The Comparison of High and Low Fraction of Inspired Oxygen in the Prevention of Surgical Site Infection in Patients Receiving Anesthesia: An Evidence-Based Education Module

Adel Bashirimoghddam  
*Florida International University, abash005@fiu.edu*

Valerie Diaz  
*Florida International University, vdiaz@fiu.edu*

Ashley Bunnell  
*Broward health, Abunnell@drivinghp.com*

Follow this and additional works at: [https://digitalcommons.fiu.edu/cnhs-studentprojects](https://digitalcommons.fiu.edu/cnhs-studentprojects)

Recommended Citation  
Bashirimoghddam, Adel; Diaz, Valerie; and Bunnell, Ashley, "The Comparison of High and Low Fraction of Inspired Oxygen in the Prevention of Surgical Site Infection in Patients Receiving Anesthesia: An Evidence-Based Education Module" (2021). *Nicole Wertheim College of Nursing Student Projects*. 82.  
[https://digitalcommons.fiu.edu/cnhs-studentprojects/82](https://digitalcommons.fiu.edu/cnhs-studentprojects/82)

This work is brought to you for free and open access by the Nicole Wertheim College of Nursing and Health Sciences at FIU Digital Commons. It has been accepted for inclusion in Nicole Wertheim College of Nursing Student Projects by an authorized administrator of FIU Digital Commons. For more information, please contact dcc@fiu.edu.
The Comparison of High and Low Fraction of Inspired Oxygen in the Prevention of Surgical Site Infection in Patients Receiving Anesthesia: An Evidence-Based Education Module

A DNP Project Presented to the Faculty of the Nicole Wertheim College of Nursing and Health Sciences

Florida International University

In partial fulfillment of the requirements
For the Degree of Doctor of Nursing Practice
By
Adel Bashirimoghaddam MSN, RN

Supervised By
Valerie J. Diaz, DNP, CRNA, APRN, CAPT, USN, NC
Ashley Bunnell CRNA

Approval Acknowledged: ______________________, DNA Program Director
Date: ______________

Approval Acknowledged: ______________________, DNP Program Director
Date: ______________
# TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>ABSTRACT</td>
<td>4</td>
</tr>
<tr>
<td>INTRODUCTION</td>
<td>5</td>
</tr>
<tr>
<td>Description of the problem</td>
<td>5</td>
</tr>
<tr>
<td>Background</td>
<td>6</td>
</tr>
<tr>
<td>Scope of Problem</td>
<td>7</td>
</tr>
<tr>
<td>Consequences of the Problem</td>
<td>7</td>
</tr>
<tr>
<td>Gaps in Knowledge</td>
<td>8</td>
</tr>
<tr>
<td>Systematic Review Rationale</td>
<td>9</td>
</tr>
<tr>
<td>Objectives of the Systematic Review</td>
<td>9</td>
</tr>
<tr>
<td>METHODOLOGY OF LITERATURE REVIEW</td>
<td>9</td>
</tr>
<tr>
<td>Search Strategy and Sources</td>
<td>9</td>
</tr>
<tr>
<td>Study Selection and Screening of Evidence</td>
<td>10</td>
</tr>
<tr>
<td>RESULTS OF LITERATURE REVIEW</td>
<td>14</td>
</tr>
<tr>
<td>Study Selection</td>
<td>14</td>
</tr>
<tr>
<td>Study Characteristics</td>
<td>16</td>
</tr>
<tr>
<td>Risk of Bias</td>
<td>16</td>
</tr>
<tr>
<td>DISCUSSION OF LITERATURE REVIEW</td>
<td>17</td>
</tr>
<tr>
<td>Summary of Evidence</td>
<td>17</td>
</tr>
<tr>
<td>Limitation of the Systematic Review</td>
<td>17</td>
</tr>
<tr>
<td>Recommendation for Future Research</td>
<td>18</td>
</tr>
<tr>
<td>CONCLUSION OF LITERATURE REVIEW</td>
<td>18</td>
</tr>
<tr>
<td>METHODOLOGY OF QUALITY IMPROVEMENT</td>
<td>19</td>
</tr>
<tr>
<td>Setting</td>
<td>19</td>
</tr>
<tr>
<td>Recruitment and Participants</td>
<td>19</td>
</tr>
<tr>
<td>Intervention &amp; Procedure</td>
<td>19</td>
</tr>
</tbody>
</table>
Protection of Human Subjects.................................................................20
Data Collection .....................................................................................21
Measurement and Analysis.................................................................21

RESULTS OF QUALITY IMPROVEMENT...........................................22
Pre-test and Post-test Sample.................................................................23
Data Analysis.......................................................................................23
Pre-test knowledge...............................................................................23
Post-test knowledge............................................................................24
Pre-Test Versus Post-Test Confidence..................................................26
Perspective of Use in Practice..............................................................27

DICUSSION OF QUALITY IMPROVEMENT ....................................28
Limitations...........................................................................................28
Future Implications for Advanced Nursing Practice..............................28

CONCLUSION ......................................................................................29

REFERENCES .......................................................................................31

APPENDICES .......................................................................................27
Appendix A: PRISMA Flow Diagram ....................................................32
Appendix B: Matrix Table.....................................................................33
Appendix C: IRB Exemption Letter.......................................................40
Appendix D: QI Project Consent.............................................................42
Appendix E: QI Project Survey...............................................................43
Appendix F: Education Module.............................................................47
ABSTRACT

**Background:** Evidence has shown that a high percentage of oxygen given during surgery has been linked to an increase in poor health outcomes. Yet, high dose oxygen is still given intraoperatively to lessen patient surgical site infection rates. During this educational session, an educational module and questionnaire will be provided to anesthesia providers pre- and post-teaching to assess and expand knowledge on oxygen and its relation to SSI.

**Objectives:** A systematic review that assess the best present randomized controlled trials (RCTs) regarding low dose fio2 (<30%) and its relation to surgical site infection (SSI) prevention, as evidence for anesthesia providers to favor this fio2 concentration intraoperative to maintain SSI prevention and minimize the harmful effect of high dose fio2 (>80%). Information and results from the systematic review will be presented to anesthesia providers in an education module.

**Data Sources:** Investigators used CINAHL, MedLine, and Science Direct databases to answer the PICO (i.e., population, intervention, comparison, outcome) question: In current anesthesia providers (P), how does an educational session on the role of high vs. low fio2 in the prevention of surgical site infection (I) improve provider's knowledge that both concentrations of oxygen can provide the same similar rates in SSI prevention while avoiding the poorer health outcomes associated with an elevated fio2, as compared to before the educational session (C) as evident by an increase in examination score in the post-evaluation survey (O)?

**Methodology:** 6 RCTs and meta-analysis of RCTs were included in this systematic review and incorporated into anesthesia providers’ educational module. Inclusion criteria included: Male or female, age ≥ 18, English language, RCTs, published after 2012, and SSI defined by the CDC. The 6 RCTs had a combined sample size of 7641 patients. Four RCTs analyzed patients undergoing general anesthesia, and two RCTs analyzed patients going through cesarean section. All studies found that <30% fio2 had the same SSI rates as >80% fio2. The systematic review results were presented in an education module containing a pre- and post-test with a voiced-over PowerPoint to a group of anesthesia providers.

**Results:** Statistical analysis using SPSS revealed a statistically significant knowledge increase from the pre- to post-test. Furthermore, there was an increased likelihood of recommending low dose fio2 for SSI prevention.

**Conclusions:** Data shows the use of low dose fio2 (<30%) has similar rates in SSI prevention as high dose fio2 (>80%). CRNAs benefit from an educational module presenting the most current evidence-based information regarding intraoperative oxygen levels and its relation to SSI prevention. This knowledge increases also led to providers being more likely to recommend the use of low-dose fio2 intraoperatively for SSI prevention.

**Keywords:** Surgical site infection, SSI, fio2, oxygen, intraoperative, infection, surgery, anesthesia.
INTRODUCTION

Description of the problem

The use of oxygen with a high fraction of inspired oxygen (FiO2) concentration is a topic that is debated for its role intraoperatively in the reduction of surgical site infection (SSI). Surgical site infection is a complication of surgical procedures that affects an estimated 2% of surgeries performed at hospitals in the United States.\(^1\) To address the prevalence of SSI, healthcare facilities such as Broward Coral Springs Hospital have instituted a standard of using high oxygen concentration (≥80% FiO2) intraoperatively to reduce its occurrence. However, without a clear consensus on whether high FiO2 is the best choice for SSI prevention, the delivery of high oxygen concentration may instead place an increased risk to the patient’s health and finance. The adverse effects of intraoperative hyperoxia may include increased oxidative stress, atelectasis, and hyperoxia vasoconstriction.\(^2\)

In a study by Chu et al., high-quality evidence discovered that liberal oxygen therapy (median FiO2 of 52%) when not required, can increase mortality.\(^3\) Oxygen is a stable, non-toxic gas present abundantly in the atmosphere, but when it gains an electron, it can create a superoxide radical and become a reactive oxygen species (ROS). A ROS is an unstable molecule whose highly reactive nature is capable of harming DNA, proteins, and lipids by leading to apoptosis. Normally, at low oxygen concentrations (21% FiO2), cells have an extensive antioxidative defense mechanism against the continuous production of ROS. At higher oxygen concentrations (80% FiO2) the balance between the antioxidative mechanism and ROS production undergoes a mismatch. According to the study, systemic oxidation when quantified using plasma malondialdehyde concentration, revealed an increase in ROS with the administration of 80% FiO2.\(^2\) It is thought that oxidative stress is a common contributor in various pathological diseases.\(^2\)
In addition to an increase in ROS, hyperoxia can also lead to absorption atelectasis, which may increase pulmonary shunting. Atelectasis development during anesthesia is due to airway closure and is dependent on the percentage of oxygen delivered into the lungs. In healthy patients breathing high concentration oxygen, atelectasis in combination with inhibition of hypoxic pulmonary vasoconstriction increases right to left shunt. In a study by Edmark and colleagues, patients were assigned specific concentrations of oxygen during the induction of anesthesia; 12 patients were assigned 100% FiO2, 12 were assigned 80% FiO2, and the remaining 12 were assigned 60% FiO2. Data showed that atelectasis appeared in all patients on 100% FiO2 versus a smaller amount in the patients with atelectasis in the 80% group and 60% FiO2 groups. Similarly, increasing FiO2 at the same rates at the end of surgery will also favor atelectasis formation, persisting postoperatively.

Background

In 2014, approximately 14 million inpatient procedures were performed in United States hospitals. The Center for Disease Control (CDC) reported that 110,800 SSI occurred for inpatient surgeries within that year. The hospital-related cost is projected to be $12,000 to $35,000 per one SSI, leading to an estimated annual expense of 3-10 billion dollars in unqualified expenditures for SSI. SSI has the highest prevalence of all healthcare-associated infections nationwide and continues to remain a significant clinical problem associated with morbidity and mortality. Surgical site infection is specified as an infection occurring within 30 days after a procedure that involves the skin or subcutaneous layer of the incision (superficial incision) and/or deep tissue (muscle or fascia) of the incision (deep incision) and/or any area of the anatomy aside from the incision that was manipulated or opened during the procedure. In many incidences SSI arise from the patient’s endogenous flora rather than outside sources. Most common causes of organisms include Coagulase negative staphylococci, Staphylococcus aureus, Escherichia coli, and
Enterococcus. Infections classified as an SSI may either be superficial, deep, or infections involving body cavities or organs.  

Patients undergoing surgical procedures require ongoing surveillance in order to quantify data on the potential sequelae of SSIs. Patients who developed SSI are at an increased risk of admittance to an intensive care unit (ICU) or readmission to a hospital, as evidenced by Kirkland and colleagues’ control study involving 215 patients with and without SSIs. The occurrence of death was 2.2%; readmission, 5.5%; and ICU treatment, 1.6%. SSI patients were shown to require a longer duration of hospitalization as compared to uninfected patients, of 11 days as opposed to 6 days, respectively. Deep SSI involving body spaces and organs is associated with a more significant prolongation in hospitalization, attributing a further increased cost than SSI affecting a localize incision.

**Scope of the problem**

The utilization of high concentration FiO2 in the intraoperative setting has stirred interest for its role in reducing SSI. Every year, millions of patients undergo operations under general anesthesia. Oxygen is the most abundant drug used in the operative setting and is often titrated based on the anesthesia provider’s preference. The practice of using high-dose oxygen intraoperatively to prevent surgical infection varies among facilities. The choice of high inspired FiO2 differs based on providers, with each of these facilities following their own distinct guidelines and protocols on the necessary amount of oxygen needed to prevent SSI.  

**Consequences of the problem**

The complications of utilizing high concentrations of intraoperative oxygen (>80%) include increased oxidative stress, atelectasis, and hyperoxia vasoconstriction. Furthermore, a higher concentration of oxygen increases the expense of the procedure for facilities. Maintaining an inspiration flow of ≥2 L/minute is required to lessen the harmful effects of volatile agents and closed circular systems, limiting the formation of Compound A when Sevoflurane is used. Sevoflurane should not exceed 2 MAC hours at a flow <2L/min because doing so may potentiate
the risk for renal injury. Considering this in conjunction with the utilization of a liquid oxygen supply for the storage of large amounts of oxygen provides a further reason why it is important to analyze fresh gas flow (FGF). Fresh gas flow requires an application of combined medical air and oxygen to calculate a desired percentage of FiO2. When applying 2 liters per minute (LPM) of medical air and oxygen into the FiO2 concentration calculation, a Fio2 of 30% will use approximately 1.28 L/min less oxygen compared to a FiO2 of 80% at a FGF of 2 LPM. As such, the use of 30% of oxygen will obtain similar infection rates while lessening the financial burden to the patient. Furthermore, hyperoxia produced throughout the intraoperative period may lead to respiratory complications and increased mortality rates. In a trial by Grief et al., individuals who received 80% oxygen were shown to have greater atelectasis postoperatively and an increase in hospital stay, quantifying the further increase in cost to patients.

Gaps in Knowledge

Gaps in previous literature identified in this systematic review include the prevalence of SSI for different types of surgical procedures and oxygen delivery methods. Yearly a wide range of surgeries are performed in U.S. hospitals, with some having a disproportionately more significant percentage development of SSI than others. Types of surgical procedures linked with a greater probability of infection include breast and abdominal operations, both of which are referenced in this systematic review. Additionally, a greater number of SSI from surgery is likely linked to the duration of the operation. In one study, the probability of SSI increased with time increments; SSI increased by a 13%, 17%, and 37% margin for every 15, 30, and 60 minutes of surgery, respectively. The method of oxygen delivery is another vital component to consider. The oxygen delivery method such as simple mask versus endotracheal tube may impact the incidence of SSI. Consideration of these factors in this literature review will help to elucidate the multiple variables affecting SSI.

Systematic Review Rationale
New studies are being performed to investigate the correlation between a high oxygen concentration and its effect on SSI. Infections near or at the surgical site incision within 30 days of an operation classify as SSI, all of which contribute significantly to a patient’s morbidity and mortality. SSI accounts for 15% of all nosocomial infections. SSI has the potential to double the length of a hospital visit and thereby increase the cost to the patient. To combat SSI, it is vital to ensure that best practices for SSI prevention are implemented. Although controversial, data from one study found that the serum byproducts of high oxygen concentrations have high bactericidal action, which contributes to attenuating infections. Research to support this claim is inconsistent. Further scrutiny is needed to determine the impact of high O2 concentrations on surgical infection. This systematic literature review will investigate whether low concentration oxygen can contribute similar effects of high concentration fio2 in reducing SSI.

Objectives of Systematic Review

High fio2 concentrations given intraoperatively for SSI prevention have been linked to increasing patient expense and poor outcomes. This systematic review aimed to assess the best present RCTs concerning low dose fio2 (<30%) and its relation to SSI prevention. By determining if low dose intraoperative fio2 has similar rates in SSI prevention than high dose fio2, the harmful effects of increased oxygen use can thus be avoided in patients. The information obtained from this systematic review using databases CINAHL, MedLine, and Science Direct will then be compiled into an educational module to present to current anesthesia providers. The educational module aims to present updated and new information to anesthesia providers on the use of intraoperative fio2 and its relation to SSI and educate them on the importance of fair oxygen use.

METHODOLOGY OF LITERATURE REVIEW

Search Strategy

Due to a lack of studies on whether the use of high concentration oxygen has any impact on SSI, a literature review is needed. The Preferred Reporting Items for Systematic Reviews and Meta-
An analyses (PRISMA) checklist was utilized to direct the search and format of this literature review. The search strategy utilized electronic databases: Cumulative Index of Nursing and Allied Health Literature (CINAHL), Medline, and Science Direct electronic databases. Below in table 1, a comprehensive search database is shown detailing subject term headings, search terms, and filters used in each of the electronic databases. The PICO format was used to assist in the creation of keywords and filters to limit unrelated results in the database search table. The CINAHL database yielded 117 results, MEDLINE database had 1100 articles, and Science Direct had 293. In total, 1509 articles resulted from these three databases. After duplicates were removed, 1481 remained. This literature aims to provide the current evidence-based research on the utilization of the low dose fio2 for SSI as well as identify any apparent inconsistencies. The search criteria are provided in Table 1, the inclusion and exclusion criteria are provided in Table 2.

**Study Selection and Screening of Evidence**

The initial search of keywords and phrases into the three databases (CINAHL, Medline, and Science Direct) along with filters, yielded a total of 1509 articles. Twenty-eight duplicate articles were eliminated, leaving 1,481 articles. After eliminating duplicate articles, a further review of the literature was completed, and an investigation was conducted concerning the preliminary PICO question, considering the title, abstract, and body. Content appraisal consisted of one investigator for analysis and data collection on available literature. From the 1,481 journals, 1459 were eliminated, leaving 23 full-text articles to be screened for eligibility.

A thorough examination of the remaining journals was done through a full-text analysis based on a firm inclusion and exclusion criteria. Inclusion criteria consisted of: the incorporation of individuals greater than 18 years old, procedures where anesthesia was involved, strict fio2 settings, studies whose primary outcome was SSI, randomized control trial (RCT), English studies, and literature published no later than 2004. By applying these inclusion materials into data collection, 12 articles were excluded from the study for reasons such as inadequate fio2
settings, languages other than English, patients who required excess of 0.35 fio2, patients with COPD who are likely to experience respiratory depression at higher fio2, patients hemodynamically unstable before surgery, and preoperative sao2 <90% without supplemental oxygen. A manual assessment was completed and did not reveal any additional RCTs that met the criteria for this systematic review. All 6 of the journals incorporated are RCTs and successfully answered the PICO question, meeting eligibility requirements for inclusion into this systematic review. The primary outcome of a SSI in this systematic review is defined as an infection that developed within 30 days after an operation where an incision was manipulated or open during the procedure.

Table 1 (Data Search Table)

<table>
<thead>
<tr>
<th>Concepts/Tops</th>
<th>Oxygen</th>
<th>Infection</th>
<th>Surgery</th>
<th>Anesthesia</th>
<th>Filters Applied</th>
</tr>
</thead>
<tbody>
<tr>
<td>CINAHL</td>
<td>Oxygen OR Fio2 OR oxy* OR oxygenat* OR Fio2 OR “fraction of inspired oxygen” OR o2 OR “80%” “Eighty percent” OR “eighty-percent” OR “30%” OR “thirty percent” OR “thirty-percent”</td>
<td>Infection OR “surgical site infection” OR SSI OR contaminati on OR contaminat* OR bacteria* OR microb* OR sepsis OR septic</td>
<td>Perioperative OR Intraoperative OR intraop* OR “Operative Room” OR “OR” OR Surgery OR Surgical OR Surgical Anesthesia OR anesthes* OR anaesth*</td>
<td>• 117 results • After peer reviewed filter and available at FIU library filter applied, 116 results found</td>
<td></td>
</tr>
<tr>
<td>MEDLINE</td>
<td>Oxygen OR Fio2 OR oxy* OR oxygenat* OR Fio2 OR “fraction of inspired oxygen” OR o2 OR “80%” “Eighty percent” OR</td>
<td>Infection OR “surgical site infection” OR SSI OR contaminati on OR contaminat* OR</td>
<td>Perioperative OR Intraoperative OR intraop* OR “Operative Room” OR “OR” OR Surgery OR Surgical Anesthesia OR anesthes* OR anaesth*</td>
<td>• 1140 results • After peer reviewed filter and available at FIU library filter applied, 1100 results found</td>
<td></td>
</tr>
<tr>
<td>Keywords</td>
<td>Results Found</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-------------------------------------------------------------------------</td>
<td>---------------</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>“eighty-percent” OR “30%” OR “thirty percent” OR “thirty-percent”</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>bacteria* OR OR micro* OR sepsis OR septic</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oxygen OR Fio2 OR oxy* OR oxygenat* OR Fio2 OR “fraction of inspired oxygen” OR o2 OR “80%” Eighty percent OR “eighty-percent” OR 30%” OR “thirty percent” OR “thirty-percent”</td>
<td>337</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Infection OR “surgical site infection” OR SSI OR contamination OR contaminat* OR bacteria* OR micro* OR sepsis OR septic</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Perioperative OR Intraoperative OR intraop* OR “Operative Room” OR “OR” OR Surgery OR Surgical</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Anesthesia OR anesth* OR anaesth* OR OR</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>After peer reviewed filter and available at FIU library filter applied, 293 results found</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inclusion</td>
<td>Exclusion</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-----------</td>
<td>-----------</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Population:</strong></td>
<td>Population:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Male or Female</td>
<td>• Children (&lt;18 years old)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Age ≥ 18</td>
<td><strong>Type of procedure:</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Critical &amp; hemodynamically unstable patients</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Type of procedure:</strong></td>
<td><strong>Intervention:</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• General, Regional, MAC</td>
<td>• The use of a different oxygen concentration range other than areas similar to 30% and 80%.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Intervention:</strong></td>
<td><strong>Outcomes:</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Implementation of 30% fio2 or 80% fio2 and its impact on SSI</td>
<td>• Definitions/outcome not defined by the CDC.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Primary outcome:</strong></td>
<td><strong>Type of study:</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• The appearance of SSI as defined by the CDC and the criteria used to define it at the time</td>
<td>• Non-English</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Type of study:</strong></td>
<td>• Publication date pre-2004</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• English language</td>
<td>• Systematic reviews</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Randomized controlled trials</td>
<td>• Meta-analysis</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Publication date 2004-Present</td>
<td>• Questionnaire</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Dissertations/theses</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
RESULTS OF LITERATURE REVIEW

Study Selection

Initially, a total of 1509 journals resulted from the three databases. After duplicates were removed, 1481 journals remained. After a more in-depth review of the journal's abstracts and titles, a total of 23 full-text journals remained, which were then assessed for eligibility. Once a thorough investigation was concluded based on the strict inclusion and exclusion criteria, 12 journals were excluded for various reasons, including outcomes other than a decrease in SSI with high oxygen, level 2 and 3 evidence, studies not related to the CDC 30-day criteria for SSI, languages other than English, and patient population <18 years. In addition, a manual assessment of the search result’s reference list was performed and did not identify further RCTs that met the criteria for this systematic review. In the end, this systematic review resulted in the incorporation of 6 RCTs that addressed the PICO. Table 3 provides a summary of RCTs included in this review.

Table 3 (Studies Included in this Appraisal)

<table>
<thead>
<tr>
<th>Author (Year) &amp; Level of Evidence</th>
<th>Study, Participants, &amp; Interventions,</th>
<th>Findings in Control Groups</th>
</tr>
</thead>
<tbody>
<tr>
<td>Williams NL, Glover MM, Crisp C, Acton AL, Mckenna DS. (2013) Level 1 Quality A</td>
<td>179pts &gt;18yrs underwent a surgery Randomly divided into 2 groups- 87 pts in Group A and 92 in Group B</td>
<td>12 out of 83 (14.5%) SSI within the control group (30% fio2) 10 out of 77 (13.0%) in the trial group (80%)</td>
</tr>
<tr>
<td></td>
<td>Group A received 80% fio2 intraop, Group B received 30% fio2.</td>
<td></td>
</tr>
</tbody>
</table>


<table>
<thead>
<tr>
<th>Study</th>
<th>Patients &gt;18 yrs underwent a surgery</th>
<th>Randomly divided into two groups</th>
<th>Rate of infection was not significant 8.9% (80% fio2) vs. 9.4% (30% fio2).</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acosta J, Alberola MJ, Alcón A, et al.</td>
<td>740 pts</td>
<td>371 pts in Group A and 369 in Group B</td>
<td>Group A received 80% fio2 intraop, Group B received 30% fio2.</td>
</tr>
<tr>
<td>(2020) (55.3% for a fio2 of 80% vs. 40.4% for a fio2 of 30%).</td>
<td></td>
<td></td>
<td>Rate of infection: (55.3% for a fio2 of 80% vs. 40.4% for a fio2 of 30%).</td>
</tr>
<tr>
<td>Mayank M, Mohsina S, Sureshkumar S, Kundra P, Kate V (2013)</td>
<td>179 pts</td>
<td>47 pts in Group A and 47 in Group B</td>
<td>Group A received 80% fio2 intraop, Group B received 30% fio2.</td>
</tr>
<tr>
<td>Overall incidence of SSI was 10.8% in high concentration oxygenation group and 11% in standard concentration of oxygen.</td>
<td></td>
<td></td>
<td>SSI occurrence in 30 days with 7.2% for 30% fio2 and 6.6% in 80% fio2. No significant difference.</td>
</tr>
</tbody>
</table>
Study characteristics

The list of studies consists of a combined series of RCTs that analyzed an extensive list of patients investigating whether low dose fio2 given intraoperatively has the same impact on SSI as high dose fio2. All studies utilized in this review were published from 2012 to 2020. The patient demographics and age group were not significantly different across the six studies except for the two, which focused on obstetric patients undergoing a C-section.

Risk of Bias

The Cochrane Handbook Collaboration’s Risk of Bias Tool was used throughout this review to assess any bias in all six included studies. All six of the studies utilized a randomized control trial where participants were randomly allocated into groups. Individual evaluations measured outcomes with patient interaction. However, Kurz et al. outcomes were gathered by the colorectal department and billing system instead of individualized evaluation and chart system to evaluate infections that occurred outside the hospital. Unlike other studies, Acosta and William's limitations included a difference in surgical technique among the providers and skill level. Also, William and Admade had a patient population of mother’s undergoing Cesarean section who used a facemask throughout the case instead of receiving General anesthesia.

DISCUSSION OF LITERATURE REVIEW

Summary of Evidence
The studies chosen to be included in this systematic review were evaluated using the John Hopkins research evidence appraisal tool. The Johns Hopkins’ quality rating scheme for evidence in research has three grades: high, good, or low. A high-quality rating is comprised of consistent, generalizable results. Within this grade, there is a sufficient sample size for the study, adequate control group, and definitive conclusions. A good-quality grade is classified as having reasonably consistent results with sufficient sample size, some control, and fairly definitive conclusions. Low-quality grade has little supportive evidence with inconsistent results, an insufficient sample size, and unsatisfactory conclusions.

Subsequently, after the evaluation of each study, each had a quality rating given to them based on the John Hopkin’s research evidence appraisal tool. All journals obtained were double-blinded RCTs. Information obtained from them were evaluated based on: (1) the study design and method, (2) sample characteristics and size, (3) setting of the study, (4) ASA of the patient, (5) fio2 setting, (6) data analysis, (7) data outcomes measured, (8) study findings, (9) study conclusions.

**Limitations of Systematic Review**

Acknowledging the limitation presented in this systematic review will help to identify the cause for future research. Restraints presented within this systematic review include the focus on a specific type of patient population, language, provider’s skill level, and the result’s measurement. Williams, Mayank, and Admade primarily focused on a specific patient population within their study, not incorporating more significant patient selection groups within their study. Both Willam and Admade only focused on pregnant females undergoing a cesarean section. Within this study's duration, oxygen was delivered to participants via facemask, and general anesthesia was not utilized. In comparison, Mayank et al. focused solely on colorectal patients receiving general anesthesia via endotracheal tube. This systematic review had an inclusion criterion of using English peer-reviewed articles, excluding journals in other languages, leading to a limited conclusion and data.
Recommendations for Future Research

To more accurately determine if low dose fio2 given intraoperatively is a better choice in preventing SSI than high dose fio2, further studies are needed. A greater number of RCTs with larger sample sizes would ensure an absolute result. Future RCTs should include more monitored anesthesia care (MAC) cases to get better generalizability when incorporating the other RCTs in conclusion. Furthermore, a more comprehensive range of different surgery modalities would be beneficial for the study to be considered universal. Both regional anesthesia and MAC surgeries should be incorporated into reviews to determine if they significantly contribute to SSI occurrence.

In addition, studies should assess how harmful high dose oxygen can be to the patient. Evaluation of the patient population and any comorbidities prior to implementation of the studies will help conclude the precision of the final data. Preexisting data has already shown that high dose oxygen is related to an increase in adverse effects, but further data is needed to quantify the onset of these harmful effects and their severity. Lastly, no studies examined the cost-benefit ratio of patients receiving low dose fio2 compared to high dose fio2.

CONCLUSION OF LITERATURE REVIEW

The use of high dose intraoperative Fio2 for the prevention of SSI remained a controversial topic to date, with a polarizing view that high dose oxygen (>80% fio2) has greater rates of SSI prevention than low dose oxygen (<30% fio2). Throughout this study, multiple RCTs were scrutinized to ascertain an answer. Previous data has shown that intraoperative hyperoxia is related to an increased cost to the patient and adverse effects such as increased oxidative stress, atelectasis, and hyperoxia vasoconstriction. The liberal use of oxygen to reduce SSI ultimately harms the patient. In this literature review, data from the 6 RCTs showed that low dose fio2 given intraoperatively has similar rates in SSI prevention than high dose fio2, thus, lessening adverse effects of abundant oxygen use and decreasing patient expense.

METHODOLOGY OF QUALITY IMPROVEMENT
Setting

The setting of this QI project took place across three hospitals located in Broward County, Florida. Broward Health Medical Center contains 716 beds, Broward Health North contains 409 beds, and Broward Health Coral Springs contains 200 beds.

Recruitment and Participants

Participants allowed to take part in the educational module include all Anesco anesthesia providers, including physician anesthesiologists, CRNAs, and AAs. Only Anesco CRNAs participated in the educational module. No other Broward Health employee participated.

Recruitment of participants involved several methods. The participant's email address was obtained from the supervising DNA (department of nursing anesthesiology) facility; subsequently, a recruitment letter was sent out outlining the project’s purpose, surveys, and the educational module. Additionally, the DNP candidate visited each of the clinical sites to promote participation in the intervention. No compensation was provided to the applicants.

Intervention & Procedures

This Quality Improvement project aims to increase anesthesia providers' knowledge and motivation in utilizing best practices on intraoperative fio2 link to SSI. The goal was to measure the provider’s knowledge, beliefs, and attitudes about the importance of liberal oxygen use and follow up after the educational intervention.

The approved Internal Review Board (IRB) protocols were obtained before initiating the DNA project. The use of the official IRB Determination Form was submitted to Broward Health following FIU's approval of the DNA candidate's quality improvement project. The education module then received IRB exemption status before being deployed to the CRNAs employed at Broward Health by Anesco. All questions and concerns from Broward Health had been addressed thoroughly; these concerns include HIPPA regulations, student-patient interactions, and involvement of human testing. A detailed explanation was given to the facility explaining this is a quality improvement project evaluating the anesthesia staff knowledge of SSI and its
correlation to Fio2 percentage, and that no direct patient care or study will be conducted. Contact information was also made available to the group to contact the DNA candidate at any time with questions or concerns.

Upon Broward's consent to participate in this quality improvement project, a step-by-step plan was initiated. In this plan, no date was selected to allow for a face-to-face meeting due to the entirety of the educational portion of this project occurring virtually. An email list of all members of Broward Health anesthesia faculty was obtained from FIU’s DNA facility. With this list, an email was sent to each participant's Broward listed email with detailed instruction on how they can enter this project along with an embedded link directing them to Qualtrics, a web-based survey tool to conduct survey research, evaluations, and other data collection activities. Upon entering Qualtrics, the partaker was directed to answer a 5-minute, 10 question pre-survey, followed by viewing a 10-minute educational PowerPoint, and subsequently answering by a 5-minute post questionnaire, all of which was anonymous. A unique code identified was created for the survey, and no personal identifiable information was captured. All attendees were required to complete the anonymous survey before the educational session to ascertain their existing beliefs, knowledge, and confidence on the topic of a high and low fraction of inspired oxygen in the prevention of surgical site infection in patients receiving anesthesia. The PowerPoint presentation began with current data of SSI and high Fio2: incidence and prevalence, the benefit of low fio2, and obstacles on the use of low fio2. The presentation also included an in-depth summarization of end goals and recommendations for the use of low fio2 in preventing SSI.

Protect of Human Subjects

No direct patient contact took place during this QI project; the human subjects within the study were nurse anesthetists. There was no anticipated risk to the DNP student or clinical personnel at any time during this project. The DNP candidate did not have any access to patient information or records, nor was there any discussion on this matter. The survey dispersed to the clinician providers did not identify any data other than their clinical title (i.e. CRNA or MD/DO).
Any data collected were analyzed, evaluated, and stored at the DNP candidate's home in a password-protected computer. The Institutional Review Board determined that based on this QI project's design, it did not meet the criteria for human subject research and thus exempted.

**Data Collection**

The DNP candidate developed an anonymous, self-reported 9 question online survey for all participating facilities before the presentation. Please see Appendix G for the complete questionnaire. Software utilized for the questionnaire is Qualtrics, a web-based survey tool to conduct research and evaluation. The survey also utilized a Likert scale approach for two additional questions and measured the following: the provider's likelihood of using low dose fio2 intraoperatively and the provider's likelihood using other methods of preventing SSI than high dose fio2. After viewing the educational PowerPoint, the DNP candidate submitted the same survey to the study's original participants to re-measure their knowledge, attitudes, and beliefs regarding their approach in applying oxygen to the management of SSI. Information from the educational PowerPoint was provided utilizing an onscreen pre-recorded video.

**Measurement and Analysis**

Data obtained from the Qualtrics survey was exported to Microsoft Excel and analyzed using SPSS. Inferential statistics accomplished analysis of the responses from the pre-and post-test survey. A paired T-test was implemented to determine if there was any meaningful change in attitudes or knowledge in the CRNAs after implementing the education module about oxygen and its relationship to SSI prevention.

For the questions utilized, the available responses were given a score. The mean score for each question was determined after administering the pre-survey. After administration of the pre-test, a post-survey was dispersed using identical questions and calculation of a mean score. If the P value's confidence level is 95%, this would indicate improved self-reported knowledge, attitudes in screening, beliefs, and facilitating self-practice of intraoperative low fio2. A decrease
in scores and unchanged scores indicated a lack of change in self-reported knowledge, attitudes, and beliefs.

RESULTS OF QUALITY IMPROVEMENT

Pre-test and Post-test Sample

The participant demographics are displayed in Table 4 below.

Table 4 Demographics

<table>
<thead>
<tr>
<th>Demographic</th>
<th>n (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Participants</td>
<td>5 (100.00%)</td>
</tr>
<tr>
<td><strong>Gender</strong></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>0 (00.00%)</td>
</tr>
<tr>
<td>Female</td>
<td>5 (100.00%)</td>
</tr>
<tr>
<td><strong>Ethnicity</strong></td>
<td></td>
</tr>
<tr>
<td>White</td>
<td>2 (40.00%)</td>
</tr>
<tr>
<td>African American</td>
<td>0 (00.00%)</td>
</tr>
<tr>
<td>Hispanic</td>
<td>3 (60.00%)</td>
</tr>
<tr>
<td>Asian</td>
<td>0 (00.00%)</td>
</tr>
<tr>
<td>Other</td>
<td>0 (00.00%)</td>
</tr>
<tr>
<td><strong>Age</strong></td>
<td></td>
</tr>
<tr>
<td>20-30</td>
<td>0 (00.00%)</td>
</tr>
<tr>
<td>30-50</td>
<td>2 (40.00%)</td>
</tr>
<tr>
<td>&gt;50</td>
<td>3 (60.00%)</td>
</tr>
<tr>
<td><strong>Education</strong></td>
<td></td>
</tr>
<tr>
<td>Bachelors</td>
<td>0 (00.00%)</td>
</tr>
<tr>
<td>Masters</td>
<td>1 (20.00%)</td>
</tr>
<tr>
<td>Doctorate</td>
<td>4 (80.00%)</td>
</tr>
<tr>
<td>Other</td>
<td>0 (00.00%)</td>
</tr>
<tr>
<td><strong>Position/Job</strong></td>
<td></td>
</tr>
<tr>
<td>CRNA</td>
<td>5 (00.00%)</td>
</tr>
<tr>
<td>Anesthesia Assistant</td>
<td>0 (00.00%)</td>
</tr>
<tr>
<td>Physician Anesthesiology</td>
<td>0 (00.00%)</td>
</tr>
<tr>
<td><strong>Years of Experience</strong></td>
<td></td>
</tr>
<tr>
<td>&lt;1</td>
<td>1 (20.00%)</td>
</tr>
<tr>
<td>1-5</td>
<td>1 (20.00%)</td>
</tr>
<tr>
<td>6-10</td>
<td>0 (00.00%)</td>
</tr>
<tr>
<td>&gt;10</td>
<td>3 (60.00%)</td>
</tr>
</tbody>
</table>
Five total participants completed the pre-test and post-test survey. The gender of the participants shows that all were female. Ethnicities revealed 2 (40%) were white and 3 (60%) were Hispanics. Participants' level of education was 1 (20%) with a master's and 4 (80%) with a doctorate. Years of experience vary between the members, with 20% having < 1-year experience, another 20% with 1 to 5 years, and 60% having >10 years. All of the individuals who participated in this study were CRNAs.

Data Analysis

Five CRNAs competed in both the pre and post-test survey. The overall average scores for the pre-test were 2.44 (SD=1.58), and the overall scores for the post-test were 4.00 (SD =1). The average post-test increased by 1.60 when compared to the pre-test, indicating a P value of 0.02, which is below the statistically significant indicator of 0.05. The paired T test results reveal a statistically significant knowledge base increase from the pre-test to the post-test as a result of the education module.

Pre-Test Knowledge

A knowledge deficit exists in this subject based on the pre-test results and its mean score of 49% correct among the five participants. Participants were knowledgeable on classifying low dose fio2 and measures used to prevent SSI, with individuals scoring 80% and 100% correctly, respectively. Questions most notable in the survey include what providers are using high dose fio2 for, the percent concentration of high dose fio2, and the adverse effects of high dose fio2. 20% of participants gave the correct answer of SSI for the first question, 0% answered the correct answer of 80% fio2 for the second question, and only 20% responded correctly to all of the above. An education module on this topic is further proven to be needed, as evidenced when applicants were asked to answer what healthcare-associated infection has the highest mortality and the number of days within the surgery is an SSI classified. Just 60% believed SSI had the highest mortality rate, and only 40% correctly answered that CDC classification for SSI is
<30 days within an operative procedure. Lastly, 60% of participants acknowledge a variability exists in the provider's choice in intraoperative \textit{fio}2, and 20% somewhat believe a variability.

**Post-Test Knowledge**

On the post-test, all five participants had a marked improvement in their results with a mean score of 80% compared to 49% in the pre-test. All participants again successfully answered the topics they were previously shown to be knowledgeable in. These topics included classifying low dose \textit{fio}2 and measures used to prevent SSI, all being answered 100% correctly. For the most notable questions in the survey, which include what providers are using high dose \textit{fio}2 for, the percent concentration of high dose \textit{fio}2, and the adverse effects high \textit{fio}2 can lead to, rose from 20% to 80%, 0% to 60%, and 20% to 100% being correctly answered, in their respective order.

The increased effectiveness of this education module is further evident by the improved participant's score answering what healthcare-associated infection has the highest mortality and how many days within the surgery is an SSI classified; both of these questions rose from 60% to 80% and 40% to 60% correctly answered. Participants further acknowledge an increase in variability of anesthesia providers' use of \textit{fio}2 throughout surgery, with 60% acknowledging it and 40% somewhat acknowledging. Lastly, when asked the most common cause of SSI, the score of this question did not change; 60% answered correctly that \textit{S. Aureus, Coagulase S. Aureus, and enterococcus} have attributed to SSI.

<table>
<thead>
<tr>
<th><strong>Table 5: Difference in Pre- and Post-Test Findings</strong></th>
<th>Pre-Test</th>
<th>Post-Test</th>
<th>Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>What is consider low dose \textit{fio}2?</td>
<td>80.00%</td>
<td>100.00%</td>
<td>20.00%</td>
</tr>
<tr>
<td>What is consider high dose \textit{fio}2?</td>
<td>00.00%</td>
<td>60.00%</td>
<td>60.00%</td>
</tr>
<tr>
<td>In this project what are providers/hospitals using as high dose intraoperative oxygen for?</td>
<td>20.00%</td>
<td>100.00%</td>
<td>80.00%</td>
</tr>
<tr>
<td>What does the CDC classify as SSI?</td>
<td>40.00%</td>
<td>60.00%</td>
<td>20.00%</td>
</tr>
<tr>
<td>Which of the following health care associated infection has the highest morbidity and mortality?</td>
<td>60.00%</td>
<td>80.00%</td>
<td>20.00%</td>
</tr>
<tr>
<td>A high \textit{fio}2 can lead to?</td>
<td>20.00%</td>
<td>100.00%</td>
<td>80.00%</td>
</tr>
</tbody>
</table>
**Select two methods of preventing SSI?**

<table>
<thead>
<tr>
<th></th>
<th>100.00%</th>
<th>100.00%</th>
<th>00.00%</th>
</tr>
</thead>
</table>

**Does the choice of fio2 largely varies with facilities?**

<table>
<thead>
<tr>
<th></th>
<th>60.00%</th>
<th>60.00%</th>
<th>00.00%</th>
</tr>
</thead>
</table>

**Most common causes of SSI?**

<table>
<thead>
<tr>
<th></th>
<th>60.00%</th>
<th>60.00%</th>
<th>00.00%</th>
</tr>
</thead>
</table>

---

**Graph 1. Pre-Test/Post-Test Knowledge**

- Most common causes of SSI
- Fio2 variation facilities
- Preventing SSI
- High Fio2 leads to
- Highest HAI M&M
- CDC classification of SSI
- Provider use for high fio2
- high dose fio2
- low dose fio2

---

**Graph 2. Pre-Test/Post-Test Percent Average of Correct Responses**

- 49%
- 80%

---

**Pre-Test Versus Post-Test Confidence**

Both the pre and post-test had two Likert questions used to evaluate the efficacy of the teaching and assess whether the education provided will impact the participant’s future clinical
practice. On all tests, the participants identified in either the extremely likely, somewhat likely, or neither likely nor unlikely category. When asked how likely they are to consider not using a high fio2 as a protective measure in preventing SSI, 60% were extremely likely, 20% were somewhat likely, and 20% were extremely unlikely. After the teaching module, 80% were extremely likely to not use high fio2 as a protective measure in preventing an SSI, and 20% were somewhat likely. In the second Likert question, the five participants were asked how likely they were to use other methods of preventing SSI rather than high intraoperative fio2; 40% were extremely likely, 40% were somewhat likely, and 20% were extremely unlikely. Post teaching, 100% of participants were extremely likely to use other methods of preventing SSI rather than high intraoperative fio2. A visual representation is shown in both Graph 3 and Graph 4.

In table 6, further elucidation is provided displaying the pre- versus the post-test likelihood of participants who are extremely likely to not use high fio2 as a protective measure in preventing SSI and those who are extremely likely to use other methods of preventing SSI rather than high intraoperative fio2. The results in the table below do not consider the other options in these two survey questions, such as somewhat likely or unlikely and extremely unlikely. Only extremely likely results are shown in this table. The results displayed on the table show a 20% increase in participants' likelihood of not using high fio2 as a protective measure in preventing SSI and a 60% increase in providers using other methods to prevent SSI rather than high intraoperative fio2.

<table>
<thead>
<tr>
<th>Table 6: Difference in Pre- and Post-Test Confidence</th>
<th>Pre-test</th>
<th>Post-test</th>
<th>Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>How likely are you to consider not using high fio2 as a protective measure in preventing SSI?</td>
<td>60.00%</td>
<td>80.00%</td>
<td>20.00%</td>
</tr>
<tr>
<td>How likely are you to use other methods of preventing SSI rather than high intraoperative fio2?</td>
<td>40.00%</td>
<td>100.00%</td>
<td>60.00%</td>
</tr>
</tbody>
</table>
Perspective of Use in Practice

Based on the evidence of the study, results show that <30% and >80% fio2 have the same rates in SSI prevention. Implementing this teaching project to anesthesia providers has displayed a general increase in understanding why low fio2 should be preferred and introduced to more hospitals nationwide; this is evident by the nine survey questions and the two Likert questions within the survey. The average score of the five participants for the eight survey questions rose from 49% to 80% when comparing the pre-test to the post-test, indicating a
significant improvement. In the first of the two Likert post-test questions, participants acknowledge that high fio2 has the same rate of SSI prevention as low dose fio2, thus, providing no additional benefit to patients undergoing surgery and only adding further financial expense and harm. The second post-test Likert question verified that the anesthesia provider understood alternative methods in preventing SSI rather than maintaining a high intraoperative fio2 during surgery; methods including the utilization of low fio2, prophylactic antibiotics, and glucose control provide more efficient measures in the prevention of SSI.

DISCUSSION OF QUALITY IMPROVEMENT

Limitations

Limitations in this analysis that may pose a risk to the accuracy of the survey include the uncertainty of the participant's sincerity when answering the sample questions and the relatively small sample size of the participants. It is unknown how seriously the subject took their role as a participant in the questionnaire and may have accidentally altered the accuracy of results by quickly answering the survey questions without careful consideration of the answer choices. Many of the staff members at Broward Health Hospital know this project is part of the student's DNP requirement and may have inattentively completed their part of the questionnaire just to satisfy the DNP candidate's school requirement. In addition, the sample size of the study contained just five persons. Having a small sample size may inadvertently reduce the power of the analysis and increase the margin of error, leading to a higher variability, which may lead to bias. The most common bias is a result of non-response. Non-response occurs when some subjects do not have the chance to participate in the survey, this may be due to potential participants not having access to their work email that the survey link was sent to or reduced access to complete the survey due to the limited time frame of the questionnaire.

Future Implications to Advanced Nursing Practice

The study results have proven to be effective in educating anesthesia providers on the importance of low intraoperative fio2 and its relation to SSI prevention. The results of this
education module revealed that this topic was necessary to discuss and teach to the anesthesia community. High-dose intraoperative oxygen should not be liberally used to lessen SSI as evident by the literature and statistics provided; instead, other methods should be explored. The same can be stated to other topics in the medical community. Previous topics that are thought to have a gold standard already should again be examined to determine if the current practice is up to date. The reluctance to change into newer and more efficient practice may not always be seamless and accepting. However, it will allow patients to receive the highest quality of care.

The anesthesia providers who participated in this education module demonstrated an increase in knowledge and understanding that freely using high intraoperative fio2 has been associated with adverse outcomes in individuals such as oxidative stress, atelectasis, and hyperoxia vasoconstriction. Future practice should include the use of an intraoperative fio2 <30% throughout the case with exceptions such as induction and emergence of anesthesia; this percentage of oxygen will serve as a baseline and in addition be adjusted based on patient medical history, surgical technique, and inability to maintain a Spo2 >90%. Traditional methods of preventing SSI such as glucose control, prophylactic antibiotics, and the use of antiseptic soap should not be abandoned to implement this intervention solely. Moreover, using a low fio2 percentage will provide greater cost-effectiveness for patients, saving roughly 1.28 L/min of oxygen.

**CONCLUSION**

The use of high dose intraoperative Fio2 for the prevention of SSI remained a controversial topic to date, with a polarizing view that high dose oxygen (>80% fio2) has different rates of infection prevention as low dose oxygen (<30% fio2). Throughout this analysis, 6 RCTs were scrutinized to ascertain an answer. Previous data has shown that intraoperative hyperoxia is related to increased patient costs and adverse effects. By liberally using oxygen with the attempt of lessening SSI, more harm will come to the patient. In this quality improvement
project, the primary aim is to educate anesthesia providers that low fio2 during surgery has similar rates in SSI prevention as high dose oxygen, thus avoiding the potentially harmful effects of increased fio2.

An educational module was conceived and implemented within this project centered on evidence-based research and the most advanced clinical practice. Upon creating this educational module, it received IRB approval exemption status prior to being deployed to the CRNAs employed at Broward Health. The CRNAs who participated in this project did so voluntarily and remained anonymous. Each one of the participants took a pre-test followed by viewing the education module and then a post-test to compare if an increase in knowledge occurred. Results concluded that providers gained significant knowledge after completing the education module and an increased likelihood of recommending low-dose fio2 for SSI prevention.
References


**Appendix A: PRISMA Diagram**

- Literature databases searched: CINAHL, Medline, and Science Direct (n = 1509)
- Duplicates removed (n = 28)
- Records screened (n = 1,481)
  - Records excluded (n = 1,459)
  - Articles assessed for eligibility (n = 23)
    - Articles excluded (n = 12)
      - 4 = Wrong outcome
      - 5 = Wrong interventions
      - 5 = Wrong study design
      - 2 = Wrong patient population
      - 1 = Wrong language
- Studies included in qualitative synthesis (n = 6)
### Appendix B: The Matrix

<table>
<thead>
<tr>
<th>Citation and Theme of the article</th>
<th>Design/Method</th>
<th>Sample/Setting</th>
<th>Major Variables Studied and Their Definitions</th>
<th>Measurement And Data Analysis</th>
<th>Findings</th>
<th>Results</th>
<th>Conclusions</th>
<th>Appraisal: Worth to Practice/Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Williams NL, Glover MM, Crisp C, Acton AL, Mckenna DS. Randomized Controlled Trial of the Effect of 30% versus 80% Fraction of Inspired Oxygen on Cesarean Delivery Surgical Site Infection. <em>American Journal of Perinatology</em>. 2013; 30(9):779-786. doi:10.1055/s-0032-1333405</td>
<td>RCT evaluating whether 30% or 80% fio2 intraop and 2hrs after c-section delivery. Purpose of study is to evaluate whether high concentration oxygen perioperative reduces SSI after c-section delivery.</td>
<td>An entire of 179 pts were involved and randomized in the study at Miami Valley Hospital. N= 87 who received 80% fio2. N= 92 who received 30% fio2. 9 were discontinued from 30% group. 6 were discontinued from 80% group. Independent variable. IV1 is 30% oxygen vs 80% oxygen administration. Dependent variable. DV1 is surgical site infection, endometriosis. Data were tabulated and analyzed using logistic regression models, two-tailed Fisher exact test, and t test. Nominal measurement. SSI was defined using CDC terms. SSI is any infection that occurred 30 days of surgery in the body part when the surgery occurred. Endometritis considered SSI in this study and met criteria when temperature &gt;38C with uterine tenderness.</td>
<td>160 pts included in the study from the original 179. 12 out of 83 (14.5%) SSI within the control group (30% fio2) vs 10 out of 77 (13.0%) in the trial group (80%)</td>
<td>80% supplemental fio2 did not lessen SSI within the participants. Perioperative 80% FIO2 shows no effective in lessening SSI following c-section delivery.</td>
<td>Strength: RCT study; high-risk obstetric population Limitation: skill level of the surgeon, surgical technique, use of a pulse oximeter to measure oxygen levels instead of ABO or VBG, use of face mask and oxygen blender.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Citation and Theme of the article</td>
<td>Design/Meth od</td>
<td>Sample/Setting</td>
<td>Major Variables Studied and Their Definitions</td>
<td>Measurement And Data Analysis</td>
<td>Findings</td>
<td>Results</td>
<td>Conclusions</td>
<td>Appraisal: Worth to Practice/Level</td>
</tr>
<tr>
<td>----------------------------------</td>
<td>---------------</td>
<td>----------------</td>
<td>---------------------------------------------</td>
<td>-------------------------------</td>
<td>----------</td>
<td>--------</td>
<td>-------------</td>
<td>----------------------------------</td>
</tr>
<tr>
<td>Acosta J, Alberola MJ, Alcón A, et al. Effects of oxygen on post-surgical infections during an individualized perioperative open lung ventilatory strategy: a randomized controlled trial. <em>British Journal of Anaesthesia</em>. 2020;124(1):110-120. doi:10.1016/j.bja.2019.10.009</td>
<td>RCT. Patients admitted for abd surgery are randomize to either to receive high oxygen concentration (80%) or low oxygen (30%) during intraop and 3 hours after surgery. Study purpose is to determine if high oxygen concentration given intra and postoperatively has any impact in open-lung ventilation pts and SSI.</td>
<td>740 total patients. N= 371 who received 80% oxygen. N= 369 who received 30% oxygen. 23 individuals excluded from study due to exclusion criteria, withdrew consent, or surgery never performed. Study was conducted in 21 university hospitals.</td>
<td>Independent variable. IV1 is 30% oxygen vs 80% oxygen administration. Dependent variable. DV1 is surgical site infection; DV2 is systemic complications; DV3 is length of intensive care and hospital care; DV4 is 6-month mortality.</td>
<td>Primary outcome: incidence of SSI as defined by the CDC’s criteria and evaluated by impartial surgeons Secondary outcomes: SSI within first 30 days after surgery. Patient evaluations will be performed by the same independent surgeons.</td>
<td>740 total subjects: 371 pts in 80% fio2 group and 369 in 30% fio2 group. Rate of infection was not significant during the first postoperative week: 8.9% (80% fio2) vs 9.4% (30% fio2). Secondary outcomes: atelectasis (7.7% compared to 9.8%) and MO (0.6% compared to 0%) did not differ.</td>
<td>Lower concentration of oxygen yields similar results as compared to higher concentration. An oxygenation strategy using high FIO2 compared with conventional FIO2 did not reduce postoperative SSIs in abdominal surgery. Utilizing high fio2 as a strategy in lessening SSI has shown not to be effective in abd surgery. Secondary outcomes shown no impact.</td>
<td>Strengths: Effectiveness of fio2 in maintaining pao2 was optimized; protocols regarding fio2 and OLA strategies were strictly followed; intraoperative and postoperative factors related to SSI were protocolized; postoperative complications were defined and standardized. Limitations: difference in surgical techniques and mix of operative procedures.</td>
<td></td>
</tr>
<tr>
<td>Citation and Theme of the article</td>
<td>Design/Method</td>
<td>Sample/Setting</td>
<td>Major Variables Studied and Their Definitions</td>
<td>Measurement And Data Analysis</td>
<td>Findings</td>
<td>Results</td>
<td>Conclusions</td>
<td>Appraisal: Worth to Practice/Level</td>
</tr>
<tr>
<td>----------------------------------</td>
<td>---------------</td>
<td>----------------</td>
<td>---------------------------------------------</td>
<td>--------------------------------</td>
<td>----------</td>
<td>---------</td>
<td>-------------</td>
<td>----------------------------------</td>
</tr>
</tbody>
</table>
| Mayank M, Mohsina S, Sureshkumar S, Kundra P, Kate V. Effect of Perioperative High Oxygen Concentration on Postoperative SSI in Elective Colorectal Surgery-A Randomized Controlled Trial. *J Gastrointest Surg.* 2019;23(1):45-152. doi:10.1007/s11605-018-3996-2 | Bliad RCT of 97 patients undergoing colorectal surgery. 47 pts receive 80% fio2. 47 receive 30% fio2. Study done to investigate the benefit of perioperative high fio2 on SSI in elective colorectal sx patients. Study conducted as a single center, blind RCT in a tertiary care center in South India over a span of 2 years. Ages > 18 underwent elective colorectal sx. | Independent variable. IV1 is 30% oxygen vs 80% oxygen administration. Dependent variables include detection of SSI, grade of SSI (superficial, deep, organ/space), incidence & rate of anastomotic leak, day leak was detected, day bowel sounds returned, day patient ambulated, and patient length of hospitalization | Statistical analysis was accomplished utilizing SPSS 19.0. Difference in SSI rates was examined via chi square test. Differences in the anastomotic leak was tested via chi square test. Wound assess daily via AEPSIS criteria. >20 score indicates SSI. SSI classify per CDC infection within 30 days. | 94 total pts. 47 high fio2 and 47 and 47 in low fio2. SSI rate was 55.3% in high fio2 group and 40.4% in standard fio2. However, difference was not statistically significant. | There was no significant difference in the rate of SSI with the use of perioperative high oxygen concentration in patients undergoing elective colorectal surgery | *Strength: RCT study; explicit guidelines were followed; 0% attrition rate; clients followed up with results Limitation: The baseline rate of SSI in the study’s population was more than the past studies; limited only to colorectal patient.*
<table>
<thead>
<tr>
<th>Citation and Theme of the article</th>
<th>Design/Method</th>
<th>Sample/Setting</th>
<th>Major Variables Studied and Their Definitions</th>
<th>Measurement And Data Analysis</th>
<th>Findings</th>
<th>Results</th>
<th>Conclusions</th>
<th>Appraisal: Worth to Practice/Level</th>
</tr>
</thead>
</table>
| Thibon P, Borgey F, Boutreux S, Hanouz JL, Le Coutour X, Parienti JJ. Effect of perioperative oxygen supplementation on 30-day surgical site infection rate in abdominal, gynecologic, and breast surgery: the ISO2 randomized controlled trial. *Anesthesiology*. 2012;117(3): 504-511. doi:10.1097/ALN0b013e3182632341 | RCT of 434 pts comparing high fio2 (80%) to standard fio2 (30%) and their relation to SSI in routine gynecologic, abd, and breast. | 434 patients underwent randomization. 208 patients allocated to 30% perioperative fio2 and 226 assigned to 80%. Four were lost to follow up. Study was conducted at François Baclesse Cancer Institute, at Caen University Hospital, at the Saint Martin Private Hospital, and at Coutances Hospital. | Independent variable. IV1 is 30% oxygen vs 80% oxygen administration. Dependent variable. DV1 is surgical site infection; DV2 is desaturation; DV3 is bradycardia; DV4 is nausea and vomiting; DV5 is atelectasis. | National Nosocomial Infection System risk index 21: tool was used to assess the chance of infection. Score 0 to 3 (highest risk). Scoring takes into consideration ASA, duration of sx, and wound class.  
SSI defined by CDC. All SSI occurring within 30 days of surgery. | 208 pts received 30% fio2 intraoperatively and 226 received 80%. Overall, no significant difference in SSI between the two.  
SSI occurrence in 30 days with 7.2% for 30% fio2 and 6.6% in 80% fio2.  
Adverse effect such as n/v, cough, hypotension, sternal pain) was similar among the two groups. | Intraoperatively 80% fio2 do not lower the frequency of SSI in the first 30 days for breast, gynecologic, and abdominal post-surgery. | Hyperoxygenation with 80% fio2 intraoperatively did not lower SSI in breast, gynecologic, and abd surgery. In addition, it had no further accompanyin g adverse effect as compared to 30% fio2. | Strength: RCT study; The two fio2 groups were similar in the patient population and characteristics  
Limitation: protocol was not able to be upheld for the entire length of the operation in 13 cases; sample size; enrollment difficulties; abruptly ended because of time restraints; surprised much lower than predicted SSI in the control group. |
<table>
<thead>
<tr>
<th>Citation and Theme of the article</th>
<th>Design/Method</th>
<th>Sample/Setting</th>
<th>Major Variables Studied and Their Definitions</th>
<th>Measurement And Data Analysis</th>
<th>Findings</th>
<th>Results</th>
<th>Conclusions</th>
<th>Appraisal: Worth to Practice/Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kurz A, Kopyeva T, Suliman I, Podolyak A, You J, Lewis B, Vlah C, Khatib R, Keebler A, Reigert R, Seuffert M, Muzie L, Drahuschak S, Gorgun E, Stocchi L, Turan A, Sessler DI. Supplemental oxygen and surgical-site infections: an alternating intervention-controlled trial. Br J Anaesth. 2018 Jan;120(1):117-126. doi: 10.1016/j.bja.2017.11.003. Epub 2017</td>
<td>Blind RCT of 5749 patients undergoing intraoperative surgery. 2896 randomized receive 80% oxygen. 2853 randomized receive 30% oxygen. Study conducted to determine whether 80% or 30% fio2 reduces the 30-day risk of SSI, complications, &amp; mortality.</td>
<td>8097 original participates. 2348 excluded, leaving 5749 to be analyzed. N=2896 who received 80% fio2. N=2853 who received 30% fio2. Excluded: surgeries where o2 data is not available, reoperations during single hospital visit, and pediatric patients (&lt;18 years). Study conducted at Cleveland Clinic.</td>
<td>Independent variable. IV1 is 30% oxygen vs 80% oxygen administration. Dependent variable. DV1 is surgical site infection; DV2 is superficial SSI; DV3 is hospital Complications</td>
<td>Wound considered to be infected and classify as an SSI if infected within 30 days. Evaluation was accomplished by registry staff via chart review.</td>
<td>Overall incidence of SSI was 10.8% in high concentration oxygenation group and 11% in standard concentration of oxygen. 80% fio2 had no effect on 30 days composite regarding SSI, mortality, and other health complication s.</td>
<td>80% fio2 given intraoperatively does not lower the risk of infection and other healing complication s.</td>
<td>Strengths: Both fio2 groups are balanced well Limitation: Outcomes were gathered Colorectal Department and billing system instead of individual evaluations; infections that happen outside the hospital were evaluated by a chart review which should include inpts and outpatients, but miss pts who decided to continue their care elsewhere</td>
<td></td>
</tr>
<tr>
<td>Citation and Theme of the article</td>
<td>Design/Method</td>
<td>Sample/Setting</td>
<td>Major Variables Studied and Their Definitions</td>
<td>Measurement and Data Analysis</td>
<td>Findings</td>
<td>Results</td>
<td>Conclusions</td>
<td>Appraisal: Worth to Practice/Level</td>
</tr>
<tr>
<td>----------------------------------</td>
<td>--------------</td>
<td>----------------</td>
<td>-----------------------------------------------</td>
<td>-------------------------------</td>
<td>---------</td>
<td>--------</td>
<td>------------</td>
<td>-----------------------------</td>
</tr>
<tr>
<td>Admadé, B.G, Reyes, O. Supplemental Perioperative Oxygen (80% FIO2) for the Prevention of Surgical Site Infection after Emergency Cesarean Section. <em>International Scholarly Research Notices, 2013.</em></td>
<td>Blind RCT of 360 patients who underwent emergency cesarean section. 180 randomized receive 80% oxygen. 180 randomized receive 30% oxygen. Purpose of the experiment is to evaluate whether the difference in oxygen concentration has an impact on surgical site infection.</td>
<td>360 total women with no previous pregnancies of ≥37 wks were only allowed eligibility. N= 180 who received 80% oxygen. N= 180 who received 30% oxygen. 17 participants excluded from study. No statistical difference in BMI, hrs in labors/before c-section, parity, gestational age, and mother’s age. Study conducted in Saint Thomas Maternity Hospital</td>
<td>Independent variable. IV1 is 30% oxygen vs 80% oxygen administration. Dependent variable. DV1 is surgical site infection; DV2 is respiratory complications.</td>
<td>Statistical analysis was performed via EpilInfo (CDC). Difference in continuous variables were analyzed utilizing Mann Whitney U test. Pts evaluated for SSI (cutaneous changes linked to infection, fever, purulent drainage) before departing from the hospital, in outpatient setting, at 15 days, and then again in 30 days. Evaluations were done by primary physicians, blind.</td>
<td>360 total patients. 17 excluded leaving 343. 179 assigned 30% fio2 and 164 to 80% fio2. No significant difference was found in the development of SSI between these two. Use of a high fio2 intraoperatively and 2hrs after surgery does not show any reduction in the prevalent of SSI as compared to the 30% group. Regarding maternal complication s, use of high fio2 was linked to pulmonary fibrosis and atelectasis.</td>
<td>Results showed that use of a high fio2 intraoperatively does not lessen the risk of SSI.</td>
<td>Strength: RCT; patient was in stable condition before randomization; all patients received ABX prophylaxis prior to operation; all procedures performed in a similar fashion; both groups were similar in general characteristics. Limitations: small sample size; patients were relatively healthy.</td>
<td></td>
</tr>
</tbody>
</table>
Appendix C: IRB Letter

MEMORANDUM

To: Dr. Yasmine Campbell
CC: Adel Bashirimoghaddam, Valerie Diaz

From: Maria Melendez-Vargas, MIBA, IRB Coordinator

Date: April 6, 2021

Protocol Title: “Quality Improvement Project: The comparison of high and low fraction of inspired oxygen in the prevention of surgical site infection in patients receiving anesthesia: An evidence-based education module”

The Florida International University Office of Research Integrity has reviewed your research study for the use of human subjects and deemed it Exempt via the Exempt Review process.

IRB Protocol Exemption #: IRB-21-0117 IRB Exemption Date: 04/06/21
TOPAZ Reference #: 110244

As a requirement of IRB Exemption you are required to:

1) Submit an IRB Exempt Amendment Form for all proposed additions or changes in the procedures involving human subjects. All additions and changes must be reviewed and approved prior to implementation.
2) Promptly submit an IRB Exempt Event Report Form for every serious or unusual or unanticipated adverse event, problems with the rights or welfare of the human subjects, and/or deviations from the approved protocol.
3) Submit an IRB Exempt Project Completion Report Form when the study is finished or discontinued.

Special Conditions: N/A

For further information, you may visit the IRB website at http://research.fiu.edu/irb.
DATE: 04/28/2021

TO: Adel Bashirimoghddam, RN

FROM: Broward Health Institutional Review Board

RECORD NUMBER: 2021-051

STUDY TITLE: Quality Improvement Project: The comparison of high and low fraction of inspired oxygen in the prevention of surgical site infection in patients receiving anesthesia: An evidence-based education module

RE: NOT HUMAN SUBJECT RESEARCH DETERMINATION

Dear Adel Bashirimoghddam, RN:

This is to advise you that your project, “Quality Improvement Project: The comparison of high and low fraction of inspired oxygen in the prevention of surgical site infection in patients receiving anesthesia: An evidence-based education module” was reviewed on behalf of the Broward Health Institutional Review Board and was declared “not research involving human subjects” based on the definitions provided in the U.S. Department of Health and Human Services Code of Federal Regulations found at 45 CFR 46.102.

Please note, this determination does not absolve the Principal Investigator from complying with other federal, state, or local laws or institutional policies and procedures that may be applicable in the conduct of this project. This determination applies to your project in the form and content as submitted to the IRB for review. Any variations or modifications to this project involving the participation of human subjects must be approved by the IRB prior to implementing such changes. Please maintain a copy of this determination for your records.

Thank you for submitting your project to the IRB for consideration.

The Broward Health Institutional Review Board – FWA00001248 operates in accordance with the Office of Human Research Protections and U.S. Food and Drug Administration (FDA) regulations. The Broward Health Institutional Review Board complies with the ICH guidelines on Good Clinical Practice (GCP) where they are compatible with the FDA and HHS regulations.

This letter has been electronically signed in accordance with all applicable regulations, and a copy is retained within Broward Health IRB’s records.
Appendix D: QI Project Consent

PURPOSE OF THE PROJECT
The goal of this project: (1) to improve anesthesia providers knowledge on the use of intraoperative \textit{\text{\text{fio2}} and its relations to surgical site infection and (2) to educate anesthesia providers on the importance of judicious oxygen use.}

DURATION OF THE PROJECT
Participation will require 20 minutes of your time.

PROCEDURES
If you agree to participate in this project, the following items need to be completed in their respective order:
1. Complete an 11-question online pre-test survey via Qualtrics (HTML link will be sent to your respective email address)
2. Review 10-minute length educational module PowerPoint (HTML link will be sent to your respective email address)
3. Complete an 11 question post-survey via Qualtrics (HTML link will be sent to your respective email address)

BENEFITS
An increased understanding of the importance of intraoperative low dose \textit{\text{fio2}} for surgical prophylaxis and patient outcome.

ALTERNATIVES
There are no known alternatives available to you other than not taking this study.

CONFIDENTIALITY
The records of this study will be kept private and will be protected to the fullest extent provided by law. In any sort of report, we might publish, we will not include any information that will make it possible to identify you. Records will be stored securely, and only the education team will have access to the records. However, your records may be inspected by authorized University or other agents who will also keep the information confidential.

COMPENSATION & COST
There are no cost or payment to you for receiving the health education and/or participating in this project.

RIGHT TO DECLINE OR WITHDRAW
Your participation in this study is voluntary. You are free to participate in the study or withdraw your consent at any time during the study. You will not lose any benefits if you decide not to participate or if you quit the study early. The investigator reserves the right to remove you without your consent at such time that he/she feels it is in the best interest.

RESEARCHER CONTACT INFORMATION
If you have any questions about the purpose, procedures, or any other issues relating to this education module you may contact Adel Bashirimoghaddam at Florida International University, 786-222-2507, abash605@fiu.edu

IRB CONTACT INFORMATION
If you would like to talk with someone about your rights of being a subject in this education module or about ethical issues with this educational session, you may contact the FIU by phone at 505-348-2494 or by email at ori@fiu.edu.

PARTICIPANT AGREEMENT
I have read the information in this consent form and agree to participate in this study. I have had a chance to ask any questions I have about this study, and they have been answered for me. I understand that I will be given a copy of this form for my records.

I consent to the project

I do not consent and do not wish to participate
Appendix E: Pre-Test and Post-Test Survey

The comparison of high and low fraction of inspired oxygen in the prevention of surgical site infection in patients receiving anesthesia: An evidence-based education module

Pretest and Posttest Questionnaire:

INTRODUCTION

High concentration fio2 given intraoperatively has been linked to harmful effects on the patient. This QI project’s primary aim is to educate anesthesia providers that the use of low fio2 during surgery has the same SSI rate as high dose oxygen, thus avoiding the potentially harmful effects of an increased fio2.

Please answer the question below to the best of your ability. The questions are either in multiple choice or true/false format and are meant to measure knowledge and perceptions on intraoperative oxygen levels and SSI.

PERSONAL INFORMATION

1. Age: 20-30  30-50  >50

2. Gender: Male  Female  Nonbinary/third gender  Prefer not to say

3. Ethnicity:

   Hispanic  Caucasian  African American  Asian  Other

4. Level of Education: Doctoral  Master  Bachelors
5. **Position/Title:** CRNA       Physician Anesthesiologist     AA

6. **Years of Professional Experience:**
   
   <1      1-15 years       6-10 years       >10 years

**QUESTIONNAIRE**

1. **What is consider low dose fio2?**
   
   a. <30%
   
   b. <50%
   
   c. <60%
   
   d. <80%

2. **What is consider high dose fio2?**
   
   a. >50%
   
   b. >60%
   
   c. >80%
   
   d. 100%

3. **In this project what are providers/hospitals using as high dose intraoperative oxygen for?**
   
   a. Surgical site infection prophylaxis
   
   b. Pain management
   
   c. To decrease ICP
   
   d. None of the above
4. What does the CDC classify as SSI?
   a. <10 days
   b. <60 days
   c. <30 days
   d. <5 days

5. Which of the following health care associated infection has the highest morbidity and mortality?
   a. VAP
   b. UTI
   c. SSI

6. A high \textit{fio2} can lead to
   a. Oxidative stress
   b. Atelectasis
   c. Hyperoxia vasoconstriction
   d. \textit{All of the above}

7. Select two methods of preventing SSI
   a. Glucose control
   b. Prophylactic antibiotics
   c. ICP management

8. Does the choice of \textit{fio2} largely varies with facilities?
   a. It varies
   b. Somewhat Varies
   c. Does not \textit{varies}
9. Most common causes of SSI infections
   a. Coagulase negative staphylococci
   b. Staphylococcus aureus
   c. Enterococcus Exacerbates
   d. All of the above

10. How likely are you to consider not using high fio2 as a protective measure in preventing SSI?
   a. Most likely
   b. Somewhat likely
   c. Somewhat unlikely
   d. Most unlikely

11. How likely are you to use other methods in preventing SSI rather than high intraoperative fio2?
   a. Most likely
   b. Somewhat likely
   c. Somewhat unlikely
   d. Most unlikely
Appendix F: Education Module

The comparison of high and low fraction of inspired oxygen in the prevention of surgical site infection in patients receiving anesthesia: An evidence-based education module

Adel Bashir, RN, MSN

Learning Goals

- After this education you will:
  - Learn about SSI prevalence
  - Understand how high oxygen concentrations intraoperatively can harm a patient
  - Know whether high vs low intraoperative FiO2 concentrations have any difference in the rate of SSI prevention
Background

- Surgical site infection is a complication of surgical procedures that affects an estimated 2% of surgeries performed at hospitals in the United States.
- Intraoperative hypoxia is linked to increased adverse effects.
- A clear consensus is needed on whether low FiO2 (<30%) has the same rate of SSI prevention as high fiO2 (>80%).

Education of Problem

- In 2014, approximately 14 million inpatient procedures were performed in United States hospitals.
- The Center for Disease Control (CDC) reported that 110,800 SSI occurred for inpatient surgeries within that year.
- Hospital-related cost is projected to be $12,000 to $35,000 per one SSI, leading to an estimated annual expense of 3-10 billion dollars in unqualified expenditures for SSI.
SSI & Complications

- SSI has the highest prevalence of all healthcare-associated infections nationwide and continues to remain a significant clinical problem associated with morbidity and mortality.

- Surgical site infection is specified as an infection occurring within 30 days after a procedure that involves the skin or subcutaneous layer of the incision (superficial incision) and/or deep tissue (muscle or fascia) of the incision (deep incision) and/or any area of the anatomy outside from the incision that was manipulated or opened during the procedure.

- In many incidences, SSI arise from the patient's endogenous flora rather than outside sources.

- Most common causes of organisms include Coagulase-negative staphylococci, Staphylococcus aureus, Escherichia coli, and Enterococcus.

Fio2 & Complications

- Oxygen is the most abundant drug used in the operative setting and is often titrated based on the anesthesiology provider’s preference.

- The practice of using high dose oxygen intraoperatively to prevent surgical infection varies among facilities.

- Complications of utilizing high concentrations of intraoperative oxygen (>80%) include an increase in oxidative stress, atelectasis, and hyperoxia vasoconstriction.

- The higher concentration of oxygen increases the expense of the procedure for facilities.
Data Characteristics

- 6 RCT used in the study
- Each evaluating whether low fio2 (<30%) intraoperatively has the same SSI rates as high fio2 (>80%)
- Data concluded that low and high dose oxygen has similar rates in SSI prevention
- Anesthetics cases range from general anesthetic, MAC, and Spinal.
- Criteria to diagnose SSI was based on the CDC’s 30 day criteria.

Goals and outcomes

- End goals for this project:
  - (1) Improve anesthesia providers knowledge on the use of intraoperative fio2 and its relations to SSI
  - (2) to educate anesthesia providers on the importance of low dose oxygen use.
Changes in practice

- Recommendation: The standardized use of low fio2 intraoperatively.

- Continue the same practices in SSI prevention aside from oxygen concentration.

Take Home Points

- High dose intraoperative oxygen should not be liberally used to lessen SSI.

- Freely using high fio2 oxygen has been associated with negative outcomes in individuals such as intraoperative hyperoxia may include oxidative stress, atelectasis, and hyperoxia vasocostriction.

- Future practice should include the use of an intraoperative fio2 <30% throughout the case with exceptions.

- Traditional methods of preventing SSI should not be abandoned.
References


