Spring 4-16-2022

To use or not to use oxygen for MI Benchmark Study

Alexia Celaya
University of Texas at Tyler, acelaya@patriots.uttyler.edu

To use or not to use oxygen for MI Benchmark Study

A Paper Submitted in Partial Fulfillment of the Requirements

For NURS5382

In the School of Nursing

The University of Texas at Tyler

Dr. Colleen Marzilli

by

Alexia Celaya

April 16, 2022

Contents

Acknowledgements

Many thanks to all the professors in the program that helped shape this project, for their recommendations and input. Special thanks to Dr. Collen Marzilli for your patience, understanding, and support throughout this semester. I would like to thank my family for their love and support in helping me reach my educational goals. Without your love and support, I would not be where I am today. I would also like to thank my colleagues, which I am proud to call my work family for listening to be ramble about this project. But most of all I would like to thank my mother for being my inspiration and without her knowing she taught me that anything in life is possible and that I am stronger than I believe.

Executive Summary

It is a common practice for emergency personnel to administer oxygen for a patient diagnosed with a myocardial infarction. It is a well-known practice to place the patient on supplemental oxygen even if they are not hypoxic. The use of supplemental oxygen has been a cornerstone in the treatment of myocardial infarction. The rationale behind the administration of oxygen therapy is to increase oxygen delivery to the myocardium, therefore limiting the infarct size and future complications (Hofmann et al., 2017). The use of supplemental oxygen on normoxic patients has been challenged due to the possibility of causing further injury to the myocardium. Above normal oxygen levels in the blood can cause coronary vasoconstriction and increase the production of reactive oxygen species, potentially contributing to reperfusion injury (Hofmann et al., 2017). Acute myocardial infarction is 1 of the 5 most expensive causes of hospitalization, any complications increase the total cost and can lead to re-admissions or recurrent emergency department visits. Under the Hospital Readmissions Reduction Programs (HRRP), Medicare will not pay for a re-admission within 30 days of the patient being discharged, meaning that hospitals will pay the expenses generated. It is important to minimize complications and be more cautious in the administration of supplement oxygen. The PICOT question developed is: In hemodynamically stable patients that present to the ED with an acute MI(P) does the usage of supplemental oxygen given upon arrival to the ED (I) compared to no usage of supplemental oxygen (C) affect mortality (O) after 1 month from hospitalization (T)?

1. Rationale for the Project

The use of supplemental oxygen has been used as part of the treatment for myocardial infarction for many years. In order to make the treatment easy to remember the mnemonic MONA (morphine, oxygen, nitroglycerin, and aspirin) has been taught to both nurses and

physicians. Oxygen should be administered if the patient is showing signs of decreased oxygenation through hypoxia with an oxygen saturation less than 90%. In patients that have an oxygen saturation equal to or greater than 90% the use of supplemental oxygen is not necessary. Tension in the blood due to increased oxygen may cause harmful effects due to vasoconstriction of the vasculature and a generation of free radicals that could lead to reperfusion injury (Hofmann & James, 2018). Loscalzo (2017) stated that oxygen administration to patients with normal oxygen saturation that underwent surgical intervention (cardiac catheterization) had a 30% decrease in coronary blood flow. Therefore, oxygen should not be used liberally. To avoid hyperoxia, oxygen should be used as a drug within therapeutic range guidelines only when indicated to treat hypoxia (Lellouche, 2018). Oxygen like any other drug has a therapeutic range and should not be used on patients that are not hypoxic.

1.1 Project Goals

The goal of this benchmark study is to determine of supplemental oxygen on normoxic patients is detrimental and provide data so that the chest pain protocol at my facility is updated specifying the use of supplemental oxygen. Data demonstrated that routine administration of supplemental oxygen in cardiac patients has untoward effects (Amsterdam et al., 2014). The most recent AHA guidelines state “supplemental oxygen should be administered to patients with NSTE-ACS with arterial oxygen saturation less than 90%, respiratory distress, or other high-risk features of hypoxemia” (Amsterdam et al., 2014). Another goal is to provide education based on the updated AHA recommendations as many nurses still practice based on the outdated guidelines. Recent studies suggest that high arterial oxygen concentrations may harm various organs or worsen outcomes.

2. Literature Synthesis

The first research article is a randomized controlled trial that aimed to determine if the use of supplemental oxygen impacts clinical outcomes and/or procedural outcomes. In total 2807 patients were randomized to receive oxygen at 6L/min for 6-12 hours or ambient air. In order to be included in the study patients had to be 30 years or older and have an oxygen saturation greater than 90%. The incidence of death at one year was 6.3% in the patients randomized to the oxygen group and 7.5% to the patients randomized to the ambient air group (Hofmann et al., 2018). Oxygen therapy did not reduce the rate of mortality at one year or at short term. It is important to mention that the oxygen therapy used during the trial was moderate and hyperoxia was avoided.

The second article is a randomized controlled trial whose aim was to determine if the routine use of supplemental oxygen administration is associated with harmful or beneficial effects (Stub et al., 2015). Due to these results, there remains uncertainty on the use of supplemental oxygen for treatment of myocardial infarction. Despite its potential adverse effects, oxygen continues to be administered to approximately 90% of patients with myocardial infarction. Patients were excluded if they presented with an oxygen saturation that was less than 94%. 470 patients were included in the study, 218 patients were randomized to the oxygen group and 223 patients were randomized to the no oxygen group. The results suggest that withholding routine oxygen therapy is safe in normoxic patients with an acute MI (Stub et al., 2015).

Another randomized controlled trial was done to determine the threshold at which oxygen therapy begins to increase myocardial injury. The findings suggest that exposure to supplemental oxygen in the first 12 hours after a STEMI causes a significant increase in myocardial injury due to patients experiencing a 17%-21% increase in myocardial infarct size (Nehme et al., 2016). The high oxygen concentrations seen in the oxygen exposure groups indicated hyperoxia

causing greater myocardial injury due to a reduction in coronary blood flow and an increase in vascular resistance (Nehme et al., 2016). At a 6-month follow-up the morality was as follows 4.7% for the no oxygen group, 5.0 for the low supplemental oxygen, 4% for the moderate oxygen, and 5.9% for the high flow oxygen.

A randomized controlled study was done to in which patients were randomized to receive oxygen at a high concentration or titrated oxygen for 6 hours. High concentration consisted of 6L/min of oxygen via a concentration mask. The titrated oxygen was delivered via nasal cannula. There were 1 of 68 and 2 of 68 deaths in the high concentration and titrated oxygen groups. The mortality from this study "identified a fixed effects odds ratio of death associated with high concentration oxygen therapy of 2.2" (Ranchord et al., 2012).

A meta-analysis study was done reviewing randomized controlled trials in any language to assess the effects of routinely used oxygen for acute MI with the primary outcomes being death and pain. The interventions of the studies that were researched were the administration of supplemental oxygen compared to room air. One of the randomized controlled studies showed that the risk ratio of death was 2.89 greater in participants receiving oxygen compared to room air (Cabello, Burls, Emparanza, Bayliss, & Quinn, 2016). A Cochrane analysis of 3 trials "showed a 3-fold higher risk of death for patients with a confirmed MI treated with oxygen than patients managed on room air (Cabello, Burls, Emparanza, Bayliss, & Quinn, 2016).

A systemic review was conducted for randomized controlled trials to compare the outcomes of oxygen therapy versus no oxygen therapy in post-acute myocardial infarction settings. The intervention for this study was providing oxygen supplementation to patients who are not hypoxic with an acute MI. Delivering more than 50% fraction of inspired oxygen to critically ill patients with oxygen saturation greater than 92% resulted in less oxygenation index

in 48 hours (Abuzaid et al., 2018). There is a lack of benefit with routine oxygen administration. There are significant hemodynamic effects: a reduction in coronary blood flow, myocardial oxygen consumption, and an increase in coronary vascular disease (Abuzaid et al., 2018).

This article is a systemic review and meta-analysis of randomized placebo-controlled trials of oxygen therapy in MI. The interventions of the studies that were researched were the administration of high-flow oxygen compared to room air. Hyperoxia may result in a marked reduction in coronary artery blood flow, increase in systemic vascular resistance and blood pressure in patients with a MI (Wijesinghe et al., 2009). The evidence suggests that the routine use of high-flow oxygen in uncomplicated MI may result in a greater infarct size and increase the risk of mortality (Wijesinghe et al., 2009).

A randomized controlled trial was done in critically ill patients whose aim was to determine whether a conservative oxygenation strategy was more beneficial than a conventional oxygen strategy. Oxygen supplementation titrated to a more conservative oxygen saturation was associated with improved outcomes (Girardis et al., 2016). Conservative oxygen supplementation was associated with less non-respiratory organ dysfunction and greater reduction in lactate levels (Girardis et al., 2016).

A systemic review and meta-analysis was conducted to review the efficacy and safety of liberal versus conservative oxygen therapy in acutely ill patients. The main outcomes were mortality and morbidity. A liberal oxygen strategy increased the risk of death at 30 days (Chu et al., 2018). Excessive oxygen can promote vasoconstriction, inflammation, and oxidative stress. The dissociation curve indicates that even small changes in SpO2 could be harmful because they lead to large increases in PaO2.

The purpose of the study was to perform a systemic review and meta-analysis to assess the effectiveness and safety of oxygen therapy for patients with AMI. The intervention for this study was oxygen therapy for 1 hour or more at any stage withing 24 hours after onset of AMI. Over 90% of patients with AMI receive routine use of oxygen. There was no beneficial, statistically significant association between oxygen therapy and AMI (Li et al., 2018). The hyperoxia may play a vital role in the reduction of coronary blood flow due to a mean increase in vascular resistance functioning at the level of the microvascular vessels (Li et al., 2018).

A systemic review was conducted for RCT's to compare the outcomes of oxygen therapy versus no oxygen therapy in post-acute myocardial infarction settings. The intervention for this study was providing oxygen supplementation to patients who are not hypoxic with an acute MI. Delivering more than 50% fraction of inspired oxygen to critically ill patients with oxygen saturation greater than 92% resulted in less oxygenation index in 48 hours (Abuzaid et al., 2018). There is a lack of benefit with routine oxygen administration. There are significant hemodynamic effects: a reduction in coronary blood flow, myocardial oxygen consumption, and an increase in coronary vascular disease (Abuzaid et al., 2018).

The purpose of the study was to synthesize the evidence from randomized controlled trials (RCTs) that investigated the effects of supplemental oxygen therapy compared with room air in patients with suspected or confirmed AMI. Oxygen therapy seems to have no additional benefit in patients with normal baseline oxygen levels (Sepehrvand et al., 2018). In a survey done, 55% of (emergency department, cardiology, and ambulance staff) believed that oxygen reduces the risk of death in AMI and 98.3% reported a routine use of oxygen (Sepehrvand et al., 2018). Oxygen therapy did not reduce the risk of 30-day mortality.

3. Project Stakeholders

The gatekeepers of this project are administrators. While administrators are responsible for clinical practice and ensuring quality care, in order to make change it is essential to have the permission of the hospital administrators. A leadership team needs to be established that includes personnel that is directly and indirectly involved in the care of patients diagnosed with a myocardial infarction. These personnel will be bedside nurses and CNA's/nurse techs. The barriers that are foreseen are clinical staff that have been practicing for many years could be resistant to change. A lack of knowledge and skills can create barriers to delivering evidence-based care due to a weak belief in the value of evidence-based practice (Melnyk & Fineout-Overholt, 2015). The best way to eliminate those barriers is through extensive training and education in regard to the topic as well as the need for change.

4. Implementation

The most appropriate model to implement changes is The Iowa Model. "This model outlines multiphase change process with feedback loops" (Melnyk, B., & Fineout-Overholt, 2015, p.389). Steps that need to be taken are forming an interdisciplinary team of stakeholders to analyze and synthesize evidence, design a pilot, and deem whether the results are appropriate for this practice. The Iowa model best correlates to the needs and structure of the organization and implementation process required for success of the project.

The first step is to evaluate current practice in the Emergency Department regarding the administration of supplemental oxygen for patients that are not hypoxic and diagnosed with acute myocardial infarction. To help engage staff and stakeholders I would need to build excitement for the EBP by demonstrating the link between proposed EBP changes and desired patient outcomes, as well as building a passionate, compelling case to drive change (Rodgers et al., 2019). An implementation team would then be established which would be responsible for

conducting searches of evidence-based articles that support the proposed change. The evidence will then be appraised and disseminated. Practice recommendations will be formulated based on the evidence. Stakeholder resistance and barriers wills be assessed early because it can result from numerous factors including hesitation to break traditional practice, unfamiliarity with how evidence will improve patient outcome, or misconceptions regarding time and effort needed to implement practice change (Rodgers et al., 2019). The practice change will be implemented and after an adequate amount of time follow-up data will be collected to measure clinical outcomes. The data collected will be analyzed and the practice/processes will be refined.

5. Timetable/Flowchart

The development of the PICOT question was initiated during the beginning of the program. The question was tweaked multiple times. At first the main focus was solely on the diagnosis of STEMI (ST elevation myocardial infarction). There were not enough articles that covered just STEMI, so it was changed to acute myocardial infarction. The initial time frame was one year, however, it was not a realistic time frame due to the length of the semesters, so it was changed to one month. Due to the pandemic, the project was unable to be implemented and it became an Evidence-Based Benchmark Study. The project will be presented to administration for approval in May 2022 now that coronavirus cases are in decline and the Cath lab is now fully operational.

6. Data Collection Methods

Data collection was through the review of studies whose dependent variable was the administration of supplemental oxygen on patients diagnosed with acute myocardial infarction. The studies sought to provide evidence that the use of oxygen on patients that are not hypoxic may have negative complications. If the project is approved, data collection will be done by the

chest pain performance improvement coordinator through audits. The main components that will be audited are room air, oxygen, how many liters of oxygen, cardiac biomarkers, complications (stroke, death, recurrent MI), and re-admission. The data will be compiled and reviewed to assess if there are any correlations between those administered oxygen versus room air and any complications that may have arisen. Feedback will also be generated from the nursing staff after education has been provided. The stakeholders will then meet and discuss the progress of the project after three months. Changes will be made based on the results generated.

7. Costs/Benefits

Acute myocardial infarction (AMI) is included under the Hospital Readmissions Reduction Programs (HRRP) from the Centers for Medicare and Medicaid Services (CMS). A readmission is defined as patient admission to a hospital within 30 days after being discharged from an earlier hospital stay at the same hospital (*Hosp. Readmission reduction*, n.d.). The 30-day all-cause readmission rate is the percentage of patients aged 18 and older who returned to the hospital within 30 days of discharge. When a Medicare patient is readmitted within 30 days, the hospital is not paid anything for the second admission. The HRRP programs incentivizes hospitals for the coordination of care and reduction of complications to decrease readmissions. Therefore, if there are complications related to the use of oxygen and the patient is re-admitted the hospital will have to pay for the stay. The average re-admission expense is $8,446, while an ICU admission is an extra $6,667.

Average LOS is 8 days for patients with complicated or uncomplicated AMI. The most common complications in the literature were: stroke, recurrent MI, heart failure, and death. Supplemental oxygen on patients that do not need it can cause increased LOS and increased costs if any complications were to arise. If the patient is uninsured and is not able to

pay their medical bill the hospital would be at a greater loss. If there are more complications, there is also a greater risk for re-admission within 30 days.

The resources that are needed are training and education for all clinical staff. There would be an associated cost in the education that needs to be done, whether it be in person or through competencies. The ongoing costs would be associated with continued education for personnel as well as education for new hires. The benefit of implementing the change over a period of one year will be in reduction of utilization of oxygen delivery masks, as well as a decrease in length of stay of patients.

8. Discussion of Evaluation

There is not an official evaluation of this benchmark study at this time. The data that needs to be gathered will be outcomes for the patients, the major ones being mortality, in-hospital deaths, and recurrent myocardial infarction for those patients admitted with a diagnosis of myocardial infarction. Clinical data such as the cardiac biomarker of troponin is also important to assess because it is an essential laboratory tool that determines whether there is damage to the myocardium.

Dissemination of evidence alone is not enough to sustain EBP, there needs to be an organizational culture that supports EBP (Melnyk et al., 2011). Nurse leaders also play an active role in the sustainability for EBP. As mentioned by Bianchi et al. (2018), nurse managers have a particular influential role on evidence-based practice in terms of providing a supportive culture and environment. Therefore, for this project to be sustained I would speak with upper management to have it implemented in the policies and procedures, specifically the chest pain policy.

Conclusions/Recommendations

The recommendation would be to continue with the synthesis of evidence as new research is being conducted and to stay up to date with the American Heart Association guidelines. The next step is the implementation of the project after it is approved by administration. The recommendation for the facility is to change protocols based on evidence-based practice. As for colleagues and patients, the recommendation is to stay informed and continue their education as new evidence comes out.

The routine use of supplemental oxygen in "cardiac patient may have untoward effects, including increased coronary vascular resistance, reduced coronary blood flow, and increased risk of mortality" (Amsterdam et al., 2014). Changing established norms and practice is not an easy task, but with the right team and mindset accompanied by evidence-based data change is possible. One of the changes that needs to be made is stopping the treatment of supplemental oxygen on patients that are not hypoxic. Education and training will be the key components in order to bring about this change in order to improve healthcare outcomes.

References

Amsterdam, E. A., Wenger, N. K., Brindis, R. G., Casey, D. E., Jr, Ganiats, T. G., Holmes, D. R., Jr, Jaffe, A. S., Jneid, H., Kelly, R. F., Kontos, M. C., Levine, G. N., Liebson, P. R., Mukherjee, D., Peterson, E. D., Sabatine, M. S., Smalling, R. W., Zieman, S. J., & ACC/AHA Task Force Members. (2014). 2014 AHA/ACC guideline for the management of patients with non-ST-elevation acute coronary syndromes: a report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines: A report of the American college of cardiology/American heart association task force on practice guidelines. *Circulation*, *130*(25), e344-426. https://doi.org/10.1161/CIR.00000000000001

Abuzaid, A., Fabrizio, C., Felpel, K., Al Ashry, H. S., Ranjan, P., Elbadawi, A., Mohamed, A. H., Barssoum, K., & Elgendy, I. Y. (2018). Oxygen therapy in patients with acute myocardial infarction: A systemic review and meta-analysis. *The American Journal of Medicine*, *131*(6), 693–701. https://doi.org/10.1016/j.amjmed.2017.12.027

Bitterman, H. (2009). Bench-to-bedside review: oxygen as a drug. *Critical Care (London, England)*, *13*(1), 205. https://doi.org/10.1186/cc7151

Cabello, J. B., Burls, A., Emparanza, J. I., Bayliss, S., & Quinn, T. (2016). Oxygen therapy for acute myocardial infarction. *Cochrane Database of Systematic Reviews*. doi: 10.1002/14651858.cd007160.pub2

Chu, D. K., Kim, L. H.-Y., Young, P. J., Zamiri, N., Almenawer, S. A., Jaeschke, R., Szczeklik, W., Schünemann, H. J., Neary, J. D., & Alhazzani, W. (2018). Mortality and morbidity in acutely ill adults treated with liberal versus conservative oxygen therapy (IOTA): a systematic review and meta-analysis. *Lancet*, *391*(10131), 1693–1705.

https://doi.org/10.1016/S0140-6736(18)30479-3

Cowper, P. A., Knight, J. D., Davidson-Ray, L., Peterson, E. D., Wang, T. Y., Mark, D. B., & TRANSLATE-ACS Investigators. (2019). Acute and 1-year hospitalization costs for acute myocardial infarction treated with percutaneous coronary intervention: Results from the TRANSLATE-ACS registry. *Journal of the American Heart Association*, *8*(8), e011322. https://doi.org/10.1161/JAHA.118.011322

Girardis, M., Busani, S., Damiani, E., Donati, A., Rinaldi, L., Marudi, A., Morelli, A., Antonelli, M., & Singer, M. (2016). Effect of conservative vs conventional oxygen therapy on mortality among patients in an intensive care unit: The oxygen-ICU randomized clinical trial. *JAMA: The Journal of the American Medical Association*, *316*(15), 1583. https://doi.org/10.1001/jama.2016.11993

Hosp. Readmission reduction. (n.d.). Cms.Gov. Retrieved April 3, 2022, from https://www.cms.gov/Medicare/Quality-Initiatives-Patient- Assessment-Instruments/Value-Based-Programs/HRRP/Hospital-Readmission-Reduction-Program

Hofmann, R., Witt, N., Lagerqvist, B., Jernberg, T., Lindahl, B., Erlinge, D., … DETO2X-SWEDEHEART Investigators (2018). Oxygen therapy in ST-elevation myocardial infarction. *European heart journal*, *39*(29), 2730–2739.

Li, W.-F., Huang, Y.-Q., & Feng, Y.-Q. (2018). Oxygen therapy for patients with acute myocardial infarction: a meta-analysis of randomized controlled clinical trials: A meta-analysis of randomized controlled clinical trials. *Coronary Artery Disease*, *29*(8), 652–656. https://doi.org/10.1097/MCA.0000000000000659

Melnyk, B. M., & Fineout-Overholt, E. (2015). *Evidence-based practice in nursing and healthcare: A guide to best practice*. Philadelphia, Pa. etc.: Wolters Kluwer.

Nehme, Z., Stub, D., Bernard, S., Stephenson, M., Bray, J. E., Cameron, P., Meredith, I. T., Barger, B., Ellims, A. H., Taylor, A. J., Kaye, D. M., Smith, K., & AVOID Investigators (2016). Effect of supplemental oxygen exposure on myocardial injury in elevation myocardial infarction. *Heart (British Cardiac Society)*, *102*(6), 444–451. https://doi-org.ezproxy.uttyler.edu/10.1136/heartjnl-2015-308636

Ni, Y.-N., Wang, Y.-M., Liang, B.-M., & Liang, Z.-A. (2019). The effect of hyperoxia on mortality in critically ill patients: a systematic review and meta analysis. *BMC Pulmonary Medicine*, *19*(1), 53. https://doi.org/10.1186/s12890-019-0810-1

O'Connor, R. E., Al Ali, A. S., Brady, W. J., Ghaemmaghami, C. A., Menon, V., Welsford, M., & Shuster, M. (2015). Part 9: Acute coronary syndromes: 2015 American heart association guidelines update for cardiopulmonary resuscitation and emergency cardiovascular care. *Circulation*, *132*(18_suppl_2). https://doi.org/10.1161/cir.0000000000000263

Ranchord, A. M., Argyle, R., Beynon, R., Perrin, K., Sharma, V., Weatherall, M., … Beasley, R. (2012). High-concentration versus titrated oxygen therapy in ST-elevation myocardial infarction: A pilot randomized controlled trial. *American Heart Journal*, *163*(2), 168–175. doi: 10.1016/j.ahj.2011.10.013

Raut, M. S., & Maheshwari, A. (2016). Oxygen supplementation in acute myocardial infarction: To be or not to be? *Annals of Cardiac Anaesthesia*, *19*(2), 342–344. https://doi.org/10.4103/0971-9784.179594

Rodgers, C., Brown, T., & Hockenberry, M. (2019). Implemeting Evidence in Clinical Settings. In B. M. Melnyk & E. Fineout-Overholt (Eds.), *Evidence- based practice in nursing and healthcare: A guide to best practice* (4th ed., pp. 314–337). Lippincott Williams and

Wilkins.

Sepehrvand, N., James, S. K., Stub, D., Khoshnood, A., Ezekowitz, J. A., & Hofmann, R. (2018). Effects of supplemental oxygen therapy in patients with suspected acute myocardial infarction: a meta-analysis of randomized clinical trials. *Heart (British Cardiac Society)*, *104*(20), 1691–1698. https://doi.org/10.1136/heartjnl-2018-313089

Stub, D., Smith, K., Bernard, S., Nehme, Z., Stephenson, M., Bray, J. E., Cameron, P., Barger B., Ellims, A. H., Taylor, A. J., Meredith, I. T., Kaye, D. M., & AVOID Investigators (2015). Air Versus Oxygen in ST-Segment-Elevation Myocardial Infarction. *Circulation*, *131*(24), 2143–2150. https://doorg.ezproxy.uttyler.edu/10.1161CIRCULATIONAHA.

Wijesinghe, M., Perrin, K., Ranchord, A., Simmonds, M., Weatherall, M., & Beasley, R. (2009). Routine use of oxygen in the treatment of myocardial infarction: systematic review. *Heart (British Cardiac Society)*, *95*(3), 198–202. https://doi.org/10.1136/hrt.2008.148742