

BLUNT ABDOMINAL TRAUMA AND UNANTICIPATED
LAPAROTOMIES: A CONCEPT ANALYSIS

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Abstract

Blunt abdominal trauma is one of the most prevalent and fatal injuries presenting in emergency departments (Mofidi et al., 2009). Due to high mortality rates, blunt abdominal trauma generally has a poor prognosis if undetected injuries lead to a delayed recognition of the need for a laparotomy, which increases a patient's risks for surgical complications. Researchers are utilizing many indicators, including base deficit, to identify the need for operating room (OR) intervention. The student researcher will conduct a concept analysis using Walker and Avant's (2005) eight-step model to explore base deficit. The purpose of this Honors Thesis is to analyze base deficit as a concept to better understand the role it plays in multiple patient clinical scenarios. The completion of a concept analysis will allow the use of this knowledge to inform clinical decision making. The goal is to provide information to a current ongoing research study at John Peter Smith Hospital. Researchers are looking at how different variables in combination with one another can indicate the need for OR intervention. Once these variables are identified, healthcare staff could potentially use electronic health records (EHR) to send alerts allowing medical providers to use these indicators to identify earlier in the treatment process when a patient needs operative intervention.

Introduction

Blunt abdominal is one of the most prevalent trauma injuries, bringing thousands of patients into the emergency department annually (O'Rourke, M., et al, 2020). Many patients who present to the Emergency Department after sustaining blunt trauma do not require a laparotomy. However, some patients present with an abdominal injury undetectable on scans, which after serial exams and trending of laboratory values results in a delayed laparotomy. Investigators in a large tertiary care center and Level I Trauma Center are currently examining the presence of indicators or factors in patients with blunt abdominal trauma that could help identify early warning signs of the need for laparotomy. The goal of the concept analysis is to identify these factors. The plan is to integrate the combination of identified variables into the clinical decision systems within the electronic health record (EHR) automated notification system to improve the healthcare team to identify earlier the need for surgical intervention in the operating room (OR).

Abdominal trauma can be challenging and complex due to the difficulty of diagnosing and locating the source, and treating the problem (O'Rourke, M., et al, 2020). Additionally, patients who undergo an emergency laparotomy have a complicated high mortality rate (Tolstrup et al., 2017). Additionally, Tolstrup et al., (2017) found that one in five patients who undergo an emergency laparotomy died. There is an existing need to reduce the mortality rates of patients with blunt traumatic injuries needing an emergency laparotomy.

The student researcher is engaged in a larger tertiary care center descriptive exploratory research study examining the potential for indices to the OR in blunt abdominal trauma. A retrospective chart review is currently underway to identify patients and factors supporting the need for an emergency laparotomy. However, this student researcher is evaluating one single potential indicator, base deficit, for her Texas Christian University (TCU) Honors Thesis.

Through this more extensive research study at John Peter Smith Hospital, the student researcher along with investigators, are looking to address the following questions:

- Can researchers prevent delayed treatment in patients who are diagnosed with blunt abdominal trauma and improve outcomes?
- What factors or indicators can help detect the need for OR intervention sooner?
- What is base deficit, and can it be an indicator of OR intervention?
- Base deficit is one indicator that the body is undergoing stress as well as a predictor of internal blood loss (Mofidi et al., 2009).

Clinical Question

The student researcher's specific question is what is the existing knowledge about base deficit levels (arterial blood gas results) in patients as a predictor for critical clinical scenarios necessitating emergent interventions, including laparotomies?

Conceptual Model

The student used a four-component conceptual model, TABLE A. The traumatic event occurs (blunt abdominal impact or injury) and potential indicators (base deficit) for emergency laparotomy are identified. Next, the interventions (clinical system modeling, clinical decision-making tools to populate an alert to staff of medical status changes [laboratory findings]) to identify the need for operative intervention (emergency laparotomy). The outcome (reduced morbidity and mortality and nurses' ability to identify and use the early warning system) would show that the implementation of the combined use of variables to prevent delayed surgical intervention in patients needing an emergent laparotomy. This conceptual model identifies how research on base deficit combined with other variables such as lactate and heart rate can help lead to earlier, successful intervention in patients with blunt abdominal trauma. This earlier

intervention of laparotomy is a result of isolating the specific combination of variables which changes how healthcare providers can diagnose and quickly treat patients with blunt abdominal impact or injury. The thought is that once these isolated variables are identified and programmed into the EHR system would be able to put out an automatic notification to alert healthcare providers of the possible need for a laparotomy.

Methods

Base deficit was explored to clarify an ambiguity in how it has been defined and measured for patients with blunt abdominal trauma and in other traumatic and non-traumatic medical cases. The expected outcome is that a significant base deficit level will serve as a reliable indicator in patients with any traumatic medical event. Facilitating nurses will be able to identify changes in patients' status in those who have experienced traumatic injuries. A four-step medical model and eight-step concept analysis framework will serve as the guide in discovering the role of base deficit in measuring changes in medical status for patients who have experienced a traumatic medical event (Walker & Avant, 2005.)

The student researcher used the following databases to collect and analyze the concept of base deficit: Medline, Wiley Online Library, Cochrane Library, Embase, PubMed, and ProQuest to search the literature. Search terms included "base deficit," "blunt abdominal trauma," "indicators for," "laparotomy," and "emergen*," "sepsis," "acid-base balance," "pH," "the significance of," "experimental," "randomized," "acid," "base," "surg*," "mortality rate," "causes of," "morbidity," "death," and "arterial blood gas." Due to the large volume of trauma patients who have blunt trauma, inclusion criteria included patients above the age of eighteen, only inpatient patients or in the hospital setting, articles written in English, both quantitative and qualitative research methods, and published literature within the last twenty years. Exclusion

criteria were patients under the age of 18, patients who had been discharged from the hospital or emergency department, studies written in any other language than English, articles dated older than 20 years, dissertations, editorials, newspapers, and opinion papers.

Concept

Base deficit, a value determined through blood analysis, can be an indicator of numerous clinical findings. *Base deficit* is defined as a chemical imbalance in the body in which there are not enough bases creating an acidotic state, indicating excess acid production (“26.5 Disorders of Acid-Base Balance,” 2013). *Base excess* is the exact opposite where there are too many bases and not enough acids, leading to an alkalotic state with excess base production (“26.5 Disorders of Acid-Base Balance,” 2013). This elevated acid production is what can tell us specific trends and condition status about patients regarding respiratory status, the amount of compensation the body is attempting, sepsis indicators, along with a large number of other values.

Purpose of Analysis

The purpose of conducting an analysis on base deficit is to better understand this specific variable and its impact on a patient’s condition and treatment plan. By conducting a concept analysis, base deficit is being explored across all current data to better understand its predictive or trending nature. The hope is that by completing a data analysis on all concepts of base deficit, determination can be made whether base deficit is a predictive value in the need for an emergent laparotomy in blunt abdominal trauma.

Use of Concept

Base deficit has been utilized in a variety of settings to help clinicians better understand what is going on in the body. Base deficit has also been studied as an indicator in other cases. Abdul-Malak et al., (2016), discovered that an elevated base deficit upon admission to the

hospital has the potential to indicate a change in the patient's immune system/inflammatory pathways which could necessitate a change in the patient's treatment. Next, Cheddie, et al. (2013) discovered that base deficit can indicate a patient's impairment in coagulation. One of the other areas of exhausted investigation regarding base deficit is its ability to indicate mortality in pesticide poisoning (Lee et. al, 2018). Javali et al., (2017) identified trauma as having the highest death rate in India. These researchers conducted a study to look at the relationship between lactate and base deficit and their relationship with mortality rates. They found that elevated lactate and base deficit can indicate a higher mortality rate, severity of the patient's condition and indication for needed blood products (Javali et al., 2017). Lastly, the indication of base deficit can vary on the type of injury sustained by the patient. Tremblay et al. (2002) found that base deficit is specifically best in predicting mortality or level of hypoxemia in patients with gunshot wounds or blunt trauma.

However, while the current literature has already identified base deficit as an indicator associated with blunt abdominal trauma, it has not examined at base deficit as an indicator for surgical intervention. Mofidi et al. (2010) studied the effects of using base deficit as an indicator to identify intra-abdominal injury after blunt abdominal trauma and found that base deficit can show that the patient has an intra-abdominal injury and has a high need for transfusion. Similarly, Heidari et al. (2017) conducted a multi-center study and found that base deficit can indicate abdominal bleeding and an increased risk of mortality. They found that 21% of patients in the study did not survive, and these patients were initially admitted with the lowest base deficit (-7.24mEq/L). A study at the University of Nairobi conducted by Ojuka et al. (2017) looked at the exact values of base deficit to determine intra-abdominal injury. They determined that a base deficit of less than - 4.15 indicates abdominal injury. The current literature has

examined base deficit as an indicator in blunt trauma but lacks information on whether or not the patient needs OR intervention.

One of the most popular topics in the literature regarding base deficit is its role in patients who are in shock. In 2013, Privette gathered data and published an article suggesting the use of replacing or revising the current Advanced Trauma Life Support classification system. This author found that base deficit is highly predictive of hypovolemic shock in patients with blunt trauma. Similarly, Sixta et al., 2012 found that worsening base deficit correlates with hemorrhaging in trauma patients. Based on this data, base deficit can play a role in predicting the severity and potential shock in blunt trauma patients.

In a study conducted by Vasileiadis et al. (2019), people with asthma are at a higher risk for base deficit due to respiratory acidosis. While base deficit occurs more frequently in asthma exacerbations or episodes of crisis, quick intervention to correct base deficit should be included in the immediate treatment plan. In addition to respiratory problems, patients with cancer have an increased risk of base deficit. In 2011, Hajjar et al. conducted a study to determine the predictability of base deficit along with lactate in mortality of cancer patients. They concluded that every cancer patient in the ICU should have both lactate and an acid base value drawn to determine any acid base balance abnormalities such as base excess or base deficit that could be problematic and contribute to further complications (Hajjar et al., 2011). Patients with Chronic Kidney Disease (CKD) may also develop base deficit due to the buildup of hydrogen ions (acid) in the kidney caused by a lack of excretion due to decreased renal function (Kovesdy, C., 2020).

Defining Attributes

Blunt trauma occurs when an injury has no open, entrance, and/or exit wound, and is most commonly caused by falls and motor vehicle accidents (Lewis et al., 2017). When

analyzing indicators, the researchers are looking at levels of various regulators in the body, including acid-base balance. *Acid-base balance* is how “the body normally maintains a steady balance between the acids continually produced during normal metabolism and the bases that neutralize and promote the excretion of the acids” (Lewis et al., 2017, p. 825) represented by pH level. If the acid-base balance is not balanced, base deficit or base excess can occur. *Base deficit* is a chemical imbalance in the body in which there are not enough bases creating an acidotic state and indicating acid production. This level is measured through *arterial blood gases*, which measures the oxygen and acid-base balance through a patient’s artery (Lewis et al., 2017).

Model & Borderline Case

Walker and Avant (2011) describe the model case as a “pure case of the concept, a paradigmatic example, or pure exemplar” (p.163), one that encompasses all defining attributes of a concept. Additionally, they describe the borderline case as one that has some defining attributes, but not all of them (Walker & Avant, 2011). Currently, the existing research and evidence demonstrates a borderline case. The literature describes the relationship between base deficit and blunt abdominal trauma as a predictor of intra-abdominal bleeding and the need for a potential blood transfusion. It has also shown sensitivity between a high level of base deficit and mortality rate. However, ongoing research at a Tarrant County hospital is looking to create the model case for the relationship between base deficit and other variables such as lactate and heart rate to detect earlier need for surgical intervention in blunt abdominal injury or impact.

Related Case

Walker and Avant (2011) describe the related case as one that is complementary to the concept but does not contain “critical defining attributes.” Base deficit has been explored across multiple realms of healthcare. While the focus on the concept of base deficit and its role in blunt

abdominal impact and injury is more limited, the literature exhausts base deficit and its role in pesticide poisoning, hypoxemia, shock, immune and inflammatory pathways, asthma, CKD, and coagulation. The use of base deficit in these situations is the goal for research in base deficit and its sensitivity towards recognizing the need for surgical intervention.

Contrary Case

A situation where base deficit is unrelated to this concept is its potential for insensitivity. While much research shows the high predictability and sensitivity of base deficit in providing more information about the critical level of the patient, some research contraindicated this statement. Chawla et al. (2010), conducted a study that found that the level of base deficit can misrepresent the lactate level, specifically hyperlactatemia. Both lactate and base deficit are measurements that can determine levels of fluid resuscitation once patients are in the OR. These researchers concluded that with fluid administration, base deficit should not be correlated with the lactate level; rather point of care testing is more accurate (Chawla et al., 2010). Another research study conducted by Gustafson et al. (2015), examined the relationship between alcohol on lactate and base deficit levels. This research concluded that patients with positive serum alcohol levels could create a misrepresentation or incorrect positive base deficit and lactate values. This “false positive” could potentially lead to a higher number of laparotomies, which would result in more unnecessary surgeries.

Antecedents

When looking at base deficit in patients with metabolic acidosis, researchers found there are a variety of potential causes leading to acidosis, including: cyanide and carbon monoxide poisoning, arsenic, toluene, methanol, metformin, uremia, DKA, paraldehyde, iron, INH, lactate, ethylene glycol, and salicylates (Burger and Schaller, 2019). These listed factors are outside

factors that can increase a patient's base deficit exponentially in combination with their condition.

Looking at acidosis specifically ($\text{pH} < 7.35$), initial presenting clinical findings include headache, lethargy, confusion, tachycardia, nausea and vomiting, and shortness of breath. These symptoms present when the blood contains more acid and less bicarbonate ("26.5 Disorders of Acid-Base Balance," 2013).

According to existing literature, the most prominent adult patient populations that healthcare providers choose to order lab work to determine acid-base balance include trauma, ICU, and surgical patients. Additionally, when healthcare providers receive an acid base balance value, they are typically looking at a trend of values from arterial blood. Most commonly coupled with base deficit is the lactate value. While base deficit has been determined as a contributing factor in determining morbidity or mortality in Intensive Care Unit (ICU) patients, a study completed by Martin et al., 2006 analyzed the relationship between lactate and base deficit and which factor is more predictive of morbidity/mortality. They concluded that both factors have a predictive nature, but lactate is more specific on its own, whereas base deficit is more predictive when combined with other indices. This combination of looking at values in a relational term improve the predictability of base deficit as an indicator.

Consequences

Base deficit can take a toll on the human body and as evidenced by the literature is highly predictive of morbidity and mortality. When the body remains in an acidotic state, different disease processes or conditions can occur, including osteoporosis, kidney stones, and different forms of cancer (Pizzorno, 2015). Additionally, if the patient remains acidotic, a trend that can indicate a worsening illness. As evidenced by the literature, base deficit is used in the healthcare

setting in patients with Acute Respiratory Distress Syndrome, sepsis, DKA, heart failure, cardiac arrest, or asthma (Castro & Keenaghan, 2020). All of these complicated illnesses combined with a trend in base deficit can cause a decline in the patient's condition.

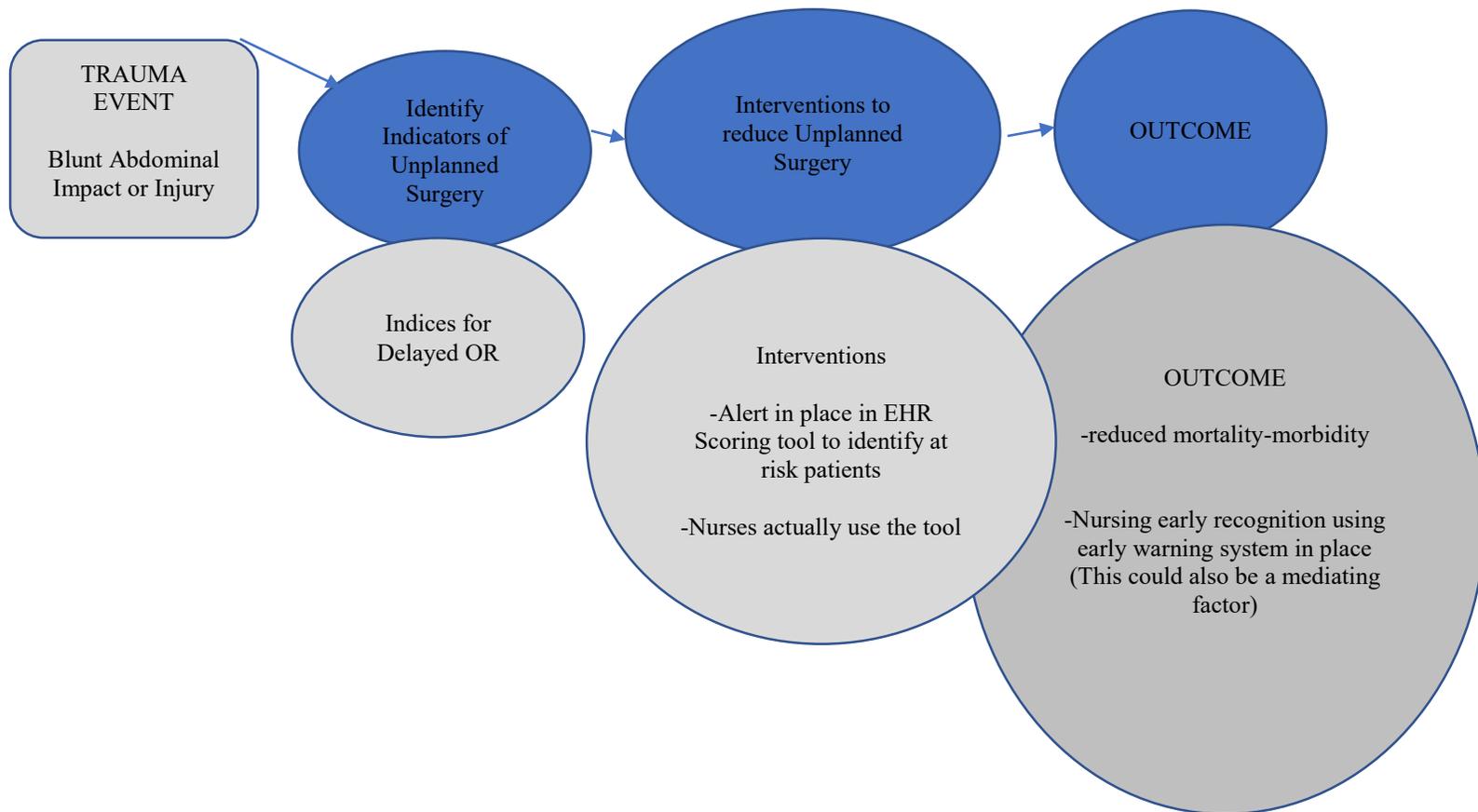
Empirical Referents

In CKD patients, base deficit results from the buildup of acids due to the kidneys impaired excretion ability. This chronic level of base deficit can lead to a number of secondary conditions, such as inflammation, hypotension, osteopenia, muscle breakdown, and an increased rate of mortality (Kovesdy, 2020). Additionally, patients in Diabetic Ketoacidosis (DKA) are in a state of acidosis due to the excessive buildup of β -hydroxybutyric and acetoacetic acids, therefore causing base deficit (Chaisson, et al., 2003). Once the body is in DKA, it attempts to compensate through hyperventilation. Base deficit will continue until the body's pH is restored through treatment of DKA. In patients with Duchenne muscular dystrophy, base deficit can occur due to the development of metabolic acidosis which can then become life threatening (Lo Cascio, et al., 2014).

Conclusion

Base deficit is used in a variety of patient populations to predict, determine, and evaluate the prognosis or status of a patient including morbidity and mortality rates. Based on current evidence and literature, base deficit plays a highly specific role in trauma. This idea shows potential for its predictability in detecting unseen intraabdominal hemorrhage or injury after a blunt traumatic injury. Once healthcare systems can more rapidly identify OR indicators based on other ongoing research, providers and nurses will be able to expeditiously identify which of their patients has a need for earlier operative intervention, thus improving overall morbidity and mortality of blunt abdominal trauma patients.

TABLE A:



References

- “26.5 Disorders of Acid-Base Balance” (2013). *Anatomy and Physiology*,
[openstax.org/r/anatomy-and-physiology-chapter/26-5-disorders-of-acid-base-balance/](https://openstax.org/r/anatomy-and-physiology-chapter-26-5-disorders-of-acid-base-balance/).
- Abdul-Malak, O., Vodovotz, Y., Zaaqoq, A., Guardado, J., Almahmoud, K., Yin, J., Zuckerbraun, B., Peitzman, A. B., Sperry, J., Billiar, T. R., & Namas, R. A. (2016). Elevated Admission Base Deficit Is Associated with a Complex Dynamic Network of Systemic Inflammation Which Drives Clinical Trajectories in Blunt Trauma Patients. *Mediators of Inflammation*.
- Burger M.K., & Schaller DJ. Physiology, Acidosis, Metabolic. [Updated 2019 Jun 4]. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2020 Jan-. Available from: <https://www.ncbi.nlm.nih.gov/books/NBK482146/>
- Castro, D., & Keenaghan, M. (2020). Arterial Blood Gas. In *StatPearls*. StatPearls Publishing.
- Chawla, L. S., Nader, A., Nelson, T., Govindji, T., Wilson, R., Szlyk, S., Nguyen, A., Junker, C., & Seneff, M. G. (2010). Utilization of base deficit and reliability of base deficit as a surrogate for serum lactate in the peri-operative setting. *BMC anesthesiology*, *10*, 16.
<https://doi.org/10.1186/1471-2253-10-16>
- Chiasson, J. L., Aris-Jilwan, N., Bélanger, R., Bertrand, S., Beaugard, H., Ekoé, J. M., Fournier, H., & Havrankova, J. (2003). Diagnosis and treatment of diabetic ketoacidosis and the hyperglycemic hyperosmolar state. *CMAJ: Canadian Medical Association Journal*, *168*(7), 859–866.
- Cheddie, S., Muckart, D. J. J., & Hardcastle, T.C. (2013). Base deficit as an early marker of coagulopathy in trauma. *South African Journal of Surgery*, *51*(3), 88.
- Gustafson, M., Hollosi, S., Chumbe, J., Samanta, D., Modak, A., & Bethea, A. (2015, January 23). The Effect of Ethanol on Lactate and Base Deficit as Predictors of Morbidity and Mortality in

Trauma. *The American Journal of Emergency Medicine*, 33(5), 607-613.

<https://doi.org/10.1016/j.ajem.2015.01.030>

Hajjar, L. A., Nakamura, R. E., de Almeida, J. P., Fukushima, J. T., Hoff, P. M., Vincent, J. L., Auler, J. O., Jr, & Galas, F. R. (2011). Lactate and base deficit are predictors of mortality in critically ill patients with cancer. *Clinics (Sao Paulo, Brazil)*, 66(12), 2037–2042.

<https://doi.org/10.1590/s1807-59322011001200007>

Heidari, K., Taghizadeh, M., Mahmoudi, S., Panahi, H., Ghaffari Shad, E., & Asadollahi, S. (2017). FAST for blunt abdominal trauma: correlation between positive findings and admission acid-base measurement. *The American Journal of Emergency Medicine*, 35(6), 823-829.

Javali, R. H., Ravindra, P., Patil, A., Srinivasarangan, M., Mundada, H., Adarsh, S. B., & Nisarg, S. (2017). A Clinical Study on the Initial Assessment of Arterial Lactate and Base Deficit as Predictors of Outcome in Trauma Patients. *Indian journal of critical care medicine: peer-reviewed, official publication of Indian Society of Critical Care Medicine*, 21(11), 719–725.

https://doi.org/10.4103/ijccm.IJCCM_218_17

Kovesdy, C. (2020). *Pathogenesis, Consequences, and Treatment of Metabolic Acidosis in Chronic Kidney Disease*. UpToDate. <http://www.uptodate.com/contents/pathogenesis-consequences-and-treatment-of-metabolic-acidosis-in-chronic-kidney-disease>.

Lee, S., Kim, D., Kim, T., Lee, S.H., Jeong, J., Kim, S.C., Park, Y.J., Lim, D., & Kang, C. (2018). Anion gap and base deficit are predictors of mortality in acute pesticide poisoning. *Human & Experimental Toxicology*, 38(2), 185-192. doi: 10.1177/0960327118788146

Lewis, S., Bucher, L., Heitkemper, M., & Harding, M. (2017). *Medical-surgical nursing*. St. Louis, Missouri: Elsevier, Inc.

- Lo Cascio, C. M., Latshang, T. D., Kohler, M., Fehr, T., & Bloch, K. E. (2014). Severe metabolic acidosis in adult patients with Duchenne muscular dystrophy. *Respiration; International Review of Thoracic Diseases*, 87(6), 499–503. <https://doi.org/10.1159/000358439>
- Martin, M. J., FitzSullivan, E., Salim, A., Brown, C. V. R., Demetriades, D., & Long, W. (2006). Discordance between lactate and base deficit in the surgical intensive care unit: Which one do you trust? *American Journal of Surgery*, 191(5), 625-630. Retrieved from http://library.tcu.edu.ezproxy.tcu.edu/PURL/EZproxy_link.asp?/login?url=https://search-proquest-com.ezproxy.tcu.edu/docview/67912515?accountid=7090
- Mofidi, M., Hasani, A., & Kianmehr, N. (2009). Determining the accuracy of base deficit in diagnosis of intra-abdominal injury in patients with blunt abdominal trauma. *The American Journal of Emergency Medicine*, 37(2), 227-228. doi: 10.1016/j.jemermed.2009.06.048
- O'Rourke, M.C., Landis, R., Burns, B. Blunt Abdominal Trauma. [Updated 2020 Jul 27]. In: StatPearls [internet]. Treasure Island (FL): StatPearls Publishing; 2020 Jan-. <https://www.ncbi.nlm.nih.gov/books/NBK431087>
- Ojuka, D., Nyongesa, D., & Ngugi, P. (2017). Base deficit as an indicator of significant blunt abdominal trauma. *Annals of African Surgery*, 14(2). doi: 10.4317/aas.v14i2.2
- Pizzorno, J. (2015, February). Acidosis: An Old Idea Validated by New Research. Retrieved August 31, 2020, from <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4566456/>
- Privette, A.R., & Dicker, R.A. Recognition of hypovolemic shock: using base deficit to think outside of the ATLS box. *Critical Care*, 17(124). <https://doi.org/10.1186/cc12513>
- Sixta, S. L., Hatch, Q. M., Matijevic, N., Wade, C. E., Holcomb, J. B., & Cotton, B. A. (2012). Mechanistic determinates of the acute coagulopathy of trauma (ACoT) in patients requiring emergency surgery. *International journal of burns and trauma*, 2(3), 158–166.

- Tolstrup, M. B., Watt, S. K., & Gögenur, I. (2017). Morbidity and mortality rates after emergency abdominal surgery: an analysis of 4346 patients scheduled for emergency laparotomy or laparoscopy. *Langenbeck's archives of surgery*, 402(4), 615–623.
<https://doi.org/10.1007/s00423-016-1493-1>
- Tremblay, L., Feliciano, D., Rozycki, G., & Morris, J. (2002). Assessment of initial base deficit as a predictor of outcome: mechanism of injury does not make a difference. *The American Surgeon*, 68(8), 689-694.
- Vasileiadis, I., Alevrakis, E., Ampelioti, S., Vagionas, D., Rovina, N., & Koutsoukou, A. (2019). Acid-Base Disturbances in Patients with Asthma: A Literature Review and Comments on Their Pathophysiology. *Journal of clinical medicine*, 8(4), 563. <https://doi.org/10.3390/jcm8040563>
- Walker, L.O., & Avant, K. C. (2005). *Strategies for theory construction in nursing*. Upper Saddle River, New Jersey: Pearson Education, Inc.