Reducing the Burden of Intravenous Drug Users with Deep Tissue Infections on Wake Forest Baptist Health

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Disclaimer: The author conducted this study as part of the program of professional education at the Frank Batten School of Leadership and Public Policy, University of Virginia. This paper is submitted in partial fulfillment of the course requirements for the Master of Public Policy degree. The judgments and conclusions are solely those of the author, and are not necessarily endorsed by the Batten School, the University, or any other agency.

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Honor Statement

On my honor as a student, I have neither given nor received any unauthorized aid on this assignment.

Nicholas Matthews

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Acronyms

ACO:
Accountable Care Organization

CDC:
The Centers of Disease Control and Prevention

CTCT:
Community Transitional Care Team

EAT:
Executive Action Team

FTE:
Full-Time Equivalent

GSS:
General Social Survey

HHS:
United States Department of Health and Human Services

IDU:
Intravenous Drug Use

IE:
Infective Endocarditis

IV:
Intravenous

ICD-9-CM:
International Classification of Diseases, Ninth Revision, Clinical Modification

ICD-10-CM:
International Classification of Diseases, Tenth Revision, Clinical Modification

MSSP:
Medicare Shared Savings Program

NHANES:
National Health and Nutrition Examination Survey

NPV:
Net Present Value

NSDUH:
National Survey of Drug Use and Health

PWID:
Persons Who Inject Drugs

RN:
Registered Nurse

WFBH:
Wake Forest Baptist Health

Executive Summary

North Carolina has had an opioid overdose death rate higher than the national average every year since 2000, with a total economic cost of $21 billion in 2016 (North Carolina Opioid Report, 2018). While opioid deaths involving prescribed drugs have been on the decline in recent years, overdose deaths involving heroin and/or other synthetic narcotics have fueled the continued rise in total North Carolina opioid overdose deaths since 2008 (Kansagra & Cohen, 2018). Intravenous drug use places individuals at a higher risk of pulmonary, endovascular, soft tissue, bone, joint, and sexually transmitted infections, as persons who inject drugs often practice risky or unsterile injection techniques (Kaushik, Kapila, & Praharaj, 2011; Gordon & Lowy, 2005; Binswanger, Kral, Bluthenthal, Rybold, & Edlin, 2000).

In North Carolina, the annual rates of hospital discharges for drug dependence combined with endocarditis increased twelve-fold between 2010 and 2015, while costs associated with these episodes of care increased eighteen-fold over the same period (Fleischauer, 2017). Wake Forest Baptist Health (WFBH) has been one of the health systems in North Carolina to bear this burden. Every year, WFBH treats approximately 150 to 200 cases of intravenous drug use-related deep tissue infections (Summers, 2019). The morale of frontline care providers at WFBH treating this patient population is very low, leading to high rates of nursing staff turnover (Thompson, 2019; Summers, 2019). Additionally, this patient population has a lower hospital reimbursement rate, resulting in significantly less revenue for WFBH to cover the treatment costs of deep tissue infections in IV drug users (Summers, 2019; Norton, 2018). Finally, outcomes for this patient population under the current treatment model have been poor. In 2015, WFBH conducted a study following 100 patients who had been to the hospital for a second IV drug use-related deep tissue infection admission. Half of these patient died within a year (Summers, 2019).

My problem definition is as follows: **As trends of non-prescribed opioid abuse continue to rise in North Carolina, the current treatment model for intravenous drug use-associated deep tissue infections at Wake Forest Baptist Health is unsustainable with respect to high rates of nursing staff turnover; inefficient hospital bed management; and poor patient treatment outcomes**. This report suggests three options for Wake Forest Baptist Health to consider in addressing this issue:

I. Hospital Administration-Directed Discharge Process
II. Community-Based Model of Outpatient Treatment
III. Comprehensive Harm Reduction Program Expansion

Each option was evaluated using three criteria: benefit-cost analysis net present value, implementation feasibility, and sustainability. After comparing each option's outcome bundle, WFBH would be best served to select Option #2: pursue a community-based model of outpatient treatment for IV drug users with deep tissue infections. Specifically, this report details how WFBH should adopt a Community Transitional Care Team model to provide the observed IV antibiotic therapy for intravenous drug users with deep tissue infections (Jafari et al., 2015). The implementation section of this report describes the ways in which WFBH can reduce the costs and risks associated with this course of action, in order to ensure its future success.

Introduction

Opioid Epidemic Origins

In 1990, the President of the American Pain Society published an editorial in the Annals of Internal Medicine criticizing the medical community's neglect to adequately treat patient's pain (Baker, 2017). Pain was an invisible characteristic not reflected in a patient's medical chart, but its management was just as fundamental to a patient's state of health as his blood pressure, heart rate, temperature, and respiration rate (Baker, 2017). The call that pain be treated as "the fifth vital sign" spurred action across accrediting agencies, governmental bodies, and professional medical organizations. By the end of the decade, The Joint Commission on the Accreditation of Healthcare Organizations, California State Assembly, U.S. Congress, Institute of Medicine, American Pain Society, and U.S Veteran Health Administration had all published recommendations to support standardized screening for, and treatment of, patient pain symptoms (Baker, 2017).

The increased willingness to prescribe opioids in the late 1990s also came as a result of pharmaceutical industry assurances that opioids were safe, non-addictive pain treatment methods (HHS, 2017). Misleading and aggressive marketing strategies accelerated the adoption of these addictive painkillers by physicians and the general public ("America's Addiction to Opioids," 2014; Van Zee, 2019). The pharmaceutical industry is currently defending itself against past dubious actions, as challenges from class action lawsuits and federal, state, and local government agencies mount. These claims focus on deceptive opioid marketing practices and failure to adequately address opioid misuse and diversion that led to widespread abuse of the drugs (Haffajee, 2017; Goodman & Neuman, 2018; Lopez, 2018; Lopez, 2019).

National Consequences

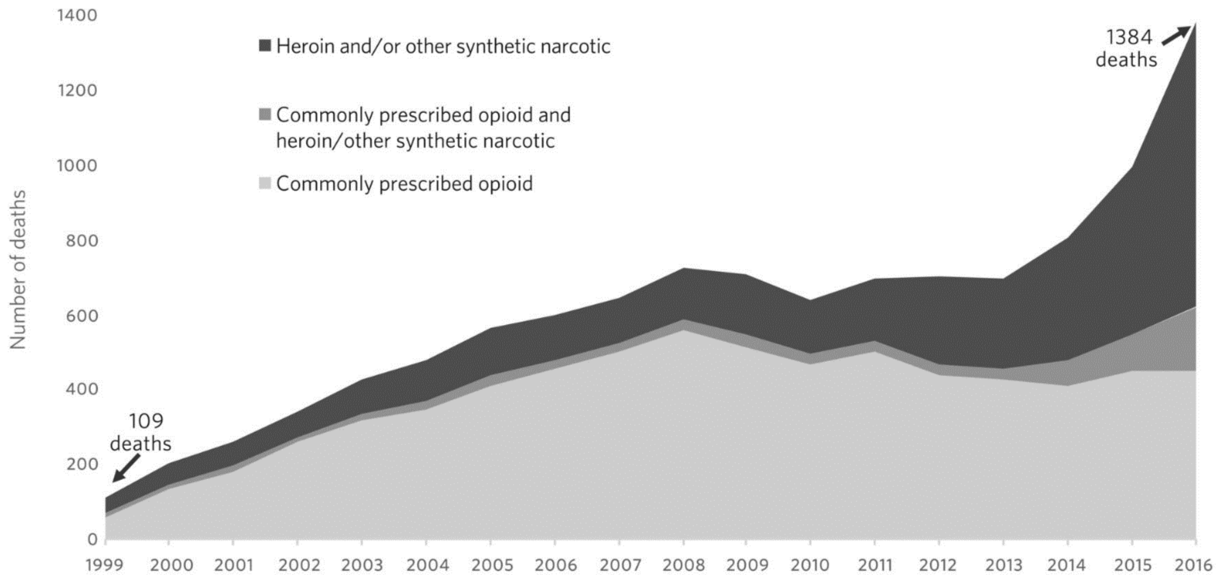
The opioid epidemic has killed over 300,000 Americans since 2000 (CDC, 2016). In 2015, the total economic impact of the opioid epidemic in the United States was $504 billion, a magnitude equal to 2.8% of the nation's GDP (Council of Economic Advisors, 2017). There were 33,091 opioid-involved overdose deaths in 2015, a statistic that had doubled over the previous ten years and quadrupled over the previous sixteen years (Council of Economic Advisors, 2017). Over the course of the opioid epidemic, the nature of addiction and fatal overdose has evolved, as the share of prescribed opioid deaths has decreased. The rate of deaths involving synthetic opioids increased 72.2 percent from 2012 to 2015 (CDC, 2016). Heroin-related deaths saw a five-fold increase from 2010 to 2017 (Heroin Overdose Data, 2018). Increases in the use of non-prescribed opioids coincides with decreasing prescribing rates of opioids. The overall national opioid prescribing rate declined from 81.3 prescriptions per 100 people in 2012 to 58.7 prescriptions per 100 people in 2017, the lowest it had been in more than ten years (CDC Injury Center, 2018).

North Carolina Impact

North Carolina has had an opioid overdose death rate higher than the national average every year since 2000. In 2016, it had the 22nd highest opioid overdose death rate in the country at 14.9 deaths per 100,000 people. The total economic cost of the 2016 opioid deaths totaled $21 billion (North Carolina Opioid Report, 2018). Figure 1 illustrates trends in North Carolina unintended opioid overdose deaths from 1999 to 2016 (Kansagra & Cohen, 2018). The most remarkable takeaway from Figure 1 is the 12-fold increase in opioid overdose deaths over the 18-year period. However, it is also notable that the overdose deaths involving commonly prescribed opioids has steadily decreased since 2008. Overdose deaths involving heroin and/or other synthetic narcotics has fueled the continued rise in deaths. There were

28,321 adults (0.37%) reporting heroin use in 2016 (North Carolina Opioid Report, 2018). This rate was the 26th highest in the country in 2016.

FIGURE 1.
Unintentional Opioid Overdose Deaths By Opioid Type, NC 1999-2016



Source. NC State Center for Health Statistics, Vital Statistics-Deaths, 1999-2016

Source: Kansagra & Cohen, 2018

Winston-Salem Metropolitan Statistical Area

Wake Forest Baptist Health's flagship hospital is located in Winston-Salem, NC, with several satellite and outpatient facilities spread throughout the region. The Winston-Salem Metropolitan Statistical Area (Winston-Salem Metro Area) includes Forsyth County, Davidson County, and Stokes County, as well as the census places of Winston-Salem, High Point, and Thomasville. The Winston-Salem Metro area has a population of 662,079. Its 2016 median household income was $47,711, compared to the national median household income of $57,617, and the North Carolina median household income of $50,584 (Winston-Salem, NC Metro Area, n.d.). In 2014, Stokes County averaged $11,225 in reimbursements per Medicare enrollee, which was the highest rate in the state. The bordering Yadkin and Surry counties had the third and seventh highest rates of reimbursements per Medicare enrollee in the state, respectively (Winston-Salem, NC Metro Area, n.d.). The Winston-Salem Metro Area counties of Forsyth, Davidson, and Stokes had opioid prescribing rates of 65.2, 67.8, and 82.1 per 100 people in 2017 (U.S. County Prescribing Rates, 2018). The national opioid prescribing rate in 2017 was 58.7 prescriptions per 100 people (CDC Injury Center, 2018).

Wake Forest Baptist Health

Wake Forest Baptist Medical Center is a tertiary care academic medical center (Trauma Centers, 2006). As a level 1 trauma center, it operates over 1,000 acute care, rehabilitation, and psychiatric beds (Our History, n.d.). It runs over 165 clinical practices in central and western North Carolina, including Alexander, Ashe, Catawba, Davie, Davidson, Forsyth, Guilford, Randolph, Rowan, Stokes, Surry and Wilkes counties (Wake Forest Health Network, n.d.). The Wake Forest School of Medicine is WFBH's education and research division. WFBH is also associated with Wake Forest Innovations, which is an entity pursuing technology innovation, research, and commercialization with partners in the biotechnology and pharmaceutical sectors (About Wake Forest Innovations, n.d.). From July 1st 2018 to December 31st 2018, WFBH earned a total net revenue of $1.6 billion, which was 16.7% higher than the previous year (Wake Forest Baptist Fiscal Year, 2019).

Background

Deep Tissue Infections

Intravenous drug use (IDU) places individuals at a higher risk of pulmonary, endovascular, soft tissue, bone, joint, and sexually transmitted infections (Kaushik, Kapila, & Praharaj, 2011). Skin and soft tissue infections are one of the most common categories of these infections, as persons who inject drugs (PWID) often practice risky or unsterile injection techniques (Gordon & Lowy, 2005; Binswanger, Kral, Bluthenthal, Rybold, & Edlin, 2000). These practices include subcutaneous or intramuscular injection of drugs due to a lack of viable veins, as well as the repeated use of contaminated injection equipment. Risky drug delivery mechanisms also introduce pathogens into the blood stream, which is one of many ways in which an IDU can acquire infective endocarditis (IE)—an infection of the inner lining of the heart and heart valves (Sexton & Chu, 2019).

When an average patient is diagnosed with a deep tissue bacterial infection, they are admitted to the hospital to start a course of intravenous (IV) antibiotics. After a week, the patient is typically healthy enough to be discharged home, where he or she is able to continue a five-week regimen of IV antibiotics administered through an outpatient clinic or a home-health service ("Endocarditis - Diagnosis and treatment - Mayo Clinic," n.d.). The nature of drug dependence in PWID make it virtually impossible to execute this course of treatment. PWID are less willing to stay in the hospital for long periods of time, and are frequently noncompliant with behavior contracts and medical advice (Sexton & Chu, 2019; Summers, 2019; Blumstein, 2019; Ti, 2015). It is incredibly risky to send IDUs into the community accompanied with any type of medically inserted injection equipment, as they will likely use the intravenous access to abuse illicit drugs (Sabin, 2009). It is optimistic to believe this patient population will independently complete five weeks of IV antibiotic therapy. Home health services are unlikely to accept the risk associated with providing the care, so these patients would be required to make daily visits to an outpatient facility for their IV antibiotics if they were not treated as inpatients (Summers, 2019; Blumstein, 2019).

Medically, it is necessary to treat the bacterial infection. Literature exists detailing the specific scenarios when prescribing a shorter course of combination antibiotic therapy is effective at eliminating deep tissue bacterial infections. However, these studies have been small in scale and lacked proper controls and patient follow-up, so there isn't a strong consensus advocating for this as a primary treatment option (Torres-Tortosa et al., 1994; Chambers, Miller, & Newman, 1988; Abrams, 1979; Ribera et al., 1996; Dworkin, Sande, Lee, &

Chambers, 1989). Instead, the accepted compromise is for hospitals to administer direct-observation therapy, where a PWID is admitted to the hospital for the entire six-week course of IV antibiotics (Summers, 2019; Blumstein, 2019).

Persons Who Inject Drugs

A 2013 meta-analysis of NSDUH, NHANES, and GSS data estimated that 3.6% of males and 1.6% of females had injected drugs at least once in their lifetime (Lansky et al., 2014). For this population, their social environment is strongly linked to their life outcomes. An individual's income, workplace control, housing situation, education status, social networks, and discrimination experiences all influence the causal pathways linking his social environment to risk behaviors and health measures (Galea, 2002). Around 1990, it was estimated that 10%-20% of homeless individuals injected drugs, with lifetime prevalence rates increasing to 25%-50% (Galea, 2002). Another study of the social determinants of health (SDOH) for drug use found that neighborhood poverty is associated with increased rates of heroin and cocaine use (Williams & Latkin, 2007). It also found that social support and connections to persons employed offered protective benefits of abusing drugs.

Incarceration has a detrimental effect to the health outcomes of PWID. Ranapurwala et al. studied opioid overdose deaths of former North Carolina inmates between 2000 and 2015. They found that the two-week, one-year, and complete follow up rates of fatal overdose after prison release were 40, 11, and 8.3 times higher than the standard North Carolina population. The corresponding heroin death rates were 74, 18, and 14 times higher than the general North Carolina population at the same time intervals (Ranapurwala et al., 2018). While the opioid epidemic has affected all members of society on the socioeconomic status continuum, it is important to maintain some degree of a SDOH perspective when designing healthcare solutions for intravenous drug users. PWID presenting with a deep tissue infection are likely to also be experiencing some degree of homelessness, poverty, criminal justice system contact, poor education, or lack of social support—in addition to their underlying drug addiction.

Problem Definition

Problem Statement

As trends of non-prescribed opioid abuse continue to rise in North Carolina, the current treatment model for intravenous drug use-associated deep tissue infections at Wake Forest Baptist Health is unsustainable with respect to high rates of nursing staff turnover; inefficient hospital bed management; and poor patient treatment outcomes.

Problem Context

In one West Virginia hospital, the number of drug-related endocarditis cases increased from 26 in 2008 to 66 in 2015 (Norton, 2018). The 2015 cases alone were billed for $4.6 million in hospital charges. Because most of the patients in the 2008-2015 study period were uninsured or insured through government programs, the hospital was only reimbursed for 22% of the $17 million dollars in hospital charges for the entire eight-year patient sample (Norton, 2018). In 2017, a single uninsured IV drug using patient at a Georgia hospital consumed $400,000 in healthcare resources to treat four cases of endocarditis (O'Donnell & DeMio, 2017). That figure does not include the cost of the patient's heart surgery at a separate hospital.

In North Carolina, the annual rates of hospital discharges for drug dependence combined with endocarditis increased twelve-fold between 2010 and 2015 (0.2 to 2.7 per 100,000 persons) (Fleischauer, 2017). Costs associated with these episodes of care increased eighteen-fold over the same period ($1.1 million to $22.2 million) (Fleischauer, 2017). This study found that 505 North Carolina residents were admitted to hospitals with the two diagnoses of drug dependence and endocarditis during the six-year study period. In today's money, the median hospital charge for these patients was $58,463. Forty-two percent of these patients were uninsured or covered by Medicare, accounting for $481,000 in charges in 2010, and $9.3 million in charges in 2015 (Fleischauer, 2017).

These statistics provide a conservative estimate of the burden PWID place on hospitals. The above study used ICD-9-CM and ICD-10-CM discharge codes to identify the frequency of drug dependence-associated endocarditis. Medical coding variation and misclassification likely under-represented the number of patients eligible for the study, as it would not have included patients failing to disclose their history of drug use. This method would have excluded patients who met substantive inclusion criteria but lacked the technical coding inclusion criteria. The opposite pathway would not have been a factor in enrollment accuracy. The cost data reflects the amount of money the hospital billed to the third-party payer of the patient, which does include the associated opportunity and societal costs of providing healthcare to the patient population. Finally, this study analyzes endocarditis specifically, which is just one of the subsets of possible infections arising from IDU. As rates of opioid abuse rise, particularly in the form of IDU, the burden on hospitals of drug-dependence-associated deep tissue infections will also rise.

Wake Forest Baptist Health treats 150 to 200 intravenous drug users per year for deep tissue infections (Summer, 2019). On a given day, there approximately 12 of these patients receiving IV antibiotic therapy across WFBH's provider footprint (Summers, 2019). The national average for hospital admission length of stay is 6.1 days ("Table 82. Hospital admissions, average length of stay, outpatient visits, and outpatient surgery," n.d.). Since the administration of direct observation antibiotic therapy is 42 days long, each IDU-associated admission for deep tissue infection has an opportunity cost of 5-6 traditional hospital stays. Forty to fifty percent of the patient population violates some form of the WFBH hospital behavior policy or medical recommendations. This is characterized by continued drug use, hours-long room absences, staff manipulation, and threatening/abusive behavior (Summers, 2019; Blumstein, 2019). Frontline workers and nurses bear disproportionate burden of this reality, substantially decreasing their morale. Perceived ambivalence from hospital administration resulted in a significant number of nurses quitting over these working conditions. From the patient's perspective, the current treatment strategy does not provide particularly good health outcomes. In the second half of 2018, WFBH had an inpatient overdose from IV drug use and die while in the hospital (Ross, 2018; Summers, 2019; Blumstein, 2019). Four years ago, WFBH conducted a study following 100 patients who had been to the hospital for a second IDU-related deep tissue infection admission. Half of these patient died within a year (Summers, 2019).

Evaluative Criteria

This report integrates information from the client organization and academic literature to develop policy alternatives that can solve the problem identified in the preceding section. The three policy alternatives considered in this analysis are as followed:

I. Hospital Administration-Directed Discharge Process

II. Community-Based Model of Outpatient Treatment

III. Comprehensive Harm Reduction Program Expansion

In projecting the outcomes of the proposed policy options, three criteria were used. The first criterion was the benefit-cost analysis net present value of each option. There were two main elements included in the benefit-cost analysis; nursing staff satisfaction and hospital bed management. Each policy option was assigned a net present value (NPV) score based on the difference between its primary benefits and costs. This singular unit allowed for an apples-to-apples comparison of the different policy alternative outcomes. The analysis is conducted over a five-year time span, so that the accrual of future benefits of a policy alternative is able to outweigh potential start-up costs. The report is conducted from the primary perspective of Wake Forest Baptist Health, and will identify primary benefits and costs accordingly. The last two criteria are implementation feasibility and sustainability. These criteria will be used to add a qualitative dimension to the analysis of the alternatives and will be ranked on a scale of low, medium, and high.

Benefit -Cost Analysis: Nursing Staff Satisfaction

There have been numerous studies in the last two decades linking nursing satisfaction with job retention (Leveck & Jones, 1996; Cowan, 2002; Andrews & Dziegielewski, 2005; Laschinger, Leiter, Day, & Gilin, 2009; Collins et al., 2009). Factors influencing nursing retention include renumeration, management styles, autonomy, respect, stress and organizational commitment, quality of provided care, routinization, etc. Caring for drug-dependence-related deep tissue infections affect many of these measures (Summers, 2019; Thompson, 2019). At Wake Forest Baptist Health, caring for patients who use IV drugs creates ethical dilemmas for the nursing staff (Thompson, 2019). Broadly speaking, the nurses enter the profession and set out day to day to be care providers, improving the health of their patients (Thompson, 2019).

However, treating IV drug users who have no intention of quitting is difficult (Thompson, 2019). The nurses feel as if they are treating one condition, only to allow the patient to continue a highly risky behavior that will certainly produce negative health outcomes (Thompson, 2019). Furthermore, the highly ambulatory nature of these patients makes it difficult for a nurse to simultaneously care for other patients for which they are responsible (Thompson, 2019). PWID often leave their hospital room and wander unscheduled outside of the hospital, making it extremely difficult for these nurses to administer scheduled IV antibiotics. The cumulative effect of these interactions has an impact on the staff satisfaction and retention, particularly of newer nurses (Thompson, 2019). Improving the treatment policies of intravenous drug users with deep tissue infections will increase nursing satisfaction and decrease nursing turnover.

In 2018, Nursing Solutions, Inc. published a “National Health Care Retention & RN Staffing Report” collecting survey data from 137 hospital responses across 26 states (2018

National Health Care Retention & RN Staffing Report, 2018). For calendar year 2017, these hospitals averaged a 16.8% RN turnover rate. The report estimated that "the average cost of turnover for a bedside RN is $49,500 and ranges from $38,000 to $61,100." A hospital loses on average $4.4 million to $7.0 million annually (2018 National Health Care Retention & RN Staffing Report, 2018). At these levels, each percent decrease in RN turnover would save the average hospital $337,500 (2018 National Health Care Retention & RN Staffing Report, 2018). At WFBH, the RN turnover rate is 14.5% (Thompson, 2019). In the first three months of 2019, the all-encompassing cost to recruit, hire, and train the nurses was $3.8 million (Thompson, 2019). This works out to be approximately $15.2 million per years and $75,000-$80,000 per new nurse for WFBH (Thompson, 2019). Estimating changes in hospital staff satisfaction will allow for calculations of labor-related cost savings to WFBH as a primary outcome of interest. A secondary outcome of interest is the improved patient care satisfied nurses are able to provide to other admitted patients.

Benefit-Cost Analysis: Hospital Bed Utilization Management

The opportunity cost of bed utilization is a significant concern for WFBH. Adjusted to 2019 dollars, the average community hospital profit per inpatient bed per year is $89,356 ("12 Statistics on Hospital Profit and Revenue in 2012," 2014). This equates to $245 of profit per day per inpatient bed. Each foregone admission for a drug-related deep tissue infection eliminates five weeks of poorly utilized inpatient bed space. On the surface, this situation appears to be a transfer of profit to the counterfactual admission. However, hospitals are incentivized to lower their average length of hospital stay, as more procedures are billed for earlier in an admission when a patient is sicker and needs more services—generating more profit. Additionally, Medicare reimbursement payments are only made up to a certain length of stay based on the admitting condition. Hospitals are simultaneously incentivized to minimize costs, because once the time period expires, the hospital is liable for the subsequent costs (Frakt, 2017). Reducing the number of lower-acuity, low-profit, direct-observation admissions would increase the relative amount of higher-acuity, higher-profit admissions. Changing the mix of admitted patients in this direction would also increase the proportion of patients who are insured, allowing WFBH to earn more revenue. Finally, the patient population of PWID is underinsured relative to non-IV drug users (Norton, 2018; Summers, 2019; Blumstein, 2019). Eliminating or reducing the burden of IV drug-related deep tissue infection admissions would reduce the amount of healthcare charges for which WFBH is not reimbursed.

Implementation Feasibility

This criterion will subjectively evaluate the policy options on how difficult the change will be to implement. In a hospital setting, there are multiple stakeholders, including hospital administration, physician leadership, nursing-staff, and the patients themselves, whose perspectives must be taken into account by WFBH. Implementation feasibility will be scored on a range of *low*, *medium*, and *high*. This is a secondary outcome of interest and will serve as a deciding factor if the quantitative criteria fail to provide a clear policy winner.

Sustainability

This criterion will subjectively evaluate the policy options on long-term prospects for consistency of desired outcomes. Ongoing trends in the opioid epidemic and healthcare management policy will be taken into account during evaluation. Sustainability will be scored on a range of *low*, *medium*, and *high*. This is a secondary outcome of interest and will serve as a deciding factor if the quantitative criteria fail to provide a clear policy winner.

Options

At the time of writing this report, Wake Forest Baptist Health has already implemented the hospital administration-directed clinical discharge process option. The initiative is still in its infancy, with data trickling in and process steps still being configured. The analysis of all options will be performed impartially, as if the report were written when decision-makers first began convening to address the burden of intravenous drug use-associated deep tissue infections.

Option #1: Hospital Administration-Directed Clinical Discharge Process

This policy option is directed at the most flagrant abusers of WFBH's current policy of treating deep tissue infections with IV antibiotics using direct-observation over a 6-week long hospital admission. As previously stated, 40%-50% of PWID with deep tissue infections are violating some form of the hospital behavioral policy (Summers, 2019; Blumstein, 2019). For a majority of these patients, their behavior can be tolerated as a natural consequence of drug dependence, especially when an acceptable alternative does not exist. However, an estimated 3%-5% of this patient population behave in a manner that wastes hospital resources and threatens the safety of hospital staff and other patients to an unacceptable degree (Summers, 2019). They are no longer able to effectively participate in current parameters of the health system, receiving no benefit from the type of care WFBH provides in the inpatient setting (Summers, 2019; Blumstein, 2019).

In order to identify this subset of patients, WFBH developed a checklist of 15 criteria that must be followed during admission. Some patients self-select out of the "social contract" of medical care, since they are unable to accept the terms of the treatment (most likely as a consequence of their underlying addiction). The hospital administration-directed clinical discharge process of Option #1 operates in the following manner. When a patient attempts to stay and simultaneously violates the tenets of the agreement, the attending physician and nurse unit manager call the Executive Action Team (EAT)—made up of representatives from the Chief Medical Officer's office, hospital nursing leadership, and risk management office. These three voting members receive informal input from the administrator on call and the care coordinator. The individual patient's case is discussed, and if the three voting members deem that the patient will not receive benefit from continued admission at the hospital, the EAT makes a recommendation to the attending physician to discharge the patient. As part of the discharge process, the hospital staff attempts to design the best outpatient antibiotic treatment plan possible (Ross, 2018; Summers, 2019; Blumstein, 2019).

Evaluating Option #1:

All relevant benefit-cost analysis assumptions, values, justifications, and sources for Option #1 are provide in Appendices A, B, and C.

I. Benefit-Cost Analysis

The costs associated with option are related to staffing full-time equivalent (FTE) employees to design, implement, and maintain the solution. The initial implementation cost for Option #1 is $313,875 (Appendix B). The annual maintenance cost of Option #1 is $62,775 (Appendix B). Option #1 produces $304,000 in nursing staff retention-related benefits in year one (Appendix B). It adds $215,460 in bed management benefits in year one as well (Appendix B). When theses costs and benefits are discounted and summated over a five-year period, Option #1 has a net present value of $1,650,178.48 (Appendix C).

II. Implementation Feasibility

Option #1's implementation feasibility is High. The creation of the EAT would immediately provide reduction in the burden of IV drug users with deep tissue infections. WFBH would be able to apply the policy to the most flagrant abusers of the current hospital policy of observed antibiotic therapy. This would increase staff moral quickly and provide for better bed management. Additionally, the behavior of the patient population would improve overall, because they will understand that WFBH is taking a tougher stance enacting a behavior policy that has enforceable consequences (Summers, 2019). Option #1 requires a change in hospital policy, and does not include any large capital expenditures that will create decision points over scare resources and competing hospital priorities.

III. Sustainability

Option #1's sustainability is Medium. The option is relatively inexpensive to maintain. However, it ultimately creates a transfer of burden from the hospital to the patient and to society as a whole. It fails to address any root-causes of deep tissue infections. While this may not be of concern in the short-term, current trends of increased opioid use will continue to put upward pressure on the size of this patient population. The EAT policy will be effective for the worst violators of hospital policy, but it will still not address the burden that about 95% of the admissions for IV drug-related deep tissue infections place on the hospital.

Option #2: Community-Based Model of Outpatient Treatment

In 2005, the Vancouver Coastal Health Authority partnered with the Providence Health Services Authority to create a "Community Transitional Care Team" (CTCT) model of care to administer IV antibiotics to IDU who have deep tissue infections (Jafari et al., 2015). The goal of this model was to administer the antibiotics in a safe medically and socially supportive environment. The nine-bed facility featured, "independent rooms complete with private bathroom, shower, cable TV, telephone, kitchenette, fridge, dining room and mechanically adjustable beds" (Jafari et al., 2015). There is 24-hour nurse and mental health worker coverage of the facility, as well as Monday through Friday daily physician sessions and 24/7 substance dependence counseling and individual case management (Jafari et al., 2015). Over the five-year study period, 165 patients were admitted to the CTCT. The annual average length of stay in the CTCT ranged from 50 to 90 days from 2005-2009 (Jafari et al., 2015). The annual average length of stay in the hospital during this time period was 16 to 22 days—suggesting that the CTCT environment provided conditions more conducive to completing a long-course of IV antibiotics. Thirty-six percent of CTCT admits were homeless upon arrive, and all of them were discharged to stable housing post-treatment. Qualitatively, 100% of the participants preferred receiving care at the CTCT to any other form of hospital treatment they had experienced (Jafari et al., 2015).

In this Option #2, WFBH would build a new, apartment-style facility using the Community Transitional Care Team model. The holistic treatment approach prioritizes the needs of the patient population over the underlying components of deep tissue infections. This model of care contrasts with a large, acute care hospital's traditional organization to treat organ-system specific diseases. Once an IDU with a deep tissue infection is stabilized at WFBH, he or she would receive the remaining five weeks of IV antibiotics in a community care-based outpatient environment. WFBH would eliminate the opportunity cost of providing acute care inpatient services to a non-acute patient, and the PWID would be able to receive treatment in a more supportive environment.

The new CTCT facility would have enough capacity to care for 15 IDUs at a time. Appendix D details the specific staffing requirements involved, but the CTCT will have the capability to provide better socially and culturally competent care for IV drug users than the inpatient hospital setting, while maintaining the requisite clinical capabilities. Patients in the CTCT facility will have virtual access to an on-call physician, as well as on-site access to nurses and case managers 24 hours a day, seven days a week.

Evaluating Option #2:

All relevant benefit-cost analysis assumptions, values, justifications, and sources for Option #2 are provide in Appendices A, D, and E.

I. Benefit-Cost Analysis

The first set of costs associated with Option #2 are the construction costs of the new CTCT facility and its annual value depreciation. The second set of costs of Option #2 are the staffing requirements to maintain the clinical and social care needed to make it a success. The third set of costs for Option #2 is the cost of care provided that the patient population does not reimburse. The initial facility costs, discounted into year zero, for Option #2 are $3,445,132.50 (Appendix D). The total staffing costs and facility depreciation is $1,272,320.40 annually (Appendix D). Option #2 will lose $5,463,545.45 a year in non-reimbursed care. Option #2 produces $608,000 in nursing staff retention-related benefits in year one (Appendix D). It adds $8,079,750 in bed management benefits in year one (Appendix D). When these costs and benefits are discounted and summated over a five-year period, Option #2 has a net present value of $5,118,195.59 (Appendix E).

II. Implementation Feasibility

Option #2's implementation feasibility is Medium. The Community Transitional Care Team facility has the highest initial implementation cost of any option considered. Nonetheless, WFBH has the capability to make such an initiative a priority. In the vacuum of this analysis, Option #2 provides a substantively higher level of net present value than the next best option proposed, making it an attractive possibility. However, the barrier that this option faces comes from competing health system priorities outside of lowering the burden of IV drug users with deep tissue infections. Frankly, committing capital to a lower-acuity facility serving a patient population that is more likely to be underinsured and uninsured creates a difficult value proposition with respect to return on investment when compared to allocating resources to a higher acuity outpatient surgery center serving a patient population with high rates of private insurance coverage.

III. Sustainability

Option #2's sustainability is High. The CTCT facility produces the largest amount of net annual benefit by freeing 5,250 inpatient hospital bed-days. If the analysis were carried out over a time period longer than 5 years, Option #2 would have outperformed the other options by an even greater degree. Additionally, national and state trends in the opioid epidemic showing increased usage rates of IV drug use make the CTCT facility more valuable when trying to manage the care of a growing patient population (Kansagra & Cohen, 2018). WFBH would be a national leader in transforming the way hospitals combat the opioid epidemic.

Option #3: Comprehensive Harm Reduction Program Expansion

The North Carolina Division of Public Health operates the Safer Syringe Initiative, which aims to "increase access to clean needles, hypodermic syringes and other injection supplies, facilitate the safe disposal of used needles and syringes, provide information about harm reduction and preventative health and connect people who inject drugs or otherwise use drugs with treatment and medical and social services, as requested ("NCDHHS: Syringe Exchange FAQs," n.d.)." Currently, the Twin City Harm Reduction Collective in Winston-Salem serves the broader Forsyth Country area ("NCDHHS: Syringe Exchange Programs in North Carolina," n.d.). There has been wide acceptance across the academic literature showing needle sharing program effectiveness at reducing rates of bloodborne pathogen transmission, including HIV, Hepatitis B virus, and Hepatitis C virus ("Access to clean syringes | Health Impact in 5 Years | Health System Transformation | AD for Policy | CDC," n.d.). A 2014 study estimated that each additional $1 invested in needle exchange programs produced an economic return of $6.38 to $7.58 when calculating foregone costs of HIV infections alone (Nguyen, Weir, Des Jarlais, Pinkerton, & Holtgrave, 2014). This rate of return would increase if prevented cases of hepatitis and deep tissue infections were also taken into account.

In this option, WFBH would partner with the Twin City Harm Reduction Collective to provide funding to expand the overall bandwidth of the current syringe exchange program. Specifically, WFBH would provide the funding to hire both a nurse and health educator for the Twin City Harm Collective. The nursing position would allow a medically licensed care provider to be present onsite during regular business hours to teach safe and sterile injection practices. Additionally, the nurse would provide a baseline level of health surveillance to the participating individuals, as he or she would be able to determine if a patient was in need of urgent medical care for an IV drug use complication. The health educator would use motivational interviewing techniques to facilitate questions around drug rehabilitation. The health educator would also be able to discuss the wide variety of risks associated with IV drug use, including deep tissue infections, communicable diseases, gender violence, sexual exploitation, and death (Haworth, 2019). A key component of the expanded service would be health education initiatives focused on sanitary injection practices to reduce rates of deep tissue infection.

The primary appeal of this option is the cost-effective nature of each prevented deep tissue infection admission. Even if only a few cases are prevented annually, costs of a needle exchange program are much cheaper than expenses associated with a 6-week hospital admission, possible readmission, and potential loss of life. Secondarily, PWID would benefit from reductions in other medical conditions simultaneously, since this option has positive spillover effects in other areas, especially in reducing the spread of other blood-borne illnesses.

Evaluating Option #3:

All relevant benefit-cost analysis assumptions, values, justifications, and sources for Option #3 are provide in Appendices A, F, and G.

I. Benefit-Cost Analysis

The costs associated with Option #3 are related to staffing the requisite FTEs to administer the program. Option #3 utilizes resources already in place, so there are no initial implementation costs. The annual maintenance cost of Option #3 is $123,523.99 (Appendix F). Option #3 does not produce nursing staff retention-related benefits, as its effect on the number of IV drug-related deep tissue infection admissions is minimal. However, it does add $193,914 in bed management benefits in year one (Appendix F). When these costs and benefits are discounted and summated over a five-year period, Option #3 has a net present value of $308,815.84 (Appendix G).

II. Implementation Feasibility

Option #3's implementation feasibility is High. There are several factors contributing to its high rating. First, Option #3 builds upon an organization's ongoing work. By providing additional staff to the syringe exchange at the Twin City Harm Reduction Collective, WFBH is merely providing funding and institutional support to increase the bandwidth of services provided. There is no additional upfront cost of implementing Option #3, as WFBH already has human resources staffing processes in place. Additionally, other community partners, such as the public health department, will already have health promotions literature available regarding safe and sterile syringe practices.

III. Sustainability

Option #3's sustainability is High. The annual burden on WFBH to maintain the solution is purely financial, and its magnitude is small. Broader trends in the opioid epidemic suggest that there will be increasing demand for syringe exchange programs in future years. The Western North Carolina AIDS Project in Asheville, NC was dispensing 26,000 syringes a month in 2015 for individuals from Georgia, South Carolina, Tennessee, and Virginia (Haworth, 2019). Additionally, this solution has the opportunity to address the root cause of deep tissue infections, unsterile injection practices. WFBH will be able to use Option #3 as a foundation for future community parentships, enhancing both its brand image and effectiveness at creating a healthier community within its provider network.

Outcomes Matrix

The table below summarizes the performance of all three options evaluated. In this report, the benefit-cost analysis NPV was prioritized when making it policy recommendation. Of note, all NPV values were positive. In this report, parentheses around dollar amounts in the benefit-cost analysis tables will indicate negative values, i.e. costs.

Option	**Benefit-Cost Analysis Net Present Value**	**Implementation Feasibility**	**Sustainability**
Option #1: Hospital Administration-Directed Clinical Discharge Process	$1,650,178.48	**High**	Medium
Option #2: Community-Based Model of Outpatient Treatment	**$5,118,195.59**	Medium	**High**
Option #3: Comprehensive Harm Reduction Program Expansion	$308,815.84	**High**	**High**

Recommendation

Adopt a Community-Based Model of Outpatient Treatment

Given the projected outcomes for the three alternatives evaluated, WFBH should invest in a community-based model of outpatient treatment by constructing a Community Transitional Care Team facility (Option #2).

The strongest advantages of this option are its five-year net present value of $5,118,196, and its annual accrual of $1,951,885 in economic benefits (Appendix E). Option #2 substantively out-performed the other two alternatives in this category, and would be a dominant winner if the analysis were carried out over a ten-year period. The majority of benefits from building the CTCT facility come from transitioning the antibiotic administration of IV drug users with deep tissue infections from a high-acuity hospital to lower-acuity clinic. This frees 5,250 bed days for WFBH to treat higher-acuity patients who will reimburse the health system at a higher rate. Option #2 also provided the largest improvement to nursing staff satisfaction and retention, saving WFBH 8 nurses per year (Appendix D). By significantly reducing the burden IV drug users with deep tissue infections place on the workload of nurses, these frontline clinicians will be able to provide a higher quality of care to the other patients they treat on a daily basis (Thompson, 2019; Summers, 2019).

From the patient's perspective, the CTCT model is able to provide the requisite medical care in a more comfortable environment (Jafari et al., 2015). For example, the CTCT facility would address housing instability issues associated with antibiotic treatment completion for the patient population. It also will allow for better coordination of social services for the patient population. In this way, Option #2 has the strongest opportunity to provide a net positive benefit to society, as opposed to a transfer of burden from the hospital to the patient or to the community.

The analysis of Option #2 identified both the high cost associated with building, staffing, and operating the CTCT. Option #2 requires the strongest financial commitment of WFBH, and therefore generates the most financial risk. This analysis also recognizes that Option #2 is transformational in how it details a new model of medical treatment for IV drug users with deep tissue infections. However, WFBH already implements policies that are in the spirit of the antibiotic administration environment described in the CTCT model. According to Summers (2019), WFBH offers patients who have completed their one week of clinically necessary inpatient medical care the opportunity to transfer to one of the four community hospitals within WFBH's network to complete the remaining 5 weeks of IV antibiotics. The rationale is to free up bed space in the higher-acuity flagship WFBH hospital, while allowing the patients to receive care in a more attentive environment, closer to home and family members (Summers, 2019). Option #2 could be generalized as a facility-specific commitment to the care strategy described above.

Implementation

As referenced on page 20 of this report, WFBH is in the early stage of implementing Option #1. The evaluation process showed that Option #1 provides a strong net present value and is favorably scored across the qualitative criteria. It was the second-best option according to this analysis when prioritizing the net present value criterion.

The following section provides insight into implementing Option #2, in addition to Option #1. If Option #2 is successfully implemented, the need for Option #1 is eliminated, as the antibiotic administration for IV drug-related deep tissue infections will be performed in the CTCT facility, not in the main WFBH hospital. WFBH is already "receiving" benefits from the implementation of Option #1. Because Option #2 relies on the same nursing staff satisfaction and bed management benefits, the net benefit of Option #2 will be lower than what was calculated in this report's benefit-cost analysis, which was conducted as if each option was mutually exclusive. In summary, the implementation of both Options #1 and #2 can not "double count" the benefits that are used to calculate the net present value of each option individually.

The most fundamental factor relating to the successful implementation of Option #2 is the buy-in of key WFBH stakeholders. Support from C-suite executive and physician leadership is a prerequisite. The Community Transitional Care Team facility will require a transformational vision of how the burden of IV drug-related deep tissue infections on WFBH can be significantly reduced. Option #2 will require leadership from its advocates to ensure successful implementation and operation of the care strategy.

Option #2 has the highest level of risks and costs of any alternative in this report, as has been previously discussed. The following section identifies strategies WFBH can pursue to reduce these risks and increase the feasibility and sustainability of the community-based treatment model.

Reducing Implementation Costs & Risks

Wake Forest Baptist Health can prioritize forming partnerships with community stakeholders to share cost burden of constructing the CTCT facility. For example, WFBH can apply for grants from non-profits and private foundations that have an interest in reducing the burden of the opioid epidemic and IV drug use. Building an outpatient facility to specifically address the needs of the IV drug-using community is innovative and would attract philanthropy from investors and activists looking to find new remedies to the opioid epidemic. The reliability of this type of funding would be variable. Applying for the financial assistance would be most relevant at the initial stage of implementing this option, with any future funding serving as a bonus. However, once a base application packet is made for the CTCT facility and model of care, it will require minimal updating efforts. If Option #2 can produce meaningful benefits to the patient population and WFBH, subsequent grant applications will be more attractive to organizations and individuals looking for measurable social returns on their investments.

Reducing Operating Costs & Risks

Financing the patient care that the CTCT provides will be a priority to maintain its sustainability. WFBH should reach out to the health insurance providers (commercial, Medicare, Medicaid) in its region to design a reimbursement structure appropriate for this patient population and medical care model. WFBH has experience operating in a fee-for-value healthcare reimbursement model, partnering with United Healthcare in 2016 to join an Accountable Care Organization (ACO) to participate in the Medicare Shared Savings Program (MSSP) (Craver, 2016). Another Wake Forest affiliate, Wake Forest University Health Sciences joined the ACO on February 9th, 2018 ("CHESS Announces Two New Participants in CHESS NextGen ACO for 2018," 2018). Of note, this ACO has been successful, saving $9.5 million in Medicare costs in 2017 ("CHESS ACO Achieves the Second Highest Savings in North Carolina," 2018). As of 2018, the ACO had earned $7.5 million in financial compensation over the previous three years (“CHESS ACO Achieves the Second Highest Savings in North Carolina,” 2018). This shows that WFBH has proven it can help create value for patients, providers, and payers by transforming the way it treats chronically ill patient populations. By incorporating this fee-for-value care finance model into Option #2, WFBH would be able to reduce the cost burden of treating IV drug use-related deep tissue infections, doing well while doing good.

Use the Community Transitional Care Team Facility in Brand Development

Pursuing Option #2 will make WFBH a leader in the treatment of both IV drug users and patients with complex care needs due to multiple negative social determinants of health. Its implementation should include intentional promotional coverage through print, broadcast, and social media. This will highlight WFBH’s vision to be “a preeminent learning health system that promotes better health for all through collaboration, excellence and innovation” by acting on its values of compassion, service, integrity, and diversity (“Mission, Vision and Values,” n.d.). WFBH’s efforts to better serve the most disadvantaged members of its community, placing the patient over profit, would certainly differentiate Wake Forest from its regional competitors. Additionally, the leadership of WFBH would be able to demonstrate to its frontline workforce that it is committed to providing a safer and less stressful work environment, since a key dimension of this report’s analysis was dedicated towards improving nursing staff satisfaction.

Appendix A

General Benefit-Cost Analysis Assumptions Table

Appendix A provides a summary of the foundational assumptions that were used to conduct the benefit-cost analyses in this report.

Assumption	Value	Justification/Source
Discount Rate	7%	Office of Management and Budget, 2016
Span of Analysis	5 Years	Appropriate span of time for Wake Forest Baptist Health to see a return on investments
Number of Cases of IV Drug-related Deep Tissue Infections at WFBH per Year	150 cases	Summers, 2019. Conservative end of the estimated spectrum used
Percentage of Patients who Validate the Executive Action Team Being Called	3%	Summers, 2019. Conservative end of the estimated spectrum used
Number of Patients who Validate the Executive Action Team being Called	5 Patients	Summers, 2019. Rounded up using the conservative end of the estimate 150 cases * 3%
Length of IV Drug-related Admission	42 days (6 weeks)	Summers, 2019
Length of IV Drug-related Admission Necessary Medically	7 days (1 week)	Summers, 2019
Length of IV Drug-related Admission that is Unnecessary Medically	35 days (5 weeks)	Summers, 2019 42 days - 7 days

Additional Length of Inpatient Compliance to IV Antibiotic Administration	7 days (1 week)	The estimated time it takes for a patient to become eligible for an administrative discharge
WFBH Annual Nursing Turnover Rate	14.5%	Thompson, 2019
January-March 2019 WFBH Expense to Recruit, Onboard, and Train New Nurses	$3.8 million	Thompson, 2019
Annual 2019 WFBH Expense to Recruit, Onboard, and Train New Nurses	$15.2 million	$3.8 million * 4 annual periods
Cost to Recruit, Onboard, and Train One New Nurse	$75,000	Thompson, 2019. Conservative end of the estimate spectrum used

Appendix B

Option #1 Benefit-Cost Analysis Assumptions Table

Appendix B details the process by which the benefit-cost analysis for Option #1 was conducted. The table below is designed to read left to right, top to bottom, in order to follow the calculations and mental model used in the analysis.

The table below is split into sub-sections for the reader to follow the calculations of costs and benefits of discrete categories. The highlighted values located at the end of each sub-section will be input values of the benefit-cost analysis in Appendix C. Of note, a few of the formulas used in the Justification/Source column reference values that are described in Appendix A.

Option #1 Bed Management Benefits		
Assumption	**Value**	**Justification/Source**
Number of Inpatient Bed Days Gained per EAT Administrative Discharge	28 days (4 weeks)	(Length of Admission - Length of Medically Necessary Care) - Estimated Compliance (42 days - 7 days) - 7 days
Annual Bed Days Saved by the EAT Program	140 days	Inpatient Bed Days Gained * Number of Patients Eligible for Administrative Discharge 28 days * 5 patients
Profit Earned per Day per Inpatient Bed for non-IV Drug-related Deep Tissue Infections	$245	"12 Statistics on Hospital Profit and Revenue in 2012," 2014. $89,356 / 365 days in a year
Expenses in IV Drug-Related Deep Tissue Infection Study	$4.6 million	Norton, 2018

Rate of reimbursement in IV Drug-Related Deep Tissue Infection Study	22%	Norton, 2018
Expenses not Reimbursed in IV Drug-Related Deep Tissue Infection Study	$3,588,000	Norton, 2018 $4.6 million * 78% non-reimbursement rate
Expenses not Reimbursed per Patient in IV Drug-Related Deep Tissue Infection Study	$54,364	Norton, 2018 $3,588,000 / 66 patients
Expenses not Reimbursed per Patient per Inpatient Bed Day in IV Drug-Related Deep Tissue Infection Study	$1,294	Norton, 2018. Assuming 42-day length of admission. $54,364 / 42 days
Opportunity Cost of an IV Drug-Related Deep Tissue Infection Admission per day	$1,539	$1,294 - $ 245
Cost Savings per EAT Discharge	$43,092	$1,539 * 28 days
EAT Administrative Discharge Cost Savings per Year	**$215,460**	$43,092 * 5 patients Or $1,539* 140 days
Option #1 Nursing Staff Satisfaction Benefits		
Assumption	**Value**	**Justification/Source**
Annual Increase of Nursing Satisfaction from EAT Administrative Discharge Process Implementation	2%	Appropriate, conservative estimate given the severity of burden the patient population places on frontline nursing staff
Annual Decrease in Nursing Staff Turnover Rate	2%	Appropriate estimate of a one to one relationship of

		nursing staff satisfaction and decreased turnover rate
Annual 2019 Expense to Recruit, Onboard, and Train New Nurses with Option #1	$14,896,000	$15.2 million * 0.98
Annual Cost Savings in Nursing Turnover Expenses with Option #1	**$304,000**	$15.2 million - $14,896,000
Number of Nurses Retained Annually with Option #1	4 nurses	$304,000 / $75,000
Option #1 Costs		
Assumption	**Value**	**Justification/Source**
Number of Executive FTEs Needed for Option #1	1 FTE	Appropriate estimate of the number of C-suite level FTEs required to implement and maintain Option #1
Annual Salary per Executive FTE	$375,000	Jurica, 2017 Chief Quality Officer
Percent Effort on Option #1 Implementation (Year 0)	25%	Conservative time estimate the FTE would spend designing and implementing Option #1
Executive FTE Implementation Cost	$93,750	$375,000 * 1 * 25%
Executive FTE Percent Effort on Option #1 Maintenance (Years 1-5)	5%	Conservative time estimate the FTE would spend maintaining the initiative once implemented
Executive FTE Maintenance Cost	$18,750	$375,000 * 1 * 5%

Number of Vice President FTEs Needed for Option #1	3 FTEs	Appropriate estimate of the number of VP level FTEs required to implement and maintain Option #1
Annual Salary per Vice President FTE	$180,000	"Average Hospital Vice President Salary," n.d. Took the average of the maximum and median salaries listed
Percent Effort on Option #1 Implementation (Year 0)	25%	Conservative time estimate the FTE would spend designing and implementing Option #1
Vice President FTE Implementation Cost	$135,000	$180,000 * 3 * 25%
Vice President Percent Effort on Option #1 Maintenance (Years 1-5)	5%	Conservative time estimate the FTE would spend maintaining the initiative once implemented
Vice President FTE Maintenance Cost	$27,000	$180,000 * 3 * 5%
Number of Managers FTEs Needed for Option #1	2 FTEs	Appropriate estimate of the number of manager level FTEs required to implement and maintain Option #1
Annual Salary per Manager FTE	$127,000	"Average Hospital Administrator Salary," n.d. Took the average of the maximum and median salaries listed
Percent Effort on Option #1 Implementation (Year 0)	25%	Conservative time estimate the FTE would spend

		designing and implementing Option #1
Manager FTE Implementation Cost	$63,500	$127,000 * 2 * 25%
Manager Percent Effort on Option #1 Maintenance (Years 1-5)	5%	Conservative time estimate the FTE would spend maintaining the initiative once implemented
Manager FTE Maintenance Cost	$12,700	$127,000 * 2 * 5%
Number of Administrative Assistant FTEs Needed for Option #1	2 FTEs	Appropriate estimate of the number of administrative assistant level FTEs required to implement and maintain Option #1
Annual Salary per Administrative Assistant FTE	$43,500	"Average Healthcare Administrative Assistant Hourly Pay," n.d. Took the average of the maximum and median salaries listed
Percent Effort on Option #1 Implementation (Year 0)	25%	Conservative time estimate the FTE would spend designing and implementing Option #1
Administrative Assistant FTE Implementation Cost	$21,625	$43,500 * 2 * 25%
Administrative Assistant Percent Effort on Option #1 Maintenance (Years 1-5)	5%	Conservative time estimate the FTE would spend maintaining the initiative once implemented

Administrative Assistant FTE Maintenance Cost	$4,325	$43,500 * 2 * 5%
Total Option #1 Implementation Cost	**$313,875**	$93,750 + $135,000 + $63,500 + $21,625
Annual Option #1 Maintenance Cost Basis	**$62,775**	$18,750 + $27,000 + $12,700 + $4,325

Appendix C

Option #1 Benefit-Cost Analysis Net Present Value Table

Appendix C shows the accumulation of benefits and costs for Option #1 over a 5-year span. Any up-front, implementation costs are listed in Year 0, and are discounted back one time period from its magnitude listed in Appendix B. The annual benefit and cost values from Appendix B are listed in Year 1, and are discounted forward each subsequent time period.

Of note, the total benefit and cost values accrued over the 5-year span are calculated by summing the values in the column. The net present value cells represent the net present value of Option #1 at the end of the given time period. Of note, Option #1 is NPV positive after its first year in operation. Parentheses indicate negative values.

Year	Bed Management Benefits	Staff Satisfaction Benefits	Annual Cost	Net Present Value
0	N/A	N/A	$(335,846.25)	$(335,846.25)
1	$215,460.00	$300,000.00	$(62,775.00)	$116,838.75
2	$201,364.49	$280,373.83	$(58,668.22)	$539,908.84
3	$188,191.11	$262,031.62	$(54,830.12)	$935,301.45
4	$175,879.54	$244,889.36	$(51,243.10)	$1,304,827.26
5	$164,373.40	$228,868.56	$(47,890.75)	$1,650,178.48
Total	**$945,269**	**$1,316,163.38**	**$(611,253.44)**	**$1,650,178.48**

Appendix D

Option #2 Benefit-Cost Analysis Assumptions Table

Appendix D details the process by which the benefit-cost analysis for Option #2 was conducted. The table below is designed to read left to right, top to bottom, in order to follow the calculations and mental model used in the analysis.

The table below is split into sub-sections for the reader to follow the calculations of costs and benefits of discrete categories. The highlighted values located at the end of each sub-section will be input values of the benefit-cost analysis in Appendix E. Of note, a few of the formulas used in the Justification/Source column reference values that are described in Appendix A.

Option #2 Bed Management Benefits		
Assumption	**Value**	**Justification/Source**
Number of WFBH Inpatient Hospital Admissions Affected	150 visits	Summers, 2019. Option #2 will apply to all cases of IV Drug-related Deep Tissue Infections
Number of Medically Unnecessary Inpatient Bed Days Saved per Foregone Hospital Admission	35 days	Summers, 2019. The length of a typical IV Drug-related Deep Tissue Infection - the 7 days of necessary medical care
Annual Inpatient Bed Days Saved by Option #2	5,250 days	150 visits * 35 days
Profit Earned per Day per Inpatient Bed for non-IV Drug-related Deep Tissue Infections	$245	"12 Statistics on Hospital Profit and Revenue in 2012," 2014. $89,356 / 365 days in a year
Expenses in IV Drug-Related Deep Tissue Infection Study	$4.6 million	Norton, 2018

Rate of reimbursement in IV Drug-Related Deep Tissue Infection Study	22%	Norton, 2018
Expenses not Reimbursed in IV Drug-Related Deep Tissue Infection Study	$3,588,000	Norton, 2018 $4.6 million * 78% non-reimbursement rate
Expenses not Reimbursed per Patient in IV Drug-Related Deep Tissue Infection Study	$54,364	Norton, 2018 $3,588,000 / 66 patients
Expenses not Reimbursed per Patient per Inpatient Bed Day in IV Drug-Related Deep Tissue Infection Study	$1,294	Norton, 2018. Assuming 42-day length of admission. $54,364 / 42 days
Opportunity Cost of an IV Drug-Related Deep Tissue Infection Admission per day	$1,539	$1,294 - $ 245
Annual Inpatient Bed Management Cost Savings of Option #2	**$8,079,750**	5,250 days * $1,539
Option #2 Nursing Staff Satisfaction Benefits		
Assumption	**Value**	**Justification/Source**
Annual Increase of Nursing Satisfaction from EAT Administrative Discharge Process Implementation	4%	Appropriate, conservative estimate given the severity of burden the patient population places on frontline nursing staff
Annual Decrease in Nursing Staff Turnover Rate	4%	Appropriate estimate of a one to one relationship of nursing staff satisfaction and decreased turnover rate

Annual 2019 Expense to Recruit, Onboard, and Train New Nurses with Option #2	$14,592,000	$15.2 million * 0.96
Annual Cost Savings in Nursing Turnover Expenses with Option #2	**$608,000**	$15.2 million - $14,592,000
Number of Nurses Retained Annually with Option #2	8 nurses	$608,000 / $75,000
Option #2 Facility Costs		
Assumption	**Value**	**Justification/Source**
The Bed Capacity of the Community Care Transition Clinic for Option #2	15 beds	Summers, 2019. WFBH has 12 patients in its network under IV antibiotic supervision at any time. This 25% increase in capacity accommodates increased caseload variation.
Square Footage per Patient Room	324 Sq Ft	This estimate was made assuming a 18x18 room dimension, adequately providing provide sleeping, lounging, cooking, and bathroom space.
Total Patient Square Footage	4,860 Sq Ft	15 beds * 324 Sq Ft
Total Facility Square Footage	12,150 Sq Ft	It is estimated that the total building will need to have 150% more capacity than the patient rooms to accommodate hallways, intake areas, closet space, and other miscellaneous staff working space. 4,860 Sq Ft * 2.5

Cost of the Facility Per Square Foot	$265	"4 Ways to Mitigate Costs When Developing Medical Offices," 2012. A Winston-Salem market estimate of $240 was converted to 2019 dollars using a CPI calculator.
Total Initial Construction Cost of the Community Care Transition Clinic	**$3,219,750**	12,150 Sq Ft * $265
"Duration" of the Property	10 years	This value is calculated for depreciation purposes and is a conservative value
Percentage Depreciation per Year	10%	1 / 10 years
Annual Building Asset Depreciation	**$321,975**	$3,219,750 * 10%
Number of Security Guards Option #2 will Staff	9 security guards	Two security guards will staff the facility at all times. Six will work through the course of the day. Three more will be hired to cover weekends and vacation gaps in coverage.
Salary of a Security Guard	$28,537.60	"Average Security Guard Hourly Pay," n.d.
Annual Option #2 Cost of Security Guards FTEs	$256,838	9 security guards * $28,537.60
Number of Administrative Assistants Option #2 will Staff	1.25	One administrative will staff the facility M-F from 9am-5pm. The extra quarter FTE will be a part-time employee to cover gaps in coverage.

Salary of an Administrative Assistant	$43,500	"Average Healthcare Administrative Assistant Hourly Pay," n.d. Took the average of the maximum and median salaries listed
Annual Option #2 Cost of Administrative Assistant FTEs	$54,375.00	1.25 administrative assistants * $43,500
Number of Nurses Option #2 will Staff	7 nurses	Two nurses will staff the facility 9am-5pm, M-F, with one nurse present during both the evening and overnight shift. Three more nurses will be hired to cover weekends and vacation gaps in coverage.
Salary of a Nurse	$62,560	"Highest Paying States for Registered Nurses," 2018
Annual Option #2 Cost of Nurse FTEs	$437,920	7 nurses * $62,560
Number of Case Managers Option #2 will Staff	2 case managers	Two case managers will staff the facility 9am-5pm, M-F.
Salary of a Case Manager	$74,606	"Salary for Case Manager in North Carolina," n.d.
Annual Option #2 Cost of Case Manager FTEs	$149,212	2 case managers * $74,606
Number of On-Call Physicians Option #2 will Staff	0.2 infectious disease physicians	The on-call infectious disease physician will only spend 20% of his or her time staffing the facility's needs.
Salary of an Infectious Disease Physician	$260,000	Knowles, 2018

Annual Option #2 Cost of Physician FTE	$52,000	0.2 infectious disease physicians * $260,000
Total Annual Staffing Cost of Option #2	**$950,345.40**	$256,838.40 + $54,375 + $437,920 + $149,212 + $52,000.00
Option #2 Patient Care Costs		
Assumption	**Value**	**Justification/Source**
Number of WFBH CTCT Admissions Option #2 will Treat	150 visits	Summers, 2019. Option #2 will apply to all cases of IV Drug-related Deep Tissue Infections
Expenses in IV Drug-Related Deep Tissue Infection Study	$4.6 million	Norton, 2018
Expenses of IV Drug-Related Deep Tissue Infections in the CTCT Model of Option #2	$3,082,000	$4.6 million * 67% It is assumed the lower acuity care center of Option #2 will be 33% cheaper than inpatient hospital care.
Rate of reimbursement in IV Drug-Related Deep Tissue Infection Study	22%	Norton, 2018
Expenses not Reimbursed in Option #2	$2,403,960	Norton, 2018 $3,082,000 * 78% non-reimbursement rate
Expenses not Reimbursed per Patient in Option #2	$36,423.64	Norton, 2018 $3,082,000 / 66 patients
Annual Expenses not Reimbursed under Option #2	**$5,463,545.45**	$36,423.64 * 150 patients

Appendix E

Option #2 Benefit-Cost Analysis Net Present Value Table

Appendix E shows the accumulation of benefits and costs for Option #2 over a 5-year span. Any up-front, implementation costs are listed in Year 0, and are discounted back one time period from its magnitude listed in Appendix D. The annual benefit and cost values from Appendix D are listed in Year 1, and are discounted forward each subsequent time period.

Of note, the total benefit and cost values accrued over the 5-year span are calculated by summing the values in the column. The net present value cells represent the net present value of Option #2 at the end of the given time period. Of note, Option #2 is NPV positive after its second year in operation. Parentheses indicate negative values.

Year	Bed Management Benefits	Staff Satisfaction Benefits	Facility Costs	Patient Care Costs	Net Present Value
0	N/A	N/A	$(3,445,132.50)	N/A	$(3,445,132.50)
1	$8,079,750.00	$608,000.00	$(1,272,320.40)	$(5,463,545.45)	$(1,493,248.35)
2	$7,551,168.22	$568,224.30	$(1,189,084.49)	$(5,106,117.25)	$330,942.44
3	$7,057,166.56	$531,050.75	$(1,111,293.91)	$(4,772,072.19)	$2,035,793.64
4	$6,595,482.77	$496,309.11	$(1,038,592.44)	$(4,459,880.55)	$3,629,112.53
5	$6,164,002.59	$463,840.29	$(970,647.14)	$(4,168,112.67)	$5,118,195.59
Total	**$35,447,570.15**	**$2,667,424.44**	**$(9,027,070.88)**	**$(23,969,728.12)**	**$5,118,195.59**

Appendix F

Option #3 Benefit-Cost Analysis Assumptions Table

Appendix F details the process by which the benefit-cost analysis for Option #3 was conducted. The table below is designed to read left to right, top to bottom, in order to follow the calculations and mental model used in the analysis.

The table below is split into sub-sections for the reader to follow the calculations of costs and benefits of discrete categories. The highlighted values located at the end of each sub-section will be input values of the benefit-cost analysis in Appendix G. Of note, a few of the formulas used in the Justification/Source column reference values that are described in Appendix A.

Option #3 Bed Management Benefits		
Assumption	Value	Justification/Source
Number of WFBH Inpatient Hospital Admissions Affected	150 visits	Summers, 2019. Option #3 will apply to all cases of IV Drug-related Deep Tissue Infections
Percentage of WFBH Admissions that will be Prevented through Option #3	2%	Appropriate estimate to represent the low take-up rate/adherence to the safe syringe practice element of Option #3
Number of WFBH Hospital Admissions Prevented	3	150 visits * 2%
Number of Inpatient Bed Days Saved per Foregone Hospital Admission for Option #3	42 days	Summers, 2019. The length of a typical IV Drug-related Deep Tissue Infection Admission (six weeks)
Annual Inpatient Bed Days Saved by Option #3	126 days	3 admissions * 42 days

Profit Earned per Day per Inpatient Bed for non-IV Drug-related Deep Tissue Infections	$245	"12 Statistics on Hospital Profit and Revenue in 2012," 2014. $89,356 / 365 days in a year
Expenses in IV Drug-Related Deep Tissue Infection Study	$4.6 million	Norton, 2018
Rate of reimbursement in IV Drug-Related Deep Tissue Infection Study	22%	Norton, 2018
Expenses not Reimbursed in IV Drug-Related Deep Tissue Infection Study	$3,588,000	Norton, 2018 $4.6 million * 78% non-reimbursement rate
Expenses not Reimbursed per Patient in IV Drug-Related Deep Tissue Infection Study	$54,364	Norton, 2018 $3,588,000 / 66 patients
Expenses not Reimbursed per Patient per Inpatient Bed Day in IV Drug-Related Deep Tissue Infection Study	$1,294	Norton, 2018. Assuming 42-day length of admission. $54,364 / 42 days
Opportunity Cost of an IV Drug-Related Deep Tissue Infection Admission per day	$1,539	$1,294 - $ 245
Annual Inpatient Bed Management Cost Savings of Option #3	**$193,914**	126 days * $1,539
Option #3 Nursing Staff Satisfaction Benefits		
Assumption	**Value**	**Justification/Source**
Option #3 will have no Effect on Nursing Staff Satisfaction, and therefore Nursing	**$0**	Option #3 provides the lowest magnitude of bed management benefits to WFBH. The patient

Turnover Rates will not be Changed		population will likely have a low take-up rate of Option #3. Omitted nursing staff satisfaction benefits allows for a more conservative benefit-cost analysis of Option #3 to accommodate the option's risk.
Option #3 Costs		
Assumption	**Value**	**Justification/Source**
Number of Nurses Option #3 will Staff	1 nurse	One nurse will staff the facility 9am-5pm, M-F.
Salary of a Nurse	$62,560	"Highest Paying States for Registered Nurses," 2018
Annual Option #3 Cost of Nurse FTEs	$62,560	1 nurse * $62,560
Number of Health Educators Option #3 will Staff	1 health educator	One health educator will staff the facility 9am-5pm, M-F.
Salary of a Health Educator	$60,254	"Salary for Health Educator in North Carolina," n.d.
Annual Option #3 Cost of Health Educator FTEs	$60,254	1 health educator * $60,254
Cost of 5,000 Informational Brochures	$709.99	"Marketing Materials," n.d.
Total Annual Costs of Option #3	**$123,523.99**	$62,560 + $60,254 + $709.99

Appendix G

Option #3 Benefit-Cost Analysis Net Present Value Table

Appendix G shows the accumulation of benefits and costs for Option #3 over a 5-year span. Any up-front, implementation costs are listed in Year 0, and are discounted back one time period from its magnitude listed in Appendix F. The annual benefit and cost values from Appendix F are listed in Year 1, and are discounted forward each subsequent time period.

Of note, the total benefit and cost values accrued over the 5-year span are calculated by summing the values in the column. The net present value cells represent the net present value of Option #3 at the end of the given time period. Of note, Option #3 is NPV positive after its first year in operation. Parentheses indicate negative values.

Year	Bed Management Benefits	Staff Satisfaction Benefits	Annual Cost	Net Present Value
0	N/A	N/A	N/A	$0
1	$193,914.00	$0	$(123,523.99)	$70,390.01
2	$181,228.04	$0	$(115,442.98)	$136,175.07
3	$169,372.00	$0	$(107,890.64)	$197,656.43
4	$158,291.59	$0	$(100,832.37)	$255,115.64
5	$147,936.06	$0	$(94,235.86)	$308,815.84
Total	**$850,742.00**	**$0**	**$(541,925.84)**	**$308,815.84**

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