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DNP Project: Knowledge and Attitudes Regarding Current Technology to Prevent Drug Diversion

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Abstract

The purpose of this project was to assess Student Registered Nurse Anesthetists (SRNA) and Certified Registered Nurse Anesthetists (CRNA) knowledge and attitudes about current interventions using technology to prevent drug diversion. A descriptive survey was sent to current Illinois Association of Nurse Anesthetists members that included SRNAs and CRNAs. The survey was a modified version of the Evidence-based nursing tool originally developed by Upton and Upton (2006) and was coded utilizing a Likert scale. Data were collected from a sample of 145 SRNAs and CRNAs. Knowledge regarding drug diversion was in the neutral range with a mean = 2.64 - 3.66 and SD = 0.85 - 1.24. Responses to attitudes regarding drug diversion were in the neutral range with a mean = 2.83 - 3.99 and SD = 0.83 - 1.35. Attitudes were more positive among females (m= 3.69, sd= 0.76) than males (m= 3.41, sd= 0.78). In addition, attitudes were more positive among those with Doctoral degrees (m= 3.86, sd= 0.56 than those with Master's degrees (m= 3.48, sd= 0.81;t(83.447) = -3.141, p = .002). Analysis of the survey results found that overall, there were neutral opinions of knowledge and attitudes on drug diversion. Based on the overall neutrality of the results, revisions were made to the original survey. The revised survey was sent to five CRNAs to evaluate the tool for clarity and appropriateness of the survey items. Overall response supported that the revised survey tool may more accurately reflect survey participant knowledge and attitudes in regards to drug diversion. Recommendations for future research include utilization of the new survey tool with a goal of obtaining a larger response rate. Dependent on results, developing an educational tool in the future may help to improve knowledge and increase positive attitudes on the topic of drug diversion.

Keywords: *anesthesia, drug diversion, evidence-based, knowledge, attitudes* and *abuse*

Introduction and Background

Drug diversion is a considerable problem in health care facilities (Bell, McDonough, Ellison, & Fitzhugh, 1999). In the operating room setting, anesthesia providers have constant access to controlled substances making it an ideal environment for diverting drugs. For the purpose of this project, "diversion" is used in reference to the act of an anesthesia provider redirecting anesthesia drugs for personal use both on and off-duty. An impaired provider who diverts cannot deliver anesthesia safely or respond appropriately to an emergency. Ultimately, patient safety is compromised (Bell et al., 1999). Education and awareness has been integrated in anesthesia training, yet the incidence of chemical dependence is not declining. Chemical dependency in anesthesia occurs most frequently in the first five years of practice. In addition, the leading cause of death in the young anesthetic provider population is addiction to anesthetic drugs (Tetzlaff, 2011). There are multiple risk factors that may contribute to the risk of chemical dependence, but stress is a precursor prevalent in anesthesia school and in the early years of practicing (Bozimowski, Groh, Rouen, & Dosch, 2014). In addition to anesthesia providers, ancillary staff working in the operating room may have access to the medication carts and an opportunity to also divert drugs. Warner et al. (2015) reported on a surgical technician who accessed medication carts and diverted an opioid, replacing a fentanyl syringe with a contaminated syringe filled with normal saline. An unknown number of patients were exposed to the hepatitis C virus; 18 patients were infected with the virus. It is essential that institutions not only monitor access to controlled substances, but adopt procedures to track individuals who actually accessed controlled substances.

Problem statement

Anesthesia providers are in continuous contact with controlled substances. The risk of misuse is a significant occupational hazard in this profession. The rate of diversion for practicing CRNAs is nearly one out of ten providers (Bell et al., 1999). Drug diversion in the operating room is a multifaceted problem that affects providers, coworkers, employers, patients, and families (Berge, Dillon, Sikkink, Taylor, & Lanier, 2012). The progression of chemical dependence is rapid with a high rate of morbidity and mortality (Tetzlaff, 2011). The American Association of Nurse Anesthetists (AANA) estimates diversion and addiction of anesthesia providers (CRNAs and anesthesiologists) at greater than 15 percent (Luck & Hendrick, 2004). It is clear that there must be more focus on ways to decrease this trend that places patients and anesthesia providers at risk (Luck & Hedrick, 2004). Although controlled substances are stored in locked cabinets, a universal code that many institutions provide allow for easy access and the opportunity for diversion. It is difficult to enforce accountability when many are able to access controlled substances. Utilizing technology with drug dispensing carts and screening programs has been shown to detect drug diversion (Epstein, Gratch, McNulty, & Grunwald, 2011). Automated drug dispensing machines with secure return bins that are subject to random quantitative assays have been shown to decrease drug diversion (Berge et al., 2012). According to Tetzlaff et al. (2010), electronic interfacing, pre-employment screening, and random drug testing will help with early detection and treatment for the provider. In addition, these interventions may be a deterrent to those entering a specialty with a history of easy access to controlled substances (Tetzlaff et al., 2010). Drug diversion is a well-documented problem in anesthesiology. Technology may be able to assist in detecting drug diversion as well as providing a more secure approach to protecting controlled substances.

Purpose of the Project

The purpose of this scholarly leadership project was to assess CRNA and SRNAs knowledge and attitudes about current interventions available to prevent drug diversion. It was important to evaluate what providers know and their opinions regarding current strategies available to deter drug diversion. There are methods and technologies available that attempt to decrease the risk of accessing and altering drugs. We attempted to determine how much is known about drug diversion as well as their views towards change of practice, such as the use of computer-driven access of controlled substances. Assessing knowledge and attitudes about available interventions helped to determine whether there was a need to develop interventions that address the knowledge and attitudes of anesthesia providers related to drug diversion.

Clinical Questions using PICOT format

(P) -Population -Among current members of the Illinois Association of Nurse Anesthetists (IANA), what are their knowledge and attitudes about computer-based access to controlled substances?

(I) - Intervention-To deter drug diversion.

(C) - Comparison -N/A

(O)- Outcome-To inform and provide education on current technologies to deter drug diversion.

(T) - Time -Survey dissemination and data collection will be conducted over a 8-week period.

Theoretical Framework

There are two theoretical frameworks that supported this project. Promoting Action on Research Implementation in Health Services (PARIHS) and Transformational Theory of Adult Learning (TL) was utilized for the development of this study. The PARIHS theoretical framework as described by Kitson, Harvey, & McCormack (1998) is a process to implement a best practice change. According to PARIHS, robust evidence-based research provides a positive environment conducive to the application of a new clinical practice. It also serves as a guide to apply evidence-based practice into the clinical setting (Hutchinson, Wilson, Kent, & Harrison, 2011). Hutchinson et al. (2011) identified the key elements of PARIHS as evidence (evidence-based research), context (target culture or environment in which change is to be introduced), and facilitation (actual introduction of research into practice).

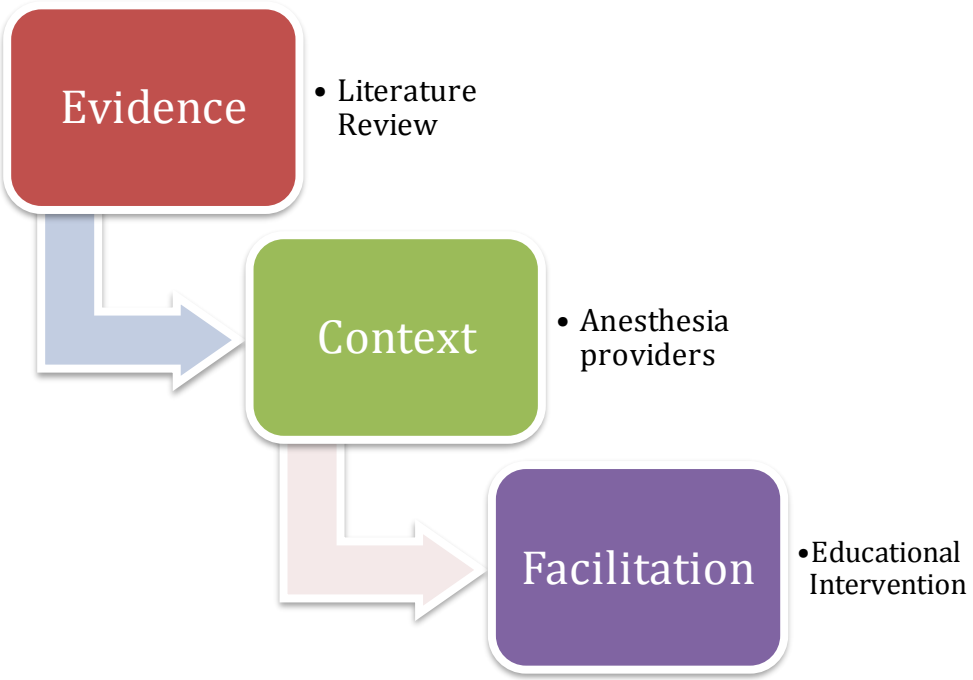

Figure 1. Theoretical Map Based on PARIHS.

The survey was used to help identify a potential a gap in knowledge among CRNAs and SRNAs preventing adoption of new technology in an attempt to quell the occurrence of drug diversion and abuse. After data collection and analysis were performed, it was determined that knowledge and attitudes regarding drug diversion were neutral. If a knowledge gap had been identified, an educational intervention, based upon Jack Mezirow's Adult learning theory - *Transformational Learning* (TL) would have been identified. Adult learning is primarily based on past experiences that are in turn re-evaluated and used to formulate a guide to future decisions (Mezirow, 1996, p. 162). McNaron (2009) utilized TL as the framework for changing behavior in the operating room. The author concluded that attaining the goal of best practice (BP) in the clinical setting requires continuous assessment of current research and an effective means to introduce the information into an environment that in many cases is unwelcoming to change. In the application of TL to evidence-based practice nursing, the author states that individuals must integrate critical thinking and research in order to convert personal learning into evidence-based knowledge (McNaron, 2009).

Survey response results were categorized and used to determine if an educational program was needed to address common beliefs and/or misconceptions regarding technology based controlled substance distribution. Providing education based on survey responses would encourage positive "re-evaluation" of past experiences to incite formulation of new beliefs encouraging adoption of proposed new technology. For example, if a common response theme to item 1 was "My workload is too heavy so I don't have time for automated anesthesia medication workstation", education could be tailored to highlight the fact that after users of the new system become acclimated, workloads in fact would be lighter.

Literature Review

A review of research literature was performed to identify studies that assessed the prevalence of drug abuse among anesthesia providers and current practices to identify and prevent abuse. CINAHL (1993 to 2014), PubMed (1983 to 2014), and PsychInfo (1993 to 2014), database searches were performed to find pertinent nursing, medical, and psychological literature. The Boolean search terms used during the search were *anesthesia*, *drug diversion, evidence-based, knowledge, attitudes* and *abuse*. One hundred ninety-one articles were initially identified, and associated abstracts were reviewed for discussion of drug abuse among anesthesia providers. Full texts of 16 studies discussing the prevalence of drug abuse among anesthesia providers, and strategies to detect and prevent abuse articles were subsequently retrieved and reviewed. Synthesis of evidence-based interventions that deter drug diversion, highlighting computer-based access for controlled substances as an effective intervention is included in Table 1.

Multiple studies confirmed the presence of drug abuse among anesthesia providers. The term *anesthesia providers* (AP) include: medical students, medical residents, anesthesiologists, student nurse anesthetists, and certified registered nurse anesthetists (CRNAs). The AANA estimates the addiction rate of anesthetists and anesthesiologists at greater than 15% (2001). A correlational study by Bell et al. (1999) found that male CRNAs with 6 to 10 years of clinical experience were at highest risk for substance abuse. Overall, addiction most frequently occurs within the first five years of professional practice. High academic performance is also a risk factor as evidenced by the top 10 percent of SRNAs showed a higher addiction rate (Tetzlaff, 2011). Shared risk factors of APs in general include: ready access to narcotics, high stress

occupation, irregular schedules, sleep deprivation, and the requirement of absolute vigilance over extended surgical procedures (Luck and Hedrick, 2004). Tetzlaff (2011) concluded the anesthesia work environment is ideal for drug diversion and dependency. Bell et al. (1999) and Luck and Hedrick (2004) found that midazolam and nitrous oxide are the two most commonly abused medications among anesthesia providers. However, Berge et al. (2012) reports that opioids are most diverted and Tetzlaff (2011) states more specifically that fentanyl is the most abused opioid in anesthesia. Given the clear prevalence and risk factors for substance abuse among APs, the need for prevention and detection is apparent.

The easy access to pharmaceutical grade drugs was highlighted by Warner et al. (2015); the authors revealed a critical need for improved safety for controlled substances in the operating room setting. The review included an example of a surgical technician (an ancillary support member of the OR staff) that diverted fentanyl from the anesthesia cart. The full or partially diverted syringes of fentanyl were replaced contaminated syringes filled with normal saline. The diversion resulted in 18 confirmed cases of Hepatitis C virus infection in exposed patients. The total exposure is unknown due to incomplete test results from 674 exposed patients.

Several studies have attempted to identify interventions to prevent or deter development of substance abuse in anesthesia providers. Berge et al. (2012) examined drug diversion in various healthcare facilities. The authors included the patterns, detection, and prevention of drug diversion. Interventions included implementation of an automated distribution and return system, random sample processing, and a more aggressive position of prevention coordinators and committees. The authors reported an overall decline in controlled substance diversions however, the data was limited and no clear findings were indicated.

Tetzlaff et al. (2010) focused on a strategy to prevent substance abuse at a specific academic anesthesiology department. The Cleveland Clinic anesthesiology department developed the Substance Abuse Prevention Protocol (SAPP). The protocol integrated a strict compliance contract that required pre-employment screening, yearly random urine drug testing, drug testing for cause (suspected drug abuse), and preventative education programs. No results were included in the study however; authors stated data collection and analysis of results would be published at a later date by the department. A search for results of this study at the time of the literature review was unsuccessful.

Detection is a common subject of studies on the problem of diversion in anesthesia. With the advent of the electronic medical record mandated by the Patient Protection and Affordable Care Act (PPACA), the development of computer algorithms to analyze drug transactions has become easier. These complex programs have the ability to compare average drug use for specific surgical procedures and can identify variance between APs. In 2012, Devine, Guitierrez, & Rogers praised the efficacy of such a program in identifying an addicted anesthesiologist. The provider was correctly recognized by an unusually high administration of narcotics relative to other APs for the same surgical procedure. The anesthesiologist was subsequently terminated for narcotic diversion and impaired practice of anesthesia. According to Epstein et al. (2011), automated drug dispensing carts have the technology to provide pharmacy with detailed reports each month. The reports take less than one hour to generate and drug diversion screening algorithms are able to detect atypical transactions that may identify diversion. According to authors, automated drug dispensing carts can help to identify providers that were diverting drugs.

Anesthesia providers have an in-depth understanding of medications that give them a particular advantage in drug selection for abuse. Many of the commonly abused drugs are

difficult to detect due to short half-lives making blood and urine detection unreliable. Simple detection of drugs in blood and urine is inadequate to identify provider impairment. Kintz, Villain, Dumestre, and Cirimele (2005) suggested the use of hair analysis to as a more sensitive method of identifying chronic usage. Hair analysis has the benefit of an increased window of detection, ease of obtaining sample, and ease of sample storage. Blood and urine samples must be collected relatively shortly after administration of drugs with short half-lives and must be carefully processed and stored for accuracy of results. The study concluded that detection of addicted APs remains under-detected; use of hair analysis in addition to blood/urine testing may be useful in detecting impaired providers.

There are multiple reasons why anesthesia providers divert drugs. According to Tetzlaff (2011), experts agree that previous chemical experimentation is associated with future addiction to anesthesia drugs and has been confirmed by interviews of APs in recovery. In addition, individuals with novelty-seeking behavior are more likely to become addicted. A majority of addicted providers have a history of personality disorders that lead to self-medication and diversion (Tetzlaff, 2011). According to Tetzlaff (2011), drug screening potential anesthesia residency candidates is a proactive measure to help deter those who are more likely to divert drugs. It is possible that these individuals with a positive drug screen could be dissuaded from entering the anesthesia specialty. Conversely, opponents of this rationale contend that screening of individuals with the requisite intellect to enter the highly competitive specialty of anesthesia will be proficient at avoiding detection by pre-entry screening to anesthesia practice.

Another common theme in the literature is the need for supplemental education and policy development regarding substance abuse in AP. All graduate and doctorate level nurse anesthesia programs include the subject of substance abuse in their curriculum. It is an

accreditation requirement by the Council on Accreditation of Nurse Anesthesia Educational Programs (COA). However, current literature emphasizes the importance of continuing education on substance abuse after entry to professional anesthesia practice.

The purpose of this literature review was to evaluate existing interventions to prevent and reduce the occurrence of drug diversion in anesthesia providers. An early study by Castellano (1993) suggested the utilization of satellite OR pharmacies and an automated method of dispensing controlled substances. The feasibility of an operating satellite pharmacy in many institutions is not possible due to financial constraints; however, rapidly evolving technology provides an excellent opportunity to provide improved control over drug access at a reasonable cost. Automated drug dispensary systems may prove invaluable to the future of anesthesia safety and the well-being of current and future anesthesia providers.

The review of literature indicated that drug diversion in anesthesia is a problem. There are technologies available to detect and deter drug diversion (**Table 1**). More studies are needed to determine methods of tracking that would detect drug diversion in the most effective and efficient manner.

Current Technology Available to Prevent Drug Diversion in Anesthesia Providers

Automated drug-dispensing systems. Computerized automated cabinets such as the Pyxis and Omnicell provide a secure location for medication storage and distribution. Username, password, and/or fingerprint scanning are required for access to medications. Detailed information of all activity is recorded and is readily available for analysis. High initial investment cost is a potential limitation of this technology. Another possible limiting factor at some facilities is the physical lack of space for these machines. (BD, 2016) (Omnicell, 2016).

Automated drug injection systems. A product such as the BD Intelliport medication management system identifies, administers, and documents in real-time intravenous bolus injections. Expense, efficiency, and effectiveness of this product could affect widespread adoption of this equipment. A potential weakness of this system to prevent drug diversion could be the susceptibility of syringe contents tampering by the user. Contents of the required prefilled syringes could possibly be replaced or diluted leaving diversion undetected. Another possible weakness is the possibility of using readily available equipment (IV tubing, stopcocks, etc.) to reroute medication from reaching the patient. (BD, 2016).

Computer algorithms to detect unusual drug usage. Complex computer programs are used to analyze drug usage information embedded in computerized charting and automated drug cabinets. Usage between providers for specific cases can then be compared and high usage outliers identified for further investigation into possible drug diversion. (Devine, Guitierrez, & Rogers, 2012) (Epstein et al., 2011)

Random drug analysis of returned / wasted by anesthesia providers. Many facilities have policies that involve returning all unused narcotics to a pharmacy monitored waste bin or pharmacy itself. Chemical analysis of samples is both costly and time consuming. Detection and identification of a drug is not necessarily sensitive to drug diversion. Diluted samples can still test positive for a drug without providing any information regarding the quantity of drug returned in a particular sample. For example, a 1mL volume of fentanyl is returned (standard concentration of 50mcg/mL). Simple analysis could detect fentanyl however; the sample could potentially be composed of 0.5mL of fentanyl (50mcg/mL) diluted with 0.5mL 0.9% Normal Saline. The capability to determine the exact amount of a drug actually present in a sample is out of reach in typical healthcare facilities. (Berge et al., 2012)

Methods

Design

An online descriptive survey was administered to SRNAS and CRNAS in an attempt to gain insight into the current knowledge and attitudes of CRNAs concerning the utilization of technology to prevent drug diversion.

Setting

Participants included Illinois Association of Nurse Anesthetists (IANA) members, including CRNAs and SRNAs. Current members practice in a variety of locations from the in-patient hospital setting to ambulatory surgical centers. Survey population was not restricted to physical locality other than the state of Illinois.

Sample

The sample population included 1,617 members of the IANA; 1,384 CRNAs and 233 SRNAs. The inclusion criteria included anesthesia providers who were current IANA members. Non-members of the IANA were excluded. According to the National Statistical Service Sample Size Calculator, the minimum sample for a population size of 1617 was 311 (20 % response rate) with a 95% confidence level (Australian Bureau of Statistics, 2015). The survey was distributed twice, but the researchers were unable to achieve the response rate goal. The actual sample size included 145 SRNA and CRNAs. It was not possible from the collected data to decipher whether a respondent was a CRNA or SRNA.

Recruitment Procedure

This project was approved by the Institutional Review Board (IRB) of DePaul University. The researchers requested the executive director of the IANA (Appendix **C**) to forward the project's email script describing the study and requesting participation (**Appendix D**). The recruitment email script included information describing the study and a secure link for participants to use to access the survey on Qualtrics. The survey is included in Appendix A and Appendix B. Completion of the survey served as informed consent and required about 15 minutes of the participants' time.

Instrument/Measures/Tools/Questionnaires

This project utilized an Evidence-based Nursing Practice (EBNP) tool, a survey originally developed by Upton and Upton (2006) with established validity through construct (correlation coefficients 0.3-0.4; P <0.001) and discriminant (knowledge of EBP initiative versus without; P= <0.001) validity methods. The EBNP tool also has excellent reliability with Cronbach's alpha of the overall scale of .87 and Cronbach's alpha of .79 and .91 for attitude and knowledge subscales, respectively (Upton & Upton, 2006). The EBNP questionnaire was modified to fit the content and research relevant to knowledge and attitudes of drug diversion among CRNAs and SRNAs. The survey utilized a Likert scale that rated a participants' opinion or attitude towards a particular subject (Grove, Burns, & Gray, 2012). A series of 19 declarative statements, each followed by a numerical scale, assessed general agreement or disagreement with the adoption of technology-driven distribution of controlled substances for anesthesia providers. The first five items provided data on attitudes and items 6 – 19 of the scale provided data on knowledge of respondents on evidence-based interventions that deter drug diversion (Appendix **A**). A sociodemographic questionnaire was also administered to describe the sample

characteristics. (**Appendix B**) A link to the survey was distributed via email to IANA members by the IANA administrator. The survey was hosted by DePaul University's Qualtrics online survey platform.

Human Subjects Protection

Consent to participate was assumed with voluntary completion of the questionnaire. Confidentiality of participants was strictly maintained through security encryption provided by Qualtrics. Questionnaires did not collect personal identifiers and response sets were not associated with participant e-mail addresses.

Analysis

The surveys were collected and coded based on responses from a Likert scale with a range of 1-5. The numerical value of one on the scale signified poor attitude or scarce knowledge, whereas the numerical value of five denoted positive attitude or greater knowledge. The responses were categorized under knowledge or attitudes.

Descriptive statistics using means, standard deviation, frequencies, and percentages were used to analyze the data on knowledge and attitudes of the respondents on evidence-based interventions that deter drug diversion. Crohnbach's alpha was used to measure reliability.

Analysis for Differences Between Groups

Knowledge and attitudes were examined with gender, educational degrees, and years of experience viewing boxplots displaying central tendency and dispersion. Independent t-tests were used to analyze gender and educational level. Levene's test was used to assess assumption of equal variances between groups. One-way ANOVAs were used to compare knowledge and attitudes between years of experience.

Results

The purpose of the survey was to assess CRNAs' and SRNAs' knowledge and attitudes regarding strategies to prevent or deter drug diversion. Analysis was performed using IBM SPSS Statistics Software Version 23. Data were collected with a sample size of 145 (see Table 1). The majority of participants were female (58.6%), White (93.8%), and had a Master's degree (75.9%). Thirty-one percent reported being 50-59 years old, 24.1% 40-49 years old, 22.1% 30-39 years old, 17.9% 60 and over, and 4.8% 20-29. The majority of participants reported having over 10 years of experience (59.3%).

Table 1
Demographic Information (N=145)

	Frequency (N)	Percent (%)
Gender		
Male	58	40.0
Female	85	58.6
Ethnic origin		
White	136	93.8
Hispanic/Latino	4	2.8
Asian/Pacific Islander	3	2.1
Mixed Race	2	1.4
Level of education		
Masters	110	75.9
Doctorate - DNP, PhD, MD	35	24.1
Age		
20-29	7	4.8
30-39	32	22.1
40-49	35	24.1

50-59	45	31.0
60 and above	26	17.9
Years of nursing experience		
Less than 1 year	4	2.8
1-5 years	19	13.1
6-10 years	35	24.1
11-20 years	28	19.3
>20 years	58	40.0

A modified version of the EBNP (Upton & Upton, 2006) was used for the survey. It included 19 statements scored on a 5-point Likert scale from 1 = *Strongly agree* to 5 = *Strongly disagree*. The first five items provided information on attitudes toward interventions that deter drug diversion and the remaining items (6-19) assessed knowledge of interventions. Higher values on items 1-5 suggested a more positive attitude toward the interventions whereas higher values on items 6-19 indicated greater knowledge. All items were written in the same direction and reverse coding was not utilized. The five attitude and 14 knowledge items were averaged together to create two total scales. Descriptive statistics for all items and the total scores are presented in Table 2. Reliability (Cronbach's alpha) for both scales were in the acceptable range (above .70) indicating adequate reliability of the tool in measuring the constructs of interest. Attitudes regarding drug diversion interventions were in the neutral range (neither agree nor disagree) with means of 2.83 to 3.99 across the five items. Responses to the knowledge of drug diversion interventions items were also in the neutral range (m = 2.64-3.66). Therefore, participants reported neutral attitudes towards drug diversion interventions and expressed similarly neutral knowledge in that area.

Table 2

Descriptive Statistics
N=145

	M	*SD*	*α*
My workload is too heavy, so I don't have time for automated anesthesia medication workstation	3.64	1.15	
I don't believe that computer-driven access to controlled substances deter drug diversion	2.83	1.35	
I resent having my current access to controlled substances be changed to traceable...	3.99	1.03	
Evidence-based interventions applied to drug diversion are a waste of time	3.93	0.83	
I stick to tried and trusted methods stated in my facility's current policies and procedures…	3.44	1.06	
Attitudes (average)	3.57	0.78	0.75
My research skills in obtaining information on evidence-based interventions that deter…	3.24	0.94	
My information technology (IT) skills in retrieving data and information on evidence-based…	3.25	0.99	
I monitor and review the current evidence-based interventions that deter drug diversion	2.64	1.13	
I know how to convert my information needs on evidence-based interventions that deter drug…	3.06	1.02	
I am aware of major information types and sources related to evidence-based interventions…	3.07	0.90	
I am able to identify gaps in my professional practice pertaining to evidence-based interventions…	3.53	0.87	
I am knowledgeable on how to retrieve evidence-based interventions that deter drug diversion	3.60	0.96	
I am able to critically analyze the evidence-based interventions on drug diversion against set…	3.66	0.90	
I am able to determine how valid (close to the truth) the evidence-based interventions on drug…	3.62	0.90	
I am able to determine how useful (clinically applicable) the evidence-based intervention on...	3.76	0.85	
I am able to apply information on evidence-based interventions on drug diversion to individual...	3.52	1.17	

I share ideas and information on evidence-based intervention on drug diversion with colleagues	2.71	1.24	
I disseminate new ideas related to evidence-based interventions on drug diversion to colleagues	2.51	1.19	
I am able to review evidence-based interventions that deter drug diversion in my own practice	3.44	0.97	
Knowledge (average)	3.26	0.70	0.92

Note. Data in table are raw data before trimming of outliers.

Analysis for Differences Between Groups

Differences on attitudes and knowledge were first examined between males and females with master's degrees and those with doctoral degrees, and years of working experience by viewing box plots. The SRNA applicant description was not included in the demographic survey, consequently, it was impossible to separate the CRNA and SRNA responses. Box plots display central tendency (median) and distributional qualities (boxes represent interquartile range, whiskers represent up to 1.5 times the interquartile range), and they identify extreme values for a dependent variable (knowledge and attitudes) with hollow dots beyond the whiskers. Separate boxes allow for a visual comparison between groups. The gender box plots for attitudes (Figure 2) show that females had a slightly higher median than males and that some males, represented as hollow circles, reported very low levels. These outliers may result in males having a lower overall mean compared to females. The gender box plots for knowledge depict a slightly higher median for males compared to females, though the range of scores appears to be similar for both genders (Figure 3). Additionally, two outliers exist for males on the knowledge scale (greater than 3 times the interquartile range), depicted by stars. Extreme outliers were trimmed to the value for the 5% or 95% percentile. The outliers for males were corrected by replacing the values on knowledge with the value for the 5^{th} percentile (1.6179).

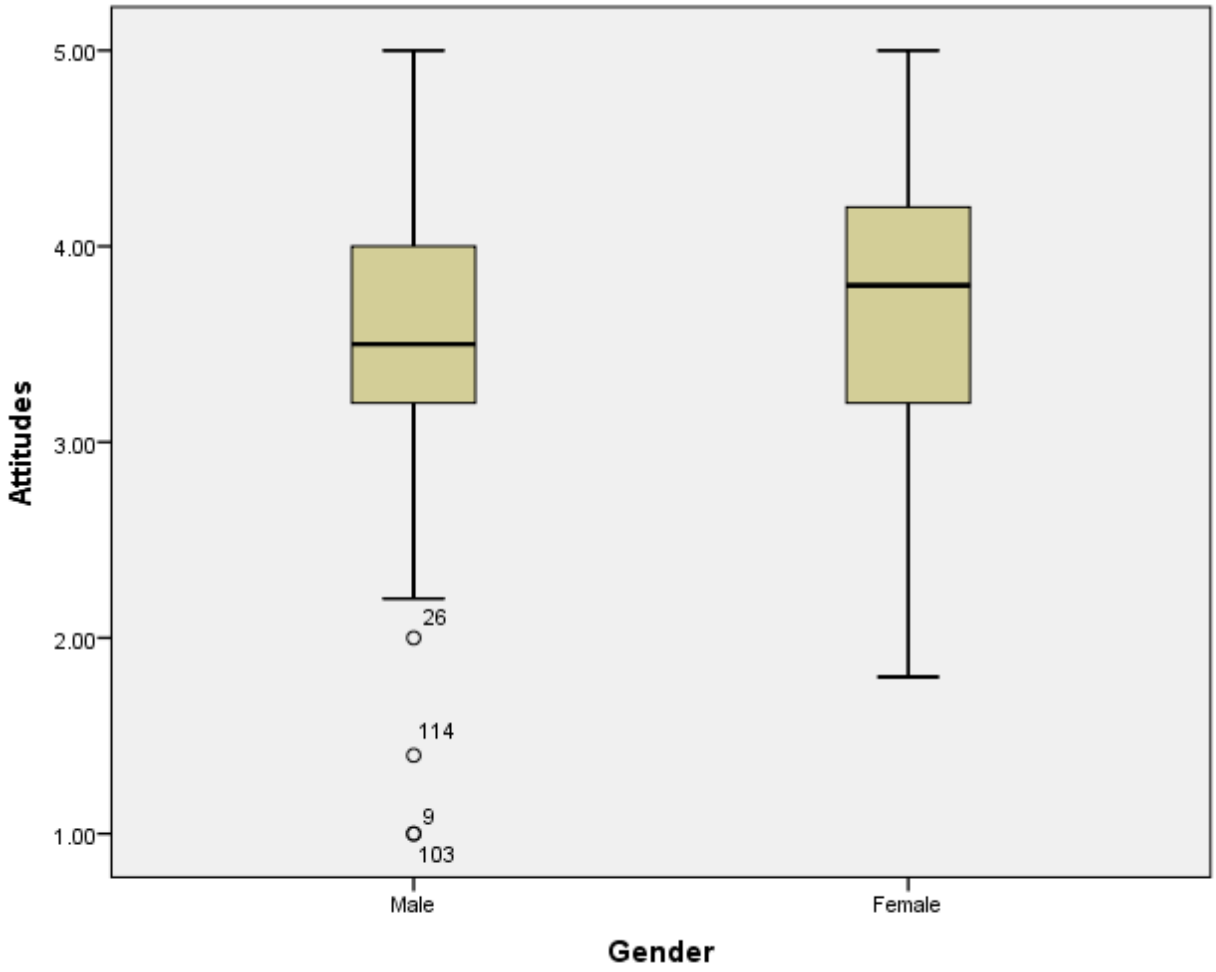

Figure 2. Box plot depicting central tendency and dispersion for attitudes towards drug diversion interventions for men and women

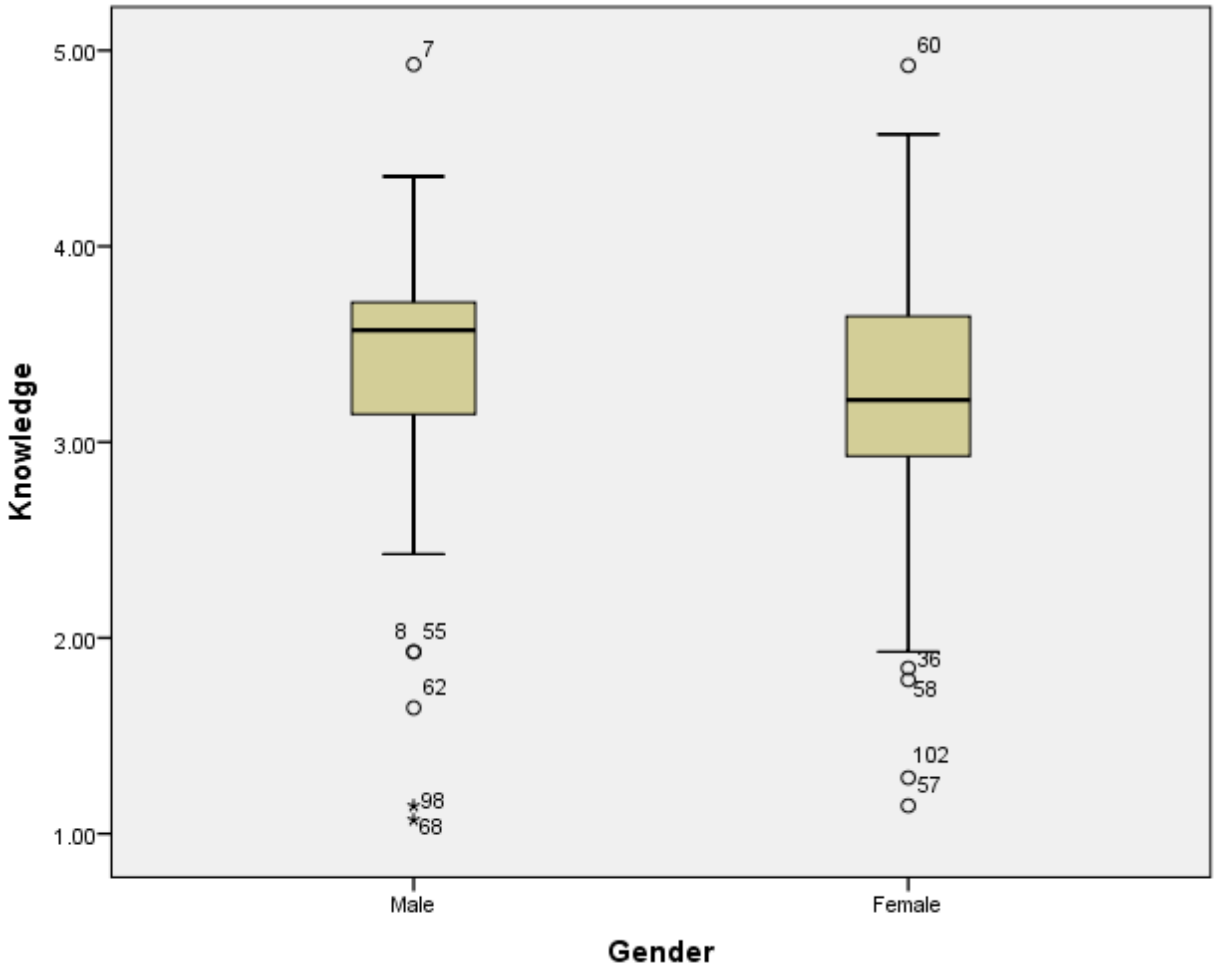

Figure 3. Box plot depicting central tendency and dispersion for knowledge of drug diversion interventions for men and women

When examining educational backgrounds, respondents with doctoral degrees had a higher median and smaller range of values for attitudes compared to those with master's degrees (Figure 4). One extreme outlier was revealed for attitudes among those with doctoral degrees, and was replaced with the value for the 5th percentile (2.72). For knowledge, the central tendency and dispersion for the two groups appear similar, indicating that statistically significant group differences were unlikely (Figure 5). Levels of education that were not included in the survey were Bachelors and Diploma.

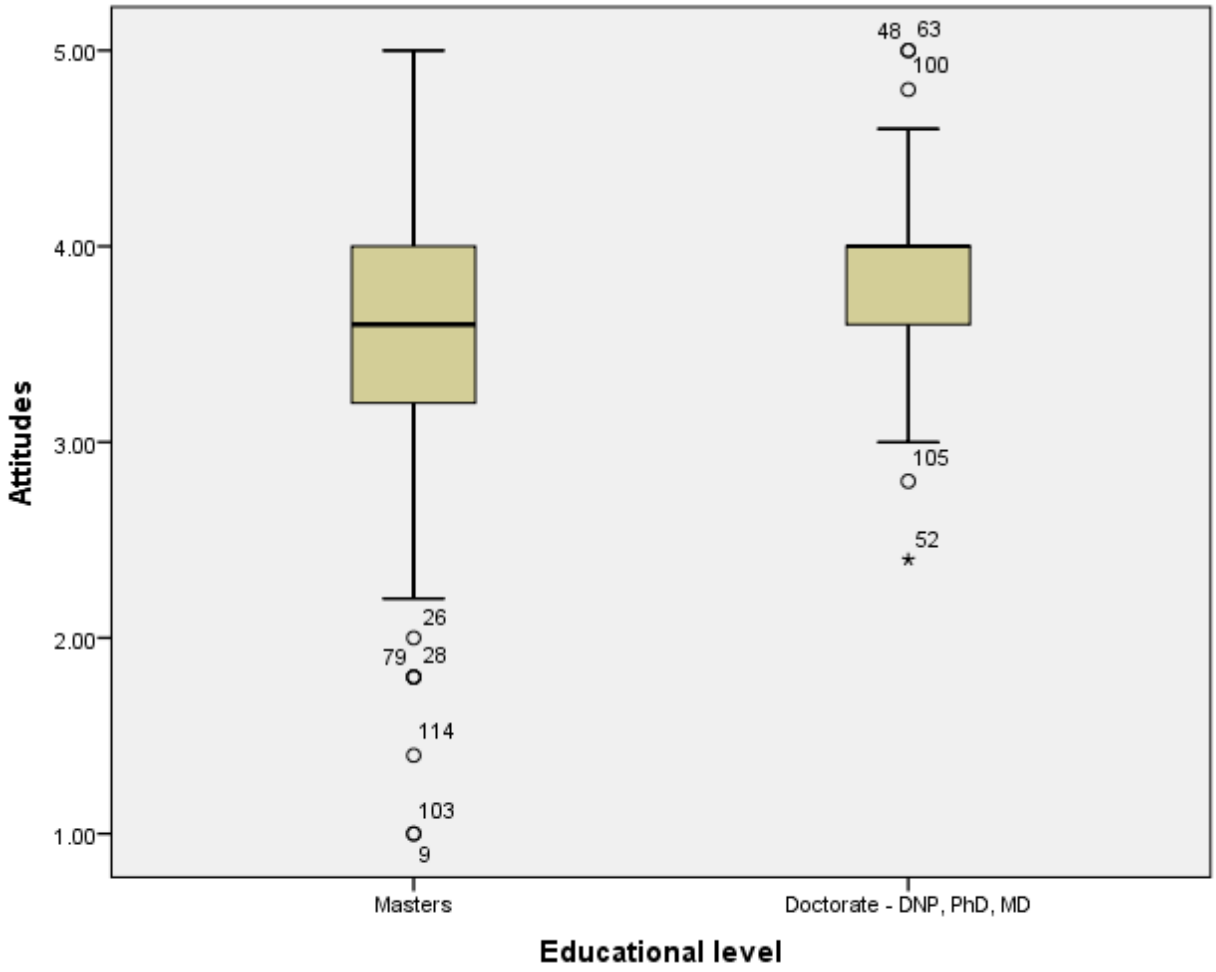

Figure 4. Box plot depicting central tendency and dispersion for attitudes towards drug diversion interventions for those with Master's and Doctoral degrees.

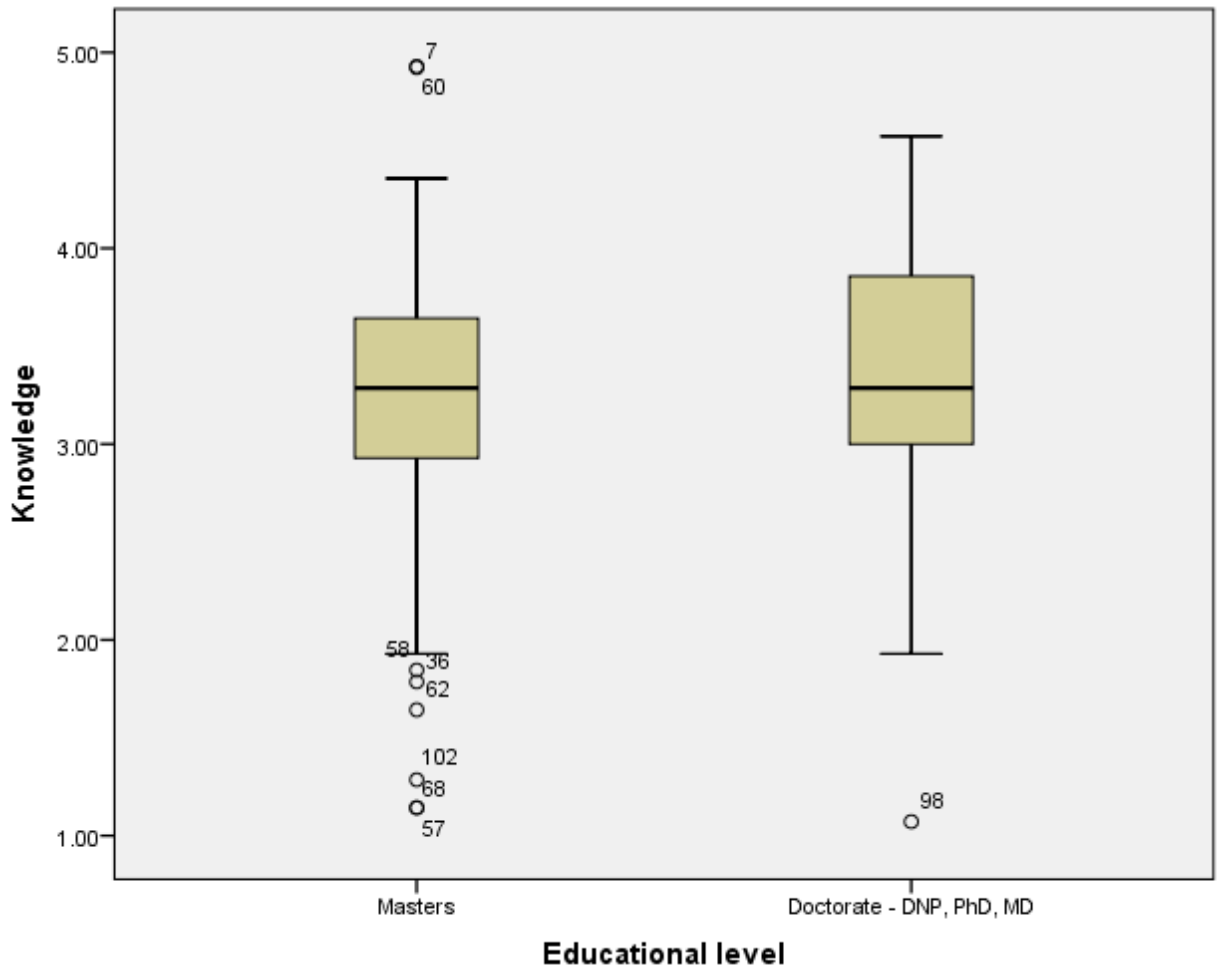

Figure 5. Box plot depicting central tendency and dispersion for knowledge of drug diversion interventions for those with Master's and Doctoral degrees

Prior to examining differences in years of work experience, the two smallest groups (less than one year of experience and 1-5 years of experience) were collapsed to create a single group because the less than one-year category only had four participants and analyzing the difference between groups required similar group sizes. This resulted in a group with 23 participants, which is more comparable in size to the other groups. The groups were compared on levels of attitude and knowledge with no extreme outliers revealed (see Figures 6 and 7). In general, the central tendency and dispersion for attitudes and knowledge were similar across age of

experience groups, indicating that statistical differences between groups by years of experience were unlikely.

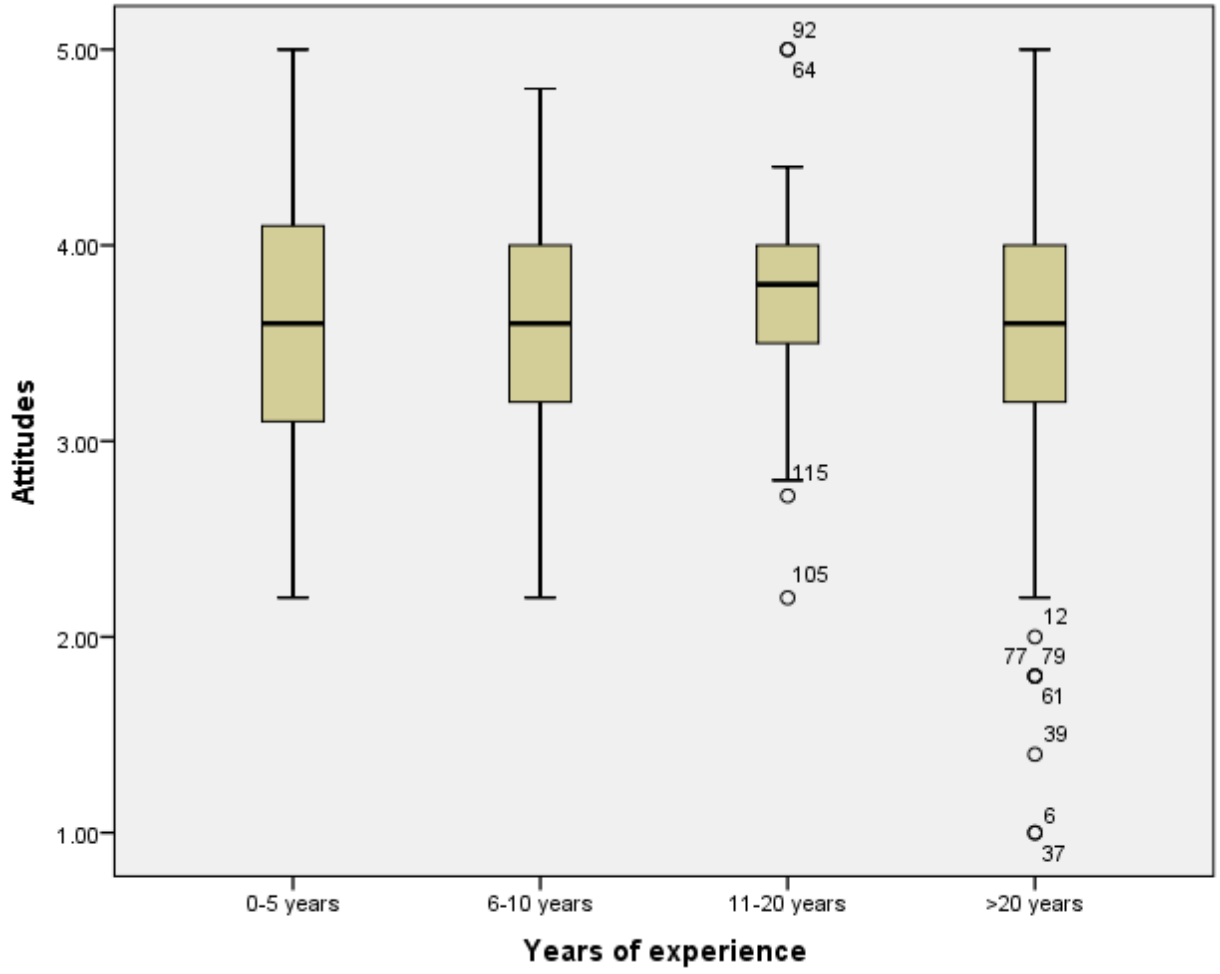

Figure 6. Box plot depicting central tendency and dispersion for attitudes towards drug diversion interventions across years of experience.

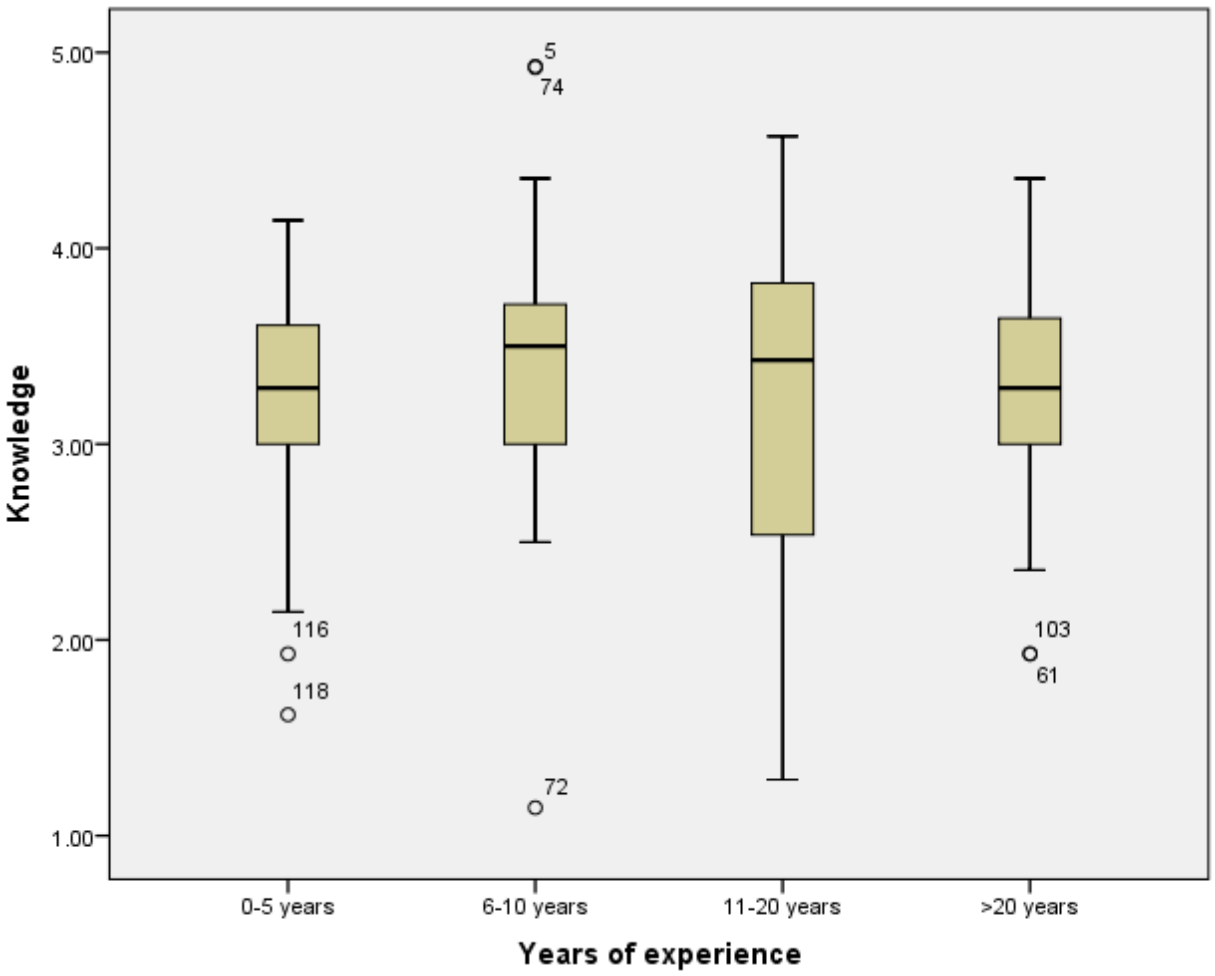

Figure 7. Box plot depicting central tendency and dispersion for knowledge of drug diversion interventions across years of experience.

When analyzing gender and educational level, independent t-tests were used because there were only two groups to compare. The assumption of equal variances between groups was evaluated using Levene's test and supported for all tests except the difference in attitudes by educational level. Therefore, a smaller degree of freedom (*df*) was utilized to determine the critical level for statistical significance for this test. Differences in attitudes and knowledge tested using independent samples *t*-tests revealed dissimilarities by gender and educational level on attitudes (see Tables 3 and 4). The findings were similar to interpretations from the box plots.

Females reported more positive attitudes (m = 3.69, sd = .76) than males (m = 3.41, sd = .78; $t(141) = -2.145$, p = .034), and CRNAs with doctoral degrees (m =3.86, sd = .56) reported more positive attitudes than those with Master's degrees (m =3.48, sd = .81; $t(83.447) = -3.141$, p = .002). Differences on knowledge were not revealed for gender ($t(140) = 1.402$, p = .163) or level of education ($t(142) = -.863$, p = .390), again as suggested by a review of the box plots.

Table 3

Differences in Attitudes and Knowledge between Men and Women

	Males		Females				
	m	*sd*	*m*	*sd*	*t*	*df*	*p*-value
Attitudes	3.406	0.783	3.687	0.759	-2.145	141	0.034
Knowledge	3.363	0.684	3.201	0.675	1.402	140	0.163

Table 4

Differences in Attitudes and Knowledge by Level of Education

	Master's		Doctorate				
	m	*sd*	*m*	*sd*	*t*	*df*	*p*-value
Attitudes	3.478	0.811	3.861	0.557	-3.141	83.477 [a]	0.002
Knowledge	3.238	0.672	3.354	0.713	-0.863	142	0.390

[a] The assumption of equal variances between groups was violated, therefore a more conservative degrees of freedom was utilized to determine the critical level for statistical significance.

One-way ANOVA's were used to compare levels of attitudes and knowledge between years of experience because there were more than 2 groups to compare. Levene's test for homogeneity of variances was not supported for either test, indicating that variances were significantly different between groups. Any significant variances between groups should be interpreted carefully. However, groups differed by less than half a point and no significant differences were found between groups for attitudes ($F(3, 140) = 1.181$, p = .319) or knowledge ($F(3, 139) = .643$, p = .589). These results support the lack of differences between groups observed in the box plots that were discussed earlier. See table 5 for more information.

Table 5

Differences in Attitudes and Knowledge by Years of Experience

	0-5 years		6-10 years		11-20 years		>20 years			
	m	*sd*	*m*	*sd*	*m*	*sd*	*m*	*sd*	*F*	*p*-valu
Attitudes	3.687	0.781	3.594	0.603	3.740	0.586	3.441	0.922	1.181 [a]	0.319
Knowledge	3.187	0.646	3.370	0.692	3.149	0.944	3.282	0.539	0.643 [b]	0.589

[a] Degrees of freedom for *F*-test = (3, 140)

[b] Degrees of freedom for *F*-test = (3, 139)

Discussion

Drug diversion among anesthesia providers is often unrecognized and therefore under-reported. A review of current literature on the occurrence of drug diversion and development of prevention strategies revealed that easy access to controlled substances has allowed anesthesia providers to successfully divert drugs without detection. Advancements in technology have helped to both secure and identify drug diversion, but more research is necessary to identify the most effective approach to prevent drug diversion. In addition, it is important to assess the current knowledge and attitudes of anesthesia providers toward technology-based toward drug diversion However, there were no studies that specifically addressed this topic.

This survey is the first to report the knowledge and attitudes towards evidence-based interventions that deter drug diversion. Analysis of the survey data revealed an overall neutral feeling of participants regarding knowledge and attitudes. There were more positive attitudes with females compared to males. Furthermore, attitudes were more positive for those who had doctoral degrees compared to those with master's degrees. The neutral results did not support the development of an educational program. The researchers made changes to the original survey that is discussed in the "implications for practice" section.

Limitations

There were several limitations to this study. First, the minimum sample size goal of 311 participants was not achieved. The sample size was limited to IANA members, which represents a small fraction of anesthesia providers. Time and financial limitations restricted the ability to obtain the number of participants desired and any possibility to expand the survey to include all anesthesia providers. The survey did not have an option to disclose whether the participants were an SRNA or CRNA. In addition, did not include the option of choosing "Bachelors" under

the item – *level of education*. Due to the omission of the SRNA identifier in the demographic section of the survey it is not clear how many, if any, SRNAs filled out the survey. This may have contributed to the low sample size. In addition, a larger student response may have skewed the results potentially indicating a need for an educational tool. Consequently, the study is underpowered and is at risk of failure to detect subtler differences in the sample group. This may also affect the generalizability of the results to the intended population. Results may not actually reflect the knowledge and attitudes of the larger group as a whole. Furthermore, modification of a previously validated survey for the purpose of this study could have also resulted in the failure to detect a knowledge deficit.

The survey was lengthy, possibly resulting in participant fatigue. In addition, multiple other surveys were being distributed concurrently through the IANA further contributing to increased participant exhaustion and low participant motivation. A response for nurse anesthesia diploma prepared CRNAs and current anesthesia students (SRNAs) was omitted on item #5 – *level of education* of the demographic information questionnaire. Levels of anesthesia education that include Bachelors, Diploma, and EdD were omitted from the survey. Participant education type is an important indicator and could have impacted results of the current study.

Implications for Practice

Healthcare organizations need to include automated medication dispensing systems for controlled substances that can detect drug diversion. Developing an educational tool may be beneficial in improving knowledge and increasing positive attitudes regarding drug diversion. Drug diversion among anesthesia providers is a problem that warrants addressing. Despite failure of the survey to identify a knowledge gap, an educational tool providing information regarding current technology to prevent drug diversion could still be beneficial. As technology

rapidly advances, periodic informative updates for providers is mandated in order to stay current. Fear of a change is natural; however, dissemination of information that results in safer patient care is crucial despite provider anxiety or resistance. An educational tool may lead to anesthesia providers more receptive to the idea of a potential change in practice.

Implications for Research

An advanced literature review on the incidence of drug diversion, that includes all anesthesia providers, is warranted. Due to the stigma and professional ramifications associated with substance abuse, drug diversion in anesthesia providers is likely underreported thus making an accurate estimation of occurrence difficult. Despite this fact, all efforts must be made to identify impaired providers for the sake of provider and patient safety.

Future studies on drug diversion by anesthesia providers require a larger sample size to provide adequate study power. A more comprehensive conclusion may be drawn by expanding the sample size and by including a variety of anesthesia providers such as anesthesiologists, anesthesiology residents, and anesthesiologist assistants. In addition, expanding the collection period for survey results may help to increase survey response and thus sample size. In the future, revising and shortening the survey would be recommended.

Based on the neutral results of the survey initially used in this study, the decision was made to create an original survey tool specifically designed to measure knowledge and attitudes regarding current technology to prevent drug diversion. An original survey tool could offer improved sensitivity to the topic of inquiry. The new survey tool was sent to a 5 member CRNA panel for review of content. General response supported the new survey items' ability to measure knowledge and attitudes regarding technology (computer-based) interventions to prevent drug diversion. Panel members unanimously agreed that survey questions 2-7 reflected

knowledge or attitude respectively. Questions 1 & 8 both received single responses disagreeing with item content and its' ability to capture the intended knowledge or attitude respectively. Open ended comment sections were included after each question for the review process. Comments included suggestions regarding formatting of response scale, typographical errors, and rephrasing of questions. The revised survey will integrally require more time for testing internal and external validity. Overall, author confidence in the revised survey to capture the research topic "knowledge and attitude regarding current technology (computer-based) to prevent drug diversion" is markedly improved over the original survey tool used.

Potential research topics should include the effectiveness of new interventions. These studies could compare the cost / benefit ratio of implementing drug diversion interventions. Another potential unutilized source of information for interventions to prevent drug diversion are providers that have successfully received treatment for substance abuse disorder. A focus group of these providers could be useful in identifying and creating more effective interventions.

The revised proposed survey and demographics appear in Appendix E and Appendix F. The items were rated by the CRNA panel as more clear and concise and may yield stronger results. A pilot study of the new survey must be conducted to ascertain the reliability of the responses to the above declarative statements. Researchers must determine the sensitivity of the survey to measure the intended area of inquiry (knowledge and attitudes). Shorter study length could result in greater survey response rate and consequent increased study power. It is recommended that the survey be distributed over a 12 - week period to attempt to receive a 20% response rate of 311 participants.

Conclusion

Drug diversion is a challenge that directly affects anesthesia providers. A review of the literature provided information on drug diversion in anesthesia as well as technology-based strategies to prevent drug diversion. With easy access and in-depth knowledge of drugs, anesthesia providers are in a perfect practice environment for diverting drugs. Technology to help detect and deter drug diversion is available. More research is necessary to determine the actual use of such technology and to identify the most effective and efficient system for detecting drug diversion.

This survey is the first to present knowledge and attitudes concerning current technology to prevent drug diversion. There were more positive attitudes among females compared to males and those with doctoral degrees compared to those with master's degrees. Nonetheless, the data analysis displayed overall neutral attitude and knowledge about prevention of drug diversion by anesthesia providers. It is recommended that further research be completed on knowledge and attitudes regarding current technology to prevent drug diversion utilizing the revised survey. Furthermore, it will be imperative to consider expanding the survey nationally to obtain comprehensive results to better determine if there is a need for education. Developing and implementing and an educational tool may enhance knowledge and increase positive attitudes toward the prevention of drug diversion.

Appendix A. Knowledge and Attitudes Survey on Evidence-based Interventions that Deter Drug Diversion Among Anesthesia Providers

1. My workload is too heavy so I don't have time for automated anesthesia medication workstation.

   1 - strongly agree 2 - agree 3 - neutral 4 - disagree 5 - strongly disagree

2. I don't believe that computer-driven access to controlled substances deter drug diversion.

   1 - strongly agree 2 - agree 3 - neutral 4 - disagree 5 - strongly disagree

3. I resent having my current access to controlled substances be changed to traceable, computer-driven access.

   1 - strongly agree 2 - agree 3 - neutral 4 - disagree 5 - strongly disagree

4. Evidence-based interventions applied to drug diversion are a waste of time.

   1 - strongly agree 2 - agree 3 - neutral 4 - disagree 5 - strongly disagree

5. I stick to tried and trusted methods stated in my facility's current policies and procedures rather than changing to a new computer-driven access to deter drug diversion.

   1 - strongly agree 2 - agree 3 - neutral 4 - disagree 5 - strongly disagree

6. My research skills in obtaining information on evidence-based interventions that deter drug diversion:

   1 - poor 2 - below average 3 - average 4 - above average 5 - excellent

7. My information technology (IT) skills in retrieving data and information on evidence-based interventions on drug diversion is:

   1- poor 2 - below average 3 - average 4 - above average 5 - excellent

8. I monitor and review the current evidence-based interventions that deter drug diversion.

1 - never 2 - rarely 3 - every once in a while 4 - sometimes 5 - almost always

9. I know how to convert my information needs on evidence-based interventions that deter drug diversion into a research question.

   1 - strongly disagree 2 - disagree 3 - neutral 4 - agree 5 - strongly agree

10. I am aware of major information types and sources related to evidence-based interventions that deter drug diversion.

    1 - strongly disagree 2 - disagree 3 - neutral 4 - agree 5 - strongly agree

11. I am able to identify gaps in my professional practice pertaining to evidence-based interventions that deter drug diversion.

    1 - strongly disagree 2 - disagree 3 - neutral 4 - agree 5 - strongly agree

12. I am knowledgeable on how to retrieve evidence-based interventions that deter drug diversion.

    1 - strongly disagree 2 - disagree 3 - neutral 4 - agree 5 - strongly agree

13. I am able to critically analyze the evidence-based interventions on drug diversion against set standards.

    1- strongly disagree 2- disagree 3- neutral 4- agree 5- strongly agree

14. I am able to determine how valid (close to the truth) the evidence-based interventions on drug diversion material are.

    1 - strongly disagree 2 - disagree 3 - neutral 4 - agree 5 - strongly agree

15. I am able to determine how useful (clinically applicable) the evidence-based intervention on drug diversion material is

    1 - strongly disagree 2 - disagree 3 - neutral 4 - agree 5 - strongly agree

16. I am able to apply information on evidence-based interventions on drug diversion to individual cases.

    1 - never 2 - rarely 3 - every once in a while 4 - sometimes 5 - almost always

17. I share ideas and information on evidence-based intervention on drug diversion with colleagues.

    1 - never 2 - rarely 3 - every once in a while 4 - sometimes 5 - almost always

18. I disseminate new ideas related to evidence-based interventions on drug diversion to colleagues.

    1 - never 2 - rarely 3 - every once in a while 4 - sometimes 5 - almost always

19. I am able to review evidence-based interventions that deter drug diversion in my own practice.

    1- strongly disagree 2 - disagree 3 - neutral 4 - agree 5 - strongly agree

20. In your current practice, how are controlled substances accessed by anesthesia providers?

    A. Locked box

    B. Secured drawer in a cart

    C. Unsecured drawer in a cart

    D. Pharmacy dispensed

    E. Computerized medication carts

    F. Others (type your answer)

21. Was the subject of drug diversion and/or abuse among providers addressed in your anesthesia program?

    yes / no

Appendix B. Demographic Information Questionnaire

1. What is your gender?

( ) Male

( ) Female

2. What is your age group?

( ) 20-29

( ) 30-39

( ) 40-49

( ) 50-59

( ) 60 and above

3. What is your ethnic origin?

( ) White

( ) Hispanic/Latino

( ) Black/African American

( ) Native American/American Indian

( ) Asian/Pacific Islander

( ) Mixed Race

4. How many years of clinical nursing experience did you have?

( ) <1 year

( ) 1-5 years

( ) 6-10 years

( ) 11-20 years

( ) >20 years

5. What is your education level?

( ) Masters

( ) Doctorate - DNP, PhD, MD

Appendix C. Request to IANA

Illinois Association of Nurse Anesthetists
100 East Washington Street
Springfield, IL 62701

To Whom It May Concern,

Hello, our names are Grant Balbarin and Cheryl Botsford. We are Doctor of Nursing Practice (DNP) students at NorthShore University HealthSystem School of Nurse Anesthesia/ DePaul University. Our DNP project is on the subject of drug diversion. Our research has shown that drug diversion is a problem in anesthesia. The purpose of our DNP project is to assess SRNA and CRNAs knowledge and attitudes regarding technologies available to prevent drug diversion. We will determine if there is a need to create an online educational tool to address current interventions that are available to detect and deter drug diversion. We would like to invite current members of the Illinois Association of Nurse Anesthetists (IANA) to participate in a survey for research purposes. The purpose of the survey is the assessment of knowledge and attitudes regarding current interventions available to prevent and deter drug diversion. The survey will take approximately 20 minutes. This script will include a secure link to access the survey on Qualtrics.

We are requesting that you forward our recruitment script to the IANA members inviting them to participate in the survey.

Grant Balbarin can be reached at gbalbarin@gmail.com and Cheryl Botsford can be reached at cheryl221@hotmail.com

Sincerely,

Grant Balbarin and Cheryl Botsford

Appendix D. E-mail Recruitment Script

Hello, our names are Grant Balbarin and Cheryl Botsford. We are Doctor of Nursing Practice (DNP) students at NorthShore University HealthSystem School of Nurse Anesthesia/ DePaul University. We would like to invite you to participate in a survey for research purposes. The survey is to assess knowledge and attitudes regarding current interventions available to prevent and deter drug diversion. The survey will take approximately 20 minutes of your time. This script will include a secure link to access the survey on Qualtrics. If you are interested in the outcome of the survey, please contact one of us via email and we will provide you with results Thank you for your time,

Grant Balbarin and Cheryl Botsford

Grant Balbarin can be reached at gbalbarin@gmail.com and Cheryl Botsford can be reached at cheryl221@hotmail.com

Appendix E. Revised Survey: Knowledge and Attitudes Survey on Evidence-based Interventions that Deter Drug Diversion Among Anesthesia Providers

1. Drug diversion exists among anesthesia providers

   1 - strongly disagree 2 – disagree 3 – neutral 4 – agree 5 - strongly agree

2. Current technology (computer-based) can be used to effectively detect and deter drug diversion

   1 - strongly disagree 2 – disagree 3 – neutral 4 – agree 5 - strongly agree

3. I welcome the use of technology (computer-based) to prevent drug diversion in my anesthesia practice

   1 - strongly disagree 2 – disagree 3 – neutral 4 – agree 5 - strongly agree

4. I have an adequate understanding of current available technology (computer-based) to prevent drug diversion.

   1 - strongly disagree 2 – disagree 3 – neutral 4 – agree 5 - strongly agree

5. Automated (computer-based) anesthesia workstations will slow down my workflow.

   1 - strongly agree 2 - agree 3 - neutral 4 - disagree 5 - strongly disagree

6. My research skills in obtaining information on evidence-based interventions that deter drug diversion is:

   1- poor 2- below average 3- average 4- above average 5- excellent

7. I monitor and review the current evidence-based interventions that deter drug diversion.

   1- never 2- rarely 3- every once in a while 4- sometimes 5- almost always

8. I share ideas and information on evidence-based interventions on drug diversion with colleagues.

1- never 2- rarely 3- every once in a while 4-sometimes 5- almost always

9. In your current practice, how are controlled substances accessed by anesthesia providers? (Check all that apply)

A. Locked box

B. Secured drawer in anesthesia cart

C. Unsecured drawer in anesthesia cart

D. Pharmacy dispensed

E. Computerized medication carts **outside** of individual operating rooms

F. Computerized medication carts **inside** of individual operating rooms

G. Others (type your answer)

10. Was the subject of drug diversion and/or abuse among providers addressed in your anesthesia program?

yes / no

Appendix F. Revised Demographic Information Questionnaire

1. What is your current status?

   ( ) SRNA

   ( ) CRNA

2. What is your gender?

   ( ) Male

   ( ) Female

3. What is your age group?

   ( ) 20-29

   ( ) 30-39

   ( ) 40-49

   ( ) 50-59

   ( ) 60 and above

4. What is your ethnic origin?

   ( ) White

   ( ) Hispanic/Latino

   ( ) Black/African American

   ( ) Native American/American Indian

   ( ) Asian/Pacific Islander

   ( ) Mixed Race

5. How many years of work experience in nurse anesthesia do you have?

   ( ) <1 year

   ( ) 1-5 years

( ) 6-10 years

( ) 11-20 years

( ) >20 years

6. What is your education level?

( ) Diploma

( ) Bachelor's

( ) Master's

( ) Clinical DNP, DNAP

( ) Research PhD, EdD, DNSc

Appendix G. E-mail Recruitment Script for evaluation of Newly Created Original Survey Tool

Dear CRNA,

We are Doctor of Nursing Practice (DNP) students at NorthShore University HealthSystem School of Nurse Anesthesia / DePaul University. Our Doctorate of Nursing Practice Project addresses current knowledge and attitudes regarding technology to prevent drug diversion. Technology to prevent drug diversion refers to computer-driven access to medications, which allows a provider to obtain controlled substances utilizing a computer system as an alternative to open access. In addition, computer algorithms are available to analyze activity, detect unusual drug usage, and discover outliers who may be diverting drugs. For the purpose of the survey, "diversion" is used in reference to the act of an anesthesia provider redirecting anesthesia drugs for personal use both on and off-duty. Diversion for the purpose of distribution is not included. Previous research has demonstrated the effectiveness of this technology to detect drug diversion. We respectfully ask you to evaluate our survey tool for clarity and appropriateness of subject matter. The evaluation will take approximately five minutes of your time. Our proposed survey tool is available at: https://www.surveymonkey.com/r/S993CWW

For any questions, comments, or concerns please feel free to contact us at the contact information provided below.

Thank you for your time,

Grant Balbarin RN, Nurse Anesthesia Trainee-3 gbalbarin@gmail.com

Cheryl Botsford RN, Nurse Anesthesia Trainee-3 cheryl221@hotmail.com

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Table 1. Synthesis Table on Interventions that Deter Drug Diversion

Article:	Purpose of Study:	Research Design:	Sampling and study sample:	Human Subjects Issues:	What was the intervention offered?	Study findings:
(Bell, McDonough, Ellison, & Fitzhugh, 1999)	Determine the prevalence of controlled drug misuse among active CRNAs. Determine significant associations between controlled substance abuse and specific variables of interest.	Correlational study using Self-administered Surveys to collect data.	2,500 subjects were randomly selected from actively practicing members of American Association of Nurse Anesthetists. Of these, 1709 completed the survey with a response rate of 68.4%.	IRB approval by University of Tennessee, Knoxville. Strict anonymity of participants was provided. Name, address, AANA membership number, or any other means were not used to identify subjects. Validity	Authors suggested interventions for CRNAs should focus on drug misuse education and prevention for an overall. Authors stress that these interventions must begin at the nurse anesthesia training level because of the high stress nature of	- 9.8% prevalence of controlled drug misuse among CRNAs - Male CRNAs with 6 to 10 years of clinical experience have increased risk for controlled drug misuse. - Significant relationship between recency of controlled drug misuse and drug(s) of choice (P = .05) - Drug of choice in descending

				of questionnaire was tested by a jury of peers with expertise in research design.	these programs.	order: Midazolam, nitrous oxide, opioids, propofol, ketamine, narcotic agonist-antagonists, and barbiturates.
(Berge, Dillon, Sikkink, Taylor, & Lanier, 2012)	To describe patterns, scope, consequences, prevention and detection efforts for drug diversion at Mayo Clinic	Institution-wide Mayo Clinic Quality Improvement Effort	Entire Mayo Healthcare System. Began in anesthesia department in the OR and expanded throughout other departments with high use of controlled substances.	No human subjects were recruited. Illustrative vignettes used to describe drug diversion events that occurred at Mayo clinic medical centers. The vignettes were altered for confidenti	Implementation of automated distribution machines, secure return bins subject to random quantitative drug assays. Creation of drug diversion response teams (DDiRT). Each team consists of the medication diversion	At the Rochester Mayo Clinic branch, approximately 75% of suspected diversion has been resolved through confession of the drug diverter (personal communication, Karen Sikkink, CPhT, Mayo Clinic Rochester MDPC,

				ality	prevention coordinator (MDPC) the Medication Diversion Prevention Committee.	August 26, 2011). Number of cases of suspected diversion not reported. Number of cases of drug diversion prevented was not reported.
(Bozimowski, Groh, Rouen, & Dosch, 2012)	Assess the prevalence, demographic factors, outcomes, and preventative measures for substance abuse among SRNAs over a 5 year	Cross-sectional, retrospective study using electronic survey.	Program Directors of 111 accredited Nurse Anesthesia Programs in the United States received the electronic survey. Of these, 23 PDs (21.7%	IRB approval by University of Detroit, Michigan. Consent to participate was assumed by completion of survey.	None	Prevalence of substance abuse was lower among SRNAs (0.65%) than CRNAs (9.8%), but comparison is based on historical data. Opiate is the top drug of choice for SRNAs. Voluntary enrollment

	period		response rate) had complete data on prevalence and demographics and additional 24 PDs (42.3% response rate) completed questions related to screening procedures and prevention strategies. PDs with complete data had a total of 2439 SRNAs over a 5-year period.			to treatment and dismissal from the program were the top reported outcomes of substance abuse Drug testing for cause during program was the top reported screening procedure Wellness activities, educational offerings and faculty support were among the themes for wellness promotion practices Authors suggest further research is necessary to confirm

						these findings and to study the effectiveness of wellness promotion programs suggested by the SRNAs.
(Epstein, Gratch, McNulty, & Grunwald, 2012)	Validate a system of analysis involving atypical transactions generated from a drug diversion screening program can identify anesthesia care providers diverting drugs	Prospective, longitudinal design with case reports	Transactions from Pyxis carts accessible to anesthesia care providers including 60 CRNAs, 48 anesthesia residents and fellows, and 50 anesthesia attendings.	Publication was approved by the IRB without requirement for written informed consent	Implementing drug diversion screening system that utilizes atypical transaction to detect drug diversion among anesthesia care providers.	Demonstrated that a drug diversion screening program analyzing atypical transactions by anesthesia providers can identify prospectively unsuspected individuals diverting drugs from OR automated dispensing carts.
(Luck & Hedrick, 2004)	Identification of current trends of	Descriptive literature review -	N/A	N/A	Education on risk factors, signs &	Estimates of Addiction among anesthesia

	addiction in anesthesia providers	the article was written to bring to attention: addiction in anesthesia providers, treatment, and re-entry to practice. The article stressed the importance of perioperative nurses in the identification of addicted practitioners.			symptoms, reporting, treatment, and re-entry to anesthesia practice	providers are as high as 15%. Midazolam and Nitrous Oxide are currently the drugs of choice for addicted anesthesia providers.
(Tetzlaff, 2011)	Synthesize current evidence for effective prevention and	Descriptive Literature review	Anesthesia care providers	N/A	Suggests random testing and electronic screening.	The anesthesia work environment is ideal for drug diversion and

	detection of drug diversion and review the state of the science of chemical dependency in anesthesia					dependency and there are multiple factors that may lead to this.
(Tetzlaff et al., 2010)	Development of a Substance Abuse Prevention Protocol (SAPP) at Cleveland Clinic's Anesthesiology Institute.	Quality improvement	All members of Anesthesiology Institute: Staff Members, Residents, Fellows, SRNAs, CRNAs, and support members with access to anesthesia drugs	All prospective and current employees were required to participate in SAPP, refusal was grounds for disciplinary action and/or termination	Implementation of a protocol for active prevention of substance abuse which consists of: 1. Mandatory education on substance abuse 2. Enhanced pre-employment screening	No results included in article

					3. Random and "for-cause" urine drug screening 4. Prevention of drug diversion through continuous reporting system that defines excessive use 5. Building staff skills in recognizing impairment from substance abuse	
(Warner et al., 2015)	Highlight the critical role of public health surveillan	Observational, epidemiological case finding	Facility A: Total Patients N=4748 Patients	A response to an emerging public health	Notifying patients of possible HCV exposure and	18 confirmed cases of HCV from the surgical tech that

	ce in detecting HCV outbreaks and reveal the impact of drug diversion to the patient's overall health as well as the urgent need for improved safety and locking measures for controlled substances in the health care setting.	and report.	tested N=4066 Facility B: Total Patients N=1222 Patients tested N=1183 HCV infected surgical technician who was suspected of narcotic drug diversion and tampering of injectable narcotic, exposing patients to his HCV infected blood.	problem to prevent and control the spread of HCV. Therefore, it was not subject to review by the Institutional Review Board.	offering testing	diverted fentanyl from the anesthesia carts in the OR. Limitations include test results were not received from 674 patients.