribute to the drug shortage crises by buying whatever supplies they can find on the market.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
d. Grey market vendors sell drugs in short supply at inflated prices.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
e. Grey market vendors offer drugs in short supply needed to treat critically ill patients at largest markups.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
f. Grey market vendors are sometimes the only source available for obtaining a drug in shortage.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
g. The practice of buying products from grey market vendors should be eliminated.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

SECTION III: DEMOGRAPHICS AND PRACTICE SETTING INFORMATION

This section will help gather some information about you and your practice setting.

Please check the appropriate box that corresponds with your answer to the questions below or write your response as appropriate.

19. Which of the following best describes the facility where you work?

- Community Hospital
- Chain Hospital
- Children's Hospital
- Health Care Group Hospital
- Health Care System Hospital
- University Hospital
- Other (please, specify)_____

20. Which of the following best describes your position within the facility where you are employed?

- Director of pharmacy
- Pharmacy manager
- Pharmaceutical purchasing agent
- Staff pharmacist
- Pharmacy technician
- Pharmacy clerk
- Other (please, specify)_____

21. Are you a licensed pharmacist?

- Yes
- No

22. Which of the following best describes the number of pharmacist Full Time Equivalents (FTEs) at your facility?

- Less or equal 10
- 11-25
- 26-50
- Greater than 50

23. Which of the following best describes the number of pharmacy technician FTEs at your facility?

- Less or equal 10
- 11-25
- 26-50
- Greater than 50

24. Which of the following best describes your facility size in terms of number of beds?

- Less than 100
- 100 – 150 beds
- 151 – 250 beds
- 251 - 350 beds
- 351 – 450 beds
- Greater than 451

25. Which of the following best describes your facility inpatient medication budget per year?

- Less than \$1.5 million
- \$1.5-5.0 million
- \$5.0-10 million
- Greater than \$10 million

26. Which of the following best describes the location of your facility?

- Large Metropolitan (Contains city of 500,000 or more, many suburbs, very little open country)
- Medium Metropolitan (Contains city of 150,000 to 499,000, several suburbs, some open country)
- Small Metropolitan (Contains city of 50,000 to 149,499, few suburbs, considerable open country)
- Semi-Urban (City of 10,000 to 49, 999, few smaller towns and contains much open country)
- Semi-Rural (Contains city of 2,500 to 9,999, one or two smaller towns, mostly open country)
- Rural (Contains town of less than 2,500, surrounded entirely by open country)

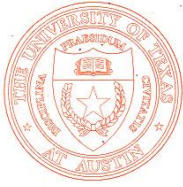
27. Please, share any additional comments or concerns regarding drug shortages.

If you would like an aggregate summary of the results, please email Tawfik Rajab at tawfikrajab@utexas.edu.

Please, fold the questionnaire, place it in the envelope provided, and drop it in any mailbox. No postage is necessary.

Thank you for taking the time to participate in this survey!

Appendix II



COLLEGE OF PHARMACY

THE UNIVERSITY OF TEXAS AT AUSTIN

Center for Pharmacoeconomic Studies • Austin, Texas 78712-0127

(512) 471-6892 • FAX (512) 471-8762

Dear Pharmacy Director,

U.S. hospitals have been combating the increasing number of drug shortages since 2001. U.S. Food and Drug Administration (FDA) and American Society of Health System Pharmacists (ASHP) in collaboration with the University of Utah Drug Information Service (UUDIS) have reported 178 and 211 drug shortages respectively for the year of 2010. The issue of increased number of drug shortages has grabbed national attention of the mass media, health professionals, federal and state regulators, health care and pharmacy associations, patients and patient groups/associations, and politicians. Yet, more researches are needed and their results communicated to policy makers, manufacturers, public agencies, wholesaler, and public as a whole in order to improve communication among different parties and present an in depth picture of the problem and its implications.

We, at the University of Texas at Austin, are conducting a research to explore the incidence and impact of drug shortages within Texas Non – Government Acute Care Hospitals. Enclosed is a questionnaire, which has been designed to gather information in regard to hospital pharmacist personnel experience when encountering drug shortages and their practices and opinions regarding grey market vendor activities associated with drug shortages. Because you are working for an Acute Care Hospital in the state of Texas, we are inviting you to participate in this research by completing the enclosed questionnaire. Although, your participation is voluntary, we hope you will participate so that our results will be representative of Texas non-government acute care hospitals.

It will only take 10 minutes to complete the questionnaire. All responses are anonymous and will be kept confidential. The questionnaire will not gather any personal/hospital identifying data. Responses will only be reported in an aggregated form so that results cannot be traced back to any particular respondent/hospital. There is no potential risk anticipated to human subjects involved in the study. Completion and return of the questionnaire will represent your consent to participate in this study. Participants must be over the age of 18 to participate.

If you have any questions about this project, you may contact Marv Shepherd (512) 471-5607 marvshepherd@mail.utexas.edu or Tawfik Rajab at tawfikrajab@utexas.edu. If you have questions about your rights as a research participant, please contact the Office of Research Support at (512) 471-8871, or email orsc@uts.cc.utexas.edu.

Thank you for your time and cooperation in participating in this study.

Sincerely,

Marvin Shepherd, Ph.D.

Director
Center for Pharmacoeconomics Studies

Tawfik Rajab, B.Pharm, M.S

Graduate Student
Health Outcomes and
Pharmacy Practice Division

References

1. Provisional observations on drug product shortages: effects, causes, and potential solutions. *Am J Health-Syst Pharm.* 2002; 59:2173-82.
2. Fox ER, Tyler LS. Managing drug shortages: Seven years' experience at one health system. *Am J Health-Syst Pharm.* 2003; 60:245-53.
3. Mitka M. FDA, US hospital and pharmacy groups report drug shortages a growing problem. *JAMA.* 2011; 306(10): 1069-70.
4. Kaakeh R, Sweet BV, Reilly C, Bush C, DeLoach S, Higgins B, et al. Impact of drug shortages on U.S. health systems. *Am J Health Syst Pharm.* 2011; 68: e13-17.
5. Center for Drug Evaluation and Research, Food and Drug Administration, Manual of Policies and Procedures (MAPP), 6003.1. Available at: <http://www.fda.gov/downloads/AboutFDA/CentersOffices/OfficeofMedicalProductsandTobacco/CDER/ManualofPoliciesProcedures/UCM079936.pdf>. Accessed October 26, 2011.
6. Fox E, Birt A, James K, et al. ASHP guidelines on managing drug product shortages in hospitals and health systems. *Am J Health Syst Pharm* 2009; 66:1399–1406.
7. Fox ER. Drug Shortage Update, Current Status and Significant Trends. Available at: <http://www.fda.gov/downloads/Drugs/NewsEvents/UCM274565.pdf>. Accessed October 30, 2011.
8. Current Drug Shortages Index. Drug Shortages. Drug Safety and Availability. FDA. Available at: <http://www.fda.gov/Drugs/DrugSafety/DrugShortages/ucm050792.htm>. Accessed March 30, 2013.
9. Drug Shortages: Current Drugs. ASHP Drug Shortage Resource Center. Available at: <http://www.ashp.org/menu/DrugShortages/CurrentShortages>. Accessed March 30, 2013.
10. Gardinar H. Obama tries to speed response to shortages in vital medicines. *The New York Times.* 2011 October 31. Available at: http://www.nytimes.com/2011/10/31/health/policy/medicine-shortages-addressed-in-obama-executive-order.html?_r=0. Accessed November 1, 2011.
11. Food and Drug Administration. Fact sheet: Drug in shortage in the United States. 2012 July 23. Available at: <http://www.fda.gov/RegulatoryInformation/Legislation/FederalFoodDrugandCosmeticAc>

[tFDCAAct/SignificantAmendments/totheFDCAAct/FDASIA/ucm313121.htm](http://www.fda.gov/oc/ohrt/FDCAAct/SignificantAmendments/totheFDCAAct/FDASIA/ucm313121.htm). Accessed October 10, 2012.

12. American Hospital Association. AHA survey on drug shortages. 2011 July 12. Available at: <http://www.aha.org/content/11/drugshortagesurvey.pdf>. Accessed November 15, 2011.

13. American Society of Anesthesiologists. Survey Reveals 90 Percent of Anesthesiologists Experiencing Drug Shortage of Anesthetics. 2011 May 9. Available at: <http://www.asahq.org/For-the-Public-and-Media/Press-Room/ASA-News/Survey-Reveals-90-Percent-of-Anesthesiologists-Experiencing-Drug-Shortages-of-Anesthetics.aspx>. Accessed November 15, 2011.

14. Kaakeh R, Sweet BV, Reilly C, Bush C, DeLoach S, Higgins B, et al. Impact of drug shortages on U.S. health systems. *Op.cit.e16*

15. Drug shortages cost U.S care providers at least \$200 million annually, pose patient safety risks, research suggests. Charlotte, N.C: Premier, Inc; 2011 March 23. Available at: <https://www.premierinc.com/about/news/11-mar/drugshortage032811.jsp>. Accessed November 20, 2011.

16. Food and Drug Administration. A review of FDA's approach to medical product shortages. 2011 October 31. Available at: <http://www.fda.gov/AboutFDA/ReportsManualsForms/Reports/ucm277745.htm>. Accessed November 10, 2011.

17. Fox ER. Drug Shortage Update, Current Status and Significant Trends. *Op.cit.*

18. Food and Drug Administration. A review of FDA's approach to medical product shortages. *Op.cit.*

19. Ibid.

20. Ibid.

21. Food and Drug Administration. Fact Sheet: Drug Products in Shortage in the United States. Available at: <http://www.fda.gov/RegulatoryInformation/Legislation/FederalFoodDrugandCosmeticAct/FDCAAct/SignificantAmendments/totheFDCAAct/FDASIA/ucm313121.htm>. Accessed September 01, 2012.

22. American Society of Health System Pharmacists. ASHP guidelines on managing drug product shortages. *Am J Health-Syst Pharm*. 2001; 58:1445-50.

23. Scott MM. Understanding and managing challenges posed by drug shortages. *Am J Health-Syst Pharm.* 2002 December 9. Available at: <http://www.ashp.org/DocLibrary/Policy/DrugShortages/DShort-abbott-drug.aspx>. Accessed November 12, 2011.
24. American Society of Health System Pharmacists. ASHP guidelines on managing drug product shortages. *Op.cit.*
25. Fox ER, Birt A, James KB, Kokko H, Salverson S, Soflin DL. ASHP guidelines on managing drug product shortages in hospitals and health systems. *Am J Health-Syst Pharm.* 2009; 66:1399-406.
26. American Society of Health System Pharmacists. ASHP guidelines on managing drug product shortages. *Op.cit.*
27. Scott MM. Understanding and managing challenges posed by drug shortages. *Op.cit.*
28. Tyler LS. Understanding and managing drug shortages. *Am J Health-Syst Pharm.* 2002 December 9. Available at: <http://www.ashp.org/DocLibrary/Policy/DrugShortages/DShort-abbott-drug.aspx>. Accessed November 12, 2011.
29. Current Shortages. FDA Drug Shortage Program. Available at: <http://www.fda.gov/Drugs/DrugSafety/DrugShortages/default.htm>. Accessed August 3, 2012.
30. Ibid.
31. Tyler LS. Understanding and managing drug shortages. *Op.cit.*
32. Drug Shortages: Current Drugs. ASHP Drug Shortage Resource Center. Available at: <http://www.ashp.org/menu/DrugShortages/CurrentShortages>. Accessed July 25, 2012.
33. Scott MM. Understanding and managing challenges posed by drug shortages. *Op.cit.*
34. Biological Product Shortages. FDA Center for Biologic Research and Evaluation. Available at: <http://www.fda.gov/BiologicsBloodVaccines/SafetyAvailability/Shortages/default.htm>. Accessed August 3, 2012.
35. Fox ER, Birt A, James KB, Kokko H, Salverson S, Soflin DL. ASHP guidelines on managing drug product shortages in hospitals and health systems. *Op.cit.*

36. Kaakeh R, Sweet BV, Reilly C, Bush C, DeLoach S, Higgins B, et al. Impact of drug shortages on U.S. health systems. *Op.cit.*, p. e20.
37. FDA Webinar on prescription drug shortages. 2011 September 30. Available at: <http://www.fda.gov/AboutFDA/Transparency/Basics/ucm272223.htm>. Accessed November 15, 2011.
38. American Society of Health-System Pharmacists. Drug Shortages Summit Report. Available at: <http://www.ashp.org/drugshortages/summitreport>. Accessed June 20, 2012.
39. Provisional observations on drug product shortages: effects, causes, and potential solutions. *Op.cit.*, p. 2179.
40. Fox ER, Birt A, James KB, Kokko H, Salverson S, Soflin DL. ASHP guidelines on managing drug product shortages in hospitals and health systems. *Op.cit.*, p.1400.
41. *Ibid.*, p. 1400.
42. Stein R. Shortages of key drugs endanger patients. *The Washington Post*. 2011 May 1. Available at: http://articles.washingtonpost.com/2011-05-01/national/35265023_1_drug-shortages-drug-information-service-cancer-drugs. Accessed June 23, 2012.
43. Provisional observations on drug product shortages: effects, causes, and potential solutions. *Op.cit.*, p. 2179.
44. Fox ER, Birt A, James KB, Kokko H, Salverson S, Soflin DL. ASHP guidelines on managing drug product shortages in hospitals and health systems. *Op.cit.*, p.1400.
45. *Ibid.*, p. 1400.
46. Provisional observations on drug product shortages: effects, causes, and potential solutions. *Op.cit.*, p. 2180-81.
47. Fox ER, Birt A, James KB, Kokko H, Salverson S, Soflin DL. ASHP guidelines on managing drug product shortages in hospitals and health systems. *Op.cit.*, p.1400.
48. *Ibid.*, p. 1400.
49. Fox ER, Tyler LS. Managing drug shortages: Seven years' experience at one health system. *Op.cit.*

50. Fox ER, Birt A, James KB, Kokko H, Salverson S, Soflin DL. ASHP guidelines on managing drug product shortages in hospitals and health systems. *Op.cit.*, p.1401.
51. *Ibid.*, p. 1401.
52. *Ibid.*, p. 1402.
53. Institute for Safe Medication Practices. Drug shortages: national survey reveals high level of frustration, low level of safety. *ISMP Med Saf Alert!* 2010 July 29. Available at: <http://www.ismp.org/newsletters/acutecare/articles/20100923.asp> Accessed November 2, 2011.
54. 54. Institute for Safe Medication Practices. Survey helps define near miss and close call. *ISMP Med Saf Alert!* 2009 September 24. Available at: <https://www.ismp.org/newsletters/acutecare/articles/20090924.asp> Accessed December 03, 2013.
55. Cherici C, Frazier J, Feldman M, Gordon B, Petrykin CA, Russell WL, Souza J; Premier healthcare alliance. Navigating drug shortages in American healthcare: A Premier healthcare alliance analysis. 2011 March. Available at: <http://www.premierinc.com/about/news/11-mar/drug-shortage-white-paper-3-28-11.pdf>. Accessed October 28, 2011.
56. Baumer AM, Clark AM, Witmer DR, Geize SB, Vermeulen LC, Deffenbaugh JH. National survey of the impact of drug shortages in acute care hospitals. *Am J Health-Syst Pharm.* 2004; 61:2015-22.
57. Kaakeh R, Sweet BV, Reilly C, Bush C, DeLoach S, Higgins B, et al. Impact of drug shortages on U.S. health systems. *Op.cit.*
58. American Hospital Association. AHA survey on drug shortages. 2011 July 12. *Op.cit.*
59. Johnson LA. Hospital drug shortages are deadly, costly. *The Associated Press.* 2011 September 24. Available at: http://www.nola.com/health/index.ssf/2011/09/hospital_drug_shortages_deadly.html. Accessed October 30, 2011.
60. Fox ER, Birt A, James KB, Kokko H, Salverson S, Soflin DL. ASHP guidelines on managing drug product shortages in hospitals and health systems. *Op.cit.*, p.1401-02.
61. Marini R. Drug shortages, skyrocketing prices anger pharmacists. *San Antonio Express-News.* 2011 May 3. Available at: <http://www.mysanantonio.com/life/health/article/Drug-shortages-skyrocketing-prices-anger-1362707.php>. Accessed October 30, 2011.

62. Ackerman T. National drug shortage has Houston hospitals scrambling. *Houston Chronicle*. 2011 March 10. Available at: <http://www.chron.com/news/houston-texas/article/National-drug-shortage-has-Houston-hospitals-1686810.php>. Accessed October 30, 2011.
63. Institute for Safe Medication Practices. Grey market, black heart: Pharmaceutical grey market finds a disturbing niche during the drug shortage crisis. *ISMP Med Saf Alert*. 2011 August 25. Available at: <http://www.pharmaline.co.il/images/documents/20110825.pdf>. Accessed October 25, 2011.
64. Cherici C, McGinnis P, Russell W; Premier healthcare alliance. Buyer beware: drug shortages and the gray market. 2011 August. Available at: <http://www.premierinc.com/about/news/11-aug/Gray-Market/Gray-Market-Analysis-08162011.pdf>. Accessed October 28, 2011.
65. Provisional observations on drug product shortages: effects, causes, and potential solutions. *Op.cit.*
66. *Ibid.*, p. 2179.
67. Fox ER, Birt A, James KB, Kokko H, Salverson S, Soflin DL. ASHP guidelines on managing drug product shortages in hospitals and health systems. *Op.cit.*, p.1400.
68. Institute for Safe Medication Practices. Drug shortages threaten patient safety. *ISMP Med Saf Alert*. 2010 July 29. *Op.cit.*
69. Johnson LA. Hospital drug shortages are deadly, costly. *The Associated Press*. 2011 September 24. *Op.cit.*
70. Fox ER, Birt A, James KB, Kokko H, Salverson S, Soflin DL. ASHP guidelines on managing drug product shortages in hospitals and health systems. *Op.cit.*, p.1401-02.
71. Kaakeh R, Sweet BV, Reilly C, Bush C, DeLoach S, Higgins B, et al. Impact of drug shortages on U.S. health systems. *Op.cit.*
72. Cochran, W. The χ^2 test of goodness of fit. *Annals of Mathematical Statistics*. 1952; 23(3): 315–345.
73. Yates D, Moore D, McCabe G. *The Practice of Statistics*. 1st ed. New York: W.H. Freeman; 1999.

74. Kaakeh R, Sweet BV, Reilly C, Bush C, DeLoach S, Higgins B, et al. Impact of drug shortages on U.S. health systems. *Op.cit.*, p.e15.
75. American Hospital Association. AHA survey on drug shortages. 2011 July 12. *Op.cit.*
76. Kaakeh R, Sweet BV, Reilly C, Bush C, DeLoach S, Higgins B, et al. Impact of drug shortages on U.S. health systems. *Op.cit.*, p.e16.
77. *Ibid.*, p.e17.
78. Baumer AM, Clark AM, Witmer DR, Geize SB, Vermeulen LC, Deffenbaugh JH. National survey of the impact of drug shortages in acute care hospitals. *Op.cit.*, p.2016.
79. *Ibid.*, p.2020.
80. Kaakeh R, Sweet BV, Reilly C, Bush C, DeLoach S, Higgins B, et al. Impact of drug shortages on U.S. health systems. *Op.cit.*, p.e16.
81. Baumer AM, Clark AM, Witmer DR, Geize SB, Vermeulen LC, Deffenbaugh JH. National survey of the impact of drug shortages in acute care hospitals. *Op.cit.*, p.2019.
82. Kaakeh R, Sweet BV, Reilly C, Bush C, DeLoach S, Higgins B, et al. Impact of drug shortages on U.S. health systems. *Op.cit.*, p.e16.
83. *Ibid.*, p.e16
84. Baumer AM, Clark AM, Witmer DR, Geize SB, Vermeulen LC, Deffenbaugh JH. National survey of the impact of drug shortages in acute care hospitals. *Op.cit.*, p.2019.
85. Kaakeh R, Sweet BV, Reilly C, Bush C, DeLoach S, Higgins B, et al. Impact of drug shortages on U.S. health systems. *Op.cit.*, p.e18.
86. Fox ER, Tyler LS. Managing drug shortages: Seven years' experience at one health system. *Op.cit.*, p.247.
87. Institute for Safe Medication Practices. Grey market, black heart: Pharmaceutical grey market finds a disturbing niche during the drug shortage crisis. *ISMP Med Saf Alert*. 2011 August 25. *Op.cit.*
88. Cherici C, McGinnis P, Russell W; Premier healthcare alliance. Buyer beware: drug shortages and the gray market. 2011 August. *Op.cit.*, p.2.

89. Institute for Safe Medication Practices. Grey market, black heart: Pharmaceutical grey market finds a disturbing niche during the drug shortage crisis. *ISMP Med Saf Alert*. 2011 August 25. *Op.cit.*

90. American Society of Health System Pharmacists. Summary of the executive session on critical threats to the pharmacy supply chain and the effects on patient care. *Am J Health-Syst Pharm*. 2013; 70:1689-98. 2012 August 20.