Appropriate Operating Room Antibiotic Re-Dosing for General Surgery Patients

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Abstract

Problem & Purpose:

Antibiotic prophylaxis is a necessary measure aimed at decreasing the number of perioperative infections. Surgical antibiotic prophylaxis is defined as the use of antibiotics to prevent infections at the surgical site (Khan, 2018). Such infections result in roughly $3.5 to $8 billion dollars in yearly costs, in addition to longer hospital stays for patients (Heuer, Kossick, Riley and Hewer, 2017). For patients, who are in long surgical procedures, it is recommended that they receive appropriate re-dosing of antibiotics throughout the remainder of the case. The most common antibiotic used for surgical prophylaxis is Cefazolin. Current Surgical Care Improvement Guidelines (SCIP), recommend re-dosing of Cefazolin every four hours while in surgery or if blood loss is greater than 1500mL (Heuer, Kossick, Riley and Hewer, 2017).

Methods:

A retrospective quality improvement project was conducted at a large academic teaching institution in Baltimore, Maryland. Data was obtained from a three-month period of time and focused on inpatient general surgery patients that underwent surgical procedures longer than 4 hours in length. Descriptive statistics were used to evaluate the data gathered. Interviews were conducted with staff Certified Registered Nurse Anesthetists and Pharmacists to obtain qualitative data about their perception of barriers towards re-dosing of antibiotics. Interviews also focused on strategies for improvement of re-dosing at the appropriate times.

Results:

From August to November 2019 there were a total of 243 general surgery cases. Of those cases, 25% (n=61) received antibiotics that did not require re-dosing. A total of 74.5% (n=182) of patients received Cefazolin for antibiotic prophylaxis. Of those 182 patients, 4.3% (n=8) did not receive proper antibiotic re-dosing during the procedure. Also, 2 of those 8 patients had surgical procedures that ended a few minutes past what is considered the “4-hour mark”. SCIP guidelines state that re-dosing of intra-operative Cefazolin should occur every 4 hours (Heuer, Kossick, Riley and Hewer, 2017). Interviews with staff members showed that further prompts within the documentation system, continued chart audits, peer comparison and ongoing education would be beneficial to increasing compliance with antibiotic re-dosing.

Conclusion:

Continued education, changes to the documentation system, peer comparison and continued staff education all have the potential to increase compliance with re-dosing of intraoperative antibiotics. Implementation of these strategies and follow-up data collection are the next steps in this initiative. Data collection after implementation of these strategies should focus on the number of patients that received appropriate prophylaxis dosing and the measures that were in place to ensure compliance. A comparison with the data collected for this project would be beneficial in measuring the effectiveness of the proposed strategies.

Introduction

Antibiotic prophylaxis is a necessary measure aimed at decreasing the number of perioperative infections. Surgical antibiotic prophylaxis is defined as the use of antibiotics to prevent infections at the surgical site (Khan, 2018). Surgical site infections result in roughly $3.5 to $8 billion dollars in yearly costs, in addition to longer hospital stays for patients (Heuer, Kossick, Riley and Hewer, 2017). Surgical site infections (SSIs) are the most common and most costly nosocomial infections in the United States (Heuer, Kossick, Riley and Hewer, 2017).

It is recommended by the evidence, that patients who are involved in long surgical procedures receive appropriate antibiotic re-dosing. Cefazolin is the most commonly administered antibiotic for surgical prophylaxis. Appropriate re-dosing of Cefazolin is defined by the Surgical Care Improvement Guidelines (SCIP), as being administered every 4 hours while surgery is ongoing or if there is greater than 1500 mL blood loss (Heuer, Kossick, Riley and Hewer, 2017). Other antibiotics used for surgical prophylaxis such as vancomycin, clindamycin, gentamycin, metronidazole and Zosyn, do not require re-dosing every 4 hours. By ensuring appropriate re-dosing of antibiotics the incidence of infection related to surgery is decreased and patient satisfaction is increased (Anderson, 2014). The development of recommendations to improve compliance with re-dosing guidelines of antibiotics during long surgical procedures is necessary in order to prevent the development of surgical site infections, leading to decreased costs to the hospital and patients.

The purpose of this Quality Improvement project was the development of recommendations to ensure compliance with appropriate antibiotic re-dosing for General Surgery patients. In order to decrease surgical site infections and to provide safe, cost-effective care to patients, it was necessary to explore the compliance with antibiotic re-dosing in the operating

room. It was also important to develop recommendations to improve compliance with re-dosing that were specific to the needs of this facility.

Literature Review

The focus of this literature review is on proper antibiotic selection and re-dosing in the operating room. According to the Centers for Disease Control (2019), surgical site infections are defined as an infection related to a surgical procedure that occurs at the site of surgery within 30 days of the procedure. Surgical site infections occur in 2-4% of all inpatient surgical procedures (CDC, 2019). Prophylactic antibiotic administration leads to a decrease in the incidence of surgical site infections for hospitalized patients.

The proper selection of antibiotics for surgical prophylaxis depends on what organisms are most likely to be encountered during the procedure (Tourmoussglou, Yiannakopoulon, Kalapothaki, Bramis and St. Papadopolus, 2007). Patients who are already receiving antibiotics should be evaluated to determine if the antibiotics they are receiving would adequately cover the organisms that will be encountered during surgery.

Zhang et al. (2017) found that in 51% of cases where intra-operative antibiotic re-dosing was required, at least one antibiotic dose was not given. The same study also found that the longer the surgical procedure, the less likely re-dosing of antibiotics was to occur. This could be due in part to multiple providers taking part in a case throughout a shift and a lack of communication among them. In addition, the study found that the reasons given for not re-dosing antibiotics included: forgetting to re-dose and communication failures among operating room staff.

Strategies for improving compliance with re-dosing of antibiotics reported in the literature included electronic reminders that are built into the documentation system. A study by

Nair, Newman, Peterson and Schwid (2011) found improved compliance with re-dosing when electronic reminders were used. This study implemented two different notification systems. A total of 940 cases used reminders provided by Anesthesia Information Management Systems (AIMS) and had a re-dose rate of 62.5%. This was compared to reminders provided by the Smart Anesthesia Messenger (SAM) in a total of 922 cases, which had a re-dose compliance rate of 83.9%.

Riggi, Castillo, Fernandez and Wawrzyniak (2016), examined appropriate surgical prophylaxis and appropriate re-dosing of antibiotics. The study also evaluated the effects of intra-operative reminders on compliance with re-dosing. A total of 7,461 surgical cases were evaluated. Prior to the implementation of reminders, compliance with re-dosing was 15.8% (n=2,183). After the implementation of intra-operative reminders, compliance increased to 65.3% (n=4,486). A second period of time was evaluated which showed an increased compliance rate of 76.7%.

The literature review demonstrated that compliance with re-dosing is not a new issue. Longer surgical procedures are more likely to have lapses in re-dosing and, frequently, when multiple antibiotics are given, at least one is not re-dosed appropriately. Multiple studies, including those by Nair et al. (2011) and Riggi et al. (2016), showed that re-dosing compliance was an ongoing issue. These same studies also demonstrated that implementing electronic reminders within the documentation systems improved overall compliance.

Theoretical Framework

The Theory of Planned Behavior (TPB) was first developed by Ajzen and Fishbein in the 1980s to describe deliberate behaviors (Asare, 2015). The TPB theorizes that actions are based on attitude, perceived behavioral control, and subjective norms (Wray, Orrells, Latch and Burch,

2018). An individual's intention or motivation to enact a specific behavior is influenced by their attitude (is there a positive or negative outcome of enacting this behavior), subjective norm (an individual's social pressure), and perceived behavioral control (ease or difficulty of changing the behavior) (Michaeldou, 2014). The Theory of Planned Behavior is used to understand why individuals act in a specific manner. Applying the theory to the project provided insight into why providers were taking or not taking specific actions for re-dosing antibiotics in the operating room.

The Theory of Planned Behavior was used to evaluate the beliefs, norms, and attitudes associated with re-dosing of antibiotics in the operating room. Providers are taught that antibiotic prophylaxis, including the re-dosing of antibiotics when appropriate, is the norm in today's medical climate. However, the pressures of stressful situations, high patient acuity and the push to perform multiple undertakings in a short amount of time, can lead to mistakes or forgotten steps. This theory would suggest that education for providers to remind them of the benefits of antibiotic prophylaxis could improve attitudes and actions with following guidelines

Methods

Setting & Population

This retrospective quality improvement project took place at a large academic teaching hospital in the Mid-Atlantic region. The target population to conduct a review of the antibiotic re-dosing procedures were anesthesia providers. The outcome measured was General Surgery patients over the age of 18 years, who underwent surgery lasting longer than four hours in length and received antibiotic prophylaxis. To conduct this chart review, the surgical procedures that occurred between August 1, 2019 and November 1, 2019 in this population were included. Pediatric patients, cardiac surgery patients and other specialties were excluded.

Measures Collected

Data points collected included the following: date of surgery, length of surgery, type of surgery, patient height, patient weight, surgical start time, antibiotic, initial antibiotic dose time and re-dosing time of antibiotic. These data points were collected in December 2019, from a data warehouse, which compiles data from Metavision and Epic documentation systems. Descriptive statistics, including mean, median, mode and standard deviation were used to evaluate the collected data. Retrospective chart audits or reviews were also completed. Chart audits were used to evaluate provider type and any issues that may have impacted the intra-operative re-dosing of antibiotics. Chart audits were completed using the Epic charting system.

Additionally, interviews with staff Certified Registered Nurse Anesthetists and Pharmacists were conducted. These interviews lasted approximately 30 minutes and occurred over a two-week span in December 2019. Information gathered during the interviews was transcribed on paper and later uploaded to a Microsoft Word document. These interviews were focused on collecting qualitative perspectives from staff members and were structured with the following questions:

1. How often are antibiotics to be re-dosed in the operating room?
2. What reminders for re-dosing are present in the current documentation system?
3. What are some barriers to re-dosing?
4. What are facilitators to re-dosing?
5. What are some possible solutions for improving compliance with re-dosing?

A total of 5 Certified Registered Nurse Anesthetists and one pharmacist took part in the interviews. These interviews were conducted on a voluntary basis and provided key findings about current practices surrounding antibiotic re-dosing, suggestions for improving compliance

with re-dosing and the barriers and facilitators encountered. Information gathered was used to formulate strategies and recommendations for improvement with intraoperative antibiotic re-dosing.

Data Analysis Plan

An information request was submitted to the facility, requesting specific information needed for the project. The information was gathered from Metavision and cataloged into an Excel spreadsheet. Descriptive statistics, including mean, median, mode and standard deviation were used to evaluate the collected data.

Chart audits were conducted on patient's charts within the Epic system. Information gathered from the audits was stored in an Excel spreadsheet. All data collected during the project was stored on a password-protected computer, with access only available to the DNP student and instructor.

Data gathered during the project was used in conjunction with the staff interviews to develop recommendations for improvement with compliance of intraoperative antibiotic re-dosing. Information from the staff interviews was stored in a Microsoft Word document. All recommendations that were developed were also stored in a Microsoft Word document.

Results

Re-dosing Data Analysis

Data from charts of patients who underwent surgery from August 1, 2019 to November 1, 2019 was retrospectively analyzed. Inclusion criteria included: adults over the age of 18 years, general surgery cases and surgical duration greater than 4 hours. Exclusion criteria included: children under the age of 18 years, trauma and cardiac surgery cases.

There were a total number of 243 surgical cases that met the inclusion criteria during this time period. The average length of surgery was 375 minutes or 6.25 hours (standard deviation= 28.09). Of the total cases, 25% (n=61) received antibiotics that did not need to be re-dosed during the procedure. Theses antibiotics included: vancomycin, clindamycin, gentamycin, metronidazole and Zosyn. These antibiotics required dosing on a different schedule and therefore did not require re-dosing at the four-hour mark, as is required for Cefazolin. A total of 74.5% (n=182) received Cefazolin as a prophylactic antibiotic. Of the 182 patients receiving Cefazolin as an antibiotic, 4.3% (n=8) did not receive a re-dose of the antibiotic.

Chart Audits

Chart audits were conducted to help determine the circumstances surrounding cases where re-dosing of antibiotics did not occur. No charts displayed any information specifically stating why the antibiotic was not re-dosed. Two of the eight cases ended just a few minutes past the 4-hour mark when re-dosing of Cefazolin is scheduled to occur.

In 62.5% (n=5) of the cases where antibiotics were not re-administered, a resident physician was the person who administered the anesthesia. Certified Registered Nurse Anesthetists' (CRNA) failed to give appropriate antibiotic re-dosing in 37.5% (n=3) of those cases. Improper compliance with re-dosing of Cefazolin was also found to be more common in August and September, with an improvement noted in October.

Interviews

Current practice at the facility is to re-dose Cefazolin when the surgery has reached 4 hours in duration and if the procedure is still underway. Secondly, when blood loss exceeds 1500

mL the antibiotic should be re-dosed. During the interviews, all anesthesia providers (n=5) stated that this is the practice that they follow, in compliance with the recommended practice.

The documentation system used intra-operatively provides a prompt when antibiotics are due to be given. A suggestion stated during 3 of these interviews was that more frequent prompts would be helpful to remind providers when antibiotics are due. These prompts would be beneficial at specific intervals prior to when the dose is due (30 minutes prior, 15 minutes prior, 5 minutes prior) and after the scheduled time. If an antibiotic is not re-dosed, it was stated that it would be beneficial to have a drop-down box, which would allow the provider to select a reason for not giving the dose.

Other suggestions included a recommendation for continuation of chart audits to review compliance of providers and re-dosing. Monthly or quarterly chart audits were recommended as the appropriate intervals to be carried out by designated individuals, such as Change Champions. It was also suggested to give individual providers reports about how they compare to the group as a whole with re-dosing. Holding individual meetings with providers who continually fail to provide adequate re-dosing was also mentioned as a way to improve compliance.

A number of facilitators and barriers were highlighted during the interviews. Facilitators to the project included: strong hospital and departmental leadership, availability of economic resources, knowledge of current hospital antibiotic guidelines and strong academic presence that facilitates change. Barriers to the project included: size of institution and department, providers rotating from other facilities and communication among staff members.

Discussion

Data analysis showed that overall compliance with re-dosing of antibiotics is high, with a total of 74.5% (n=182) of General Surgery patients receiving Cefazolin for antibiotic prophylaxis

and of those only 4.3% (n=8) did not receive a re-dose at the 4-hour mark. However, room for improvement still exists. Studies by Nair et al. (2011) and Riggi et al. (2016), found that compliance with antibiotic re-dosing was increased with the implementation of electronic reminders within the documentation system. Two options for electronic reminders are demonstrated within the Evidence Table (see Appendix A). These options include the implementation of multiple electronic reminders that are demonstrated within the documentation system at predetermined intervals and sending out reminders via a paging system to anesthesia providers. While the number of cases not receiving re-dosing at the facility under discussion was low (n=8) during the time period of August-November 2019, the implementation of electronic reminders will help to decrease the rate of non-compliance, or increase the rate of compliance, as recommended in the research. While this number is low, it is only referencing a three month time period. Yearly numbers have the potential to be much higher. Multiple providers highlighted the suggestion of more electronic reminders during staff interviews. Currently the facility utilizes a single reminder when an antibiotic is due to be re-dosed.

One of the limitations of this study was the length. Surgical procedures that took place over a 3-month period of time were included in the study. In order to analyze a larger population, data analysis over a full year would be beneficial. The inclusion of other surgical specialties would also be of benefit. Most of the studies that were referenced in the literature review examined multiple specialties including neurosurgery, general surgery and trauma patients.

Comparisons of compliance between Certified Registered Nurse Anesthetists and Physician Anesthesiologists would also be valuable to determine provider specific behaviors and opportunities to address it in other practice changes. In the majority of cases (n=5), where re-dosing did not occur, a resident physician was responsible for patient care. Most of these cases

took place during the months of August and September. It could be theorized that this occurred because new residents start in July and further education or training is needed.

Other staff recommendations for improvement of compliance included peer comparison, chart audits and education. Peer comparison would apply to providers who continually perform poorly on re-dosing of antibiotics. However, one limitation of this would be the time that would be needed to breakdown compliance on an individual basis. The limitation associated with chart audits would also include having available staff to do them and the frequency with which they would be needed. Continued education could be provided via email, staff meetings or education days.

The recommendations for improvement of provider compliance at this facility for antibiotic re-dosing includes: on-going staff education, electronic reminders/prompts within the documentation system, peer comparison and chart audits. Research has proven that these interventions work to improve provider compliance with antibiotic guidelines.

Conclusion

Data was analyzed over a three-month period of time (August-November), and found a total of 243 General Surgery cases met inclusion criteria for this project. Of those cases, 182 patients (74.5%) received Cefazolin for surgical prophylaxis. Out of the patients receiving Cefazolin only 4.3% (n=8) did not receive the appropriate re-dosing of the antibiotic.

Currently, the facility that was evaluated, utilizes an electronic reminder within the documentation system to remind staff when antibiotics are due to be re-dosed. The implementation of more prompts, education, chart audits and peer comparison, can all be used as tools to improve compliance with the re-dosing recommendations of practice for this surgical group of patients within this facility. Continued education of staff members on the importance of

proper antibiotic prophylaxis and the implications of it on patients would be effective at reinforcing the recommended practice guidelines. The changes to the daily practice, more electronic prompts, education and peer comparison, are minor and will easily be adopted throughout the operating rooms and surgical specialties.

While the data analysis revealed that the number of patients not receiving appropriate re-dosing was low, it is important to strive for a 100% compliance rate. Having strict compliance with re-dosing will help to prevent surgical site infections, thus improving patient satisfaction and overall patient outcomes as well as reducing healthcare costs.

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