# BEHAVIORAL FACTORS ASSOCIATED WITH CLINICAL LABORATORY TEST UTILIZATION OF HEALTHCARE PROVIDERS IN AN INTENSIVE CARE UNIT

by

MICHELLE BROWN

LARRELL WILKINSON, COMMITTEE CHAIR
RETTA EVANS
JENNA LACHENAYE
SUMMER LANGSTON
LAWRENCE WILLIAMS

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MICHELLE R. BROWN

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ABSTRACT

**Purpose:** Hospital-acquired anemia occurs in 74% of patients in the intensive care unit, a considerable portion of this is due to diagnostic blood loss. Anemia is strongly associated with increased morbidity and mortality. The purpose of this study is to determine the behavioral factors which influence test ordering by healthcare providers and to examine the feasibility of implementing techniques to decrease unnecessary test ordering.

**Methods:** A mixed methods design was used to explore the knowledge, attitudes, behavioral control, and subjective norm of attending physicians, fellows, residents, and nurse practitioners relative to laboratory test utilization. A survey was created to assess these behavioral factors for the quantitative phase. The qualitative interview phase provided a more robust understanding of the behavioral factors that impact ordering practices.

**Analysis/Results:** The 18-question survey was distributed to 155 providers with 98 returning a completed survey for a 63.2% response rate. Means and standard deviations were calculated for each item. Interviews were recorded and transcribed verbatim. Thematic analysis was used to evaluate the interviews.

**Conclusions:** The diversity of the opinions represented in the data reaffirms the importance of understanding the behavioral factors associated with ordering laboratory

tests. Knowledge of the behaviors that influence evidence-based practice can be used to decrease overutilization of tests.

Keywords: test utilization, diagnostic blood loss, theory of planned behavior, mixed methods, hospital-acquired anemia

DEDICATION

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TABLE OF CONTENTS

*Page*

APPENDIX

LIST OF TABLES

*Table* *Page*

LIST OF FIGURES

*Figures* *Page*

REVIEW OF LITERATURE: HOSPITAL-ACQUIRED ANEMIA DUE TO DIAGNOSTIC BLOOD LOSS



DEVELOPMENT OF AN INSTRUMENT TO ASSESS HEALTHCARE PROVIDER ATTITUDES AND BELIEFS ABOUT HOSPITAL-ACQUIRED ANEMIA DUE TO DIAGNOSTIC BLOOD LOSS



HEALTHCARE PROVIDER BELIEFS ABOUT CLINICAL LABORATORY TEST ORDERING PRACTICES: A MIXED METHODS DESIGN USING THE THEORY OF PLANNED BEHAVIOR

LIST OF ABREVIATIONS

| | |
|---|---|
| AMI | acute myocardial infarction |
| ANH | acute normovolemic hemodilution |
| aPTT | activated partial thromboplastin time |
| BMP | basic metabolic profile |
| CAP | College of American Pathologists |
| CABG | coronary artery bypass graft |
| CBC w/diff | complete blood count with differential |
| CDST | clinical decision support tool |
| CVAD | central venous access device |
| FDA | food and drug administration |
| HAA | hospital-acquired anemia |
| HBV | hepatitis B virus |
| HCV | hepatitis C virus |
| HIV | human immunodeficiency virus |
| HLA | human leukocyte antigen |
| ICU | intensive care unit |
| IOM | Institutes of Medicine |
| IV | Intravenous |

| | |
|---|---|
| LOS | length of stay |
| MICU | medical intensive care unit |
| NAT | nucleic acid test |
| PT | prothrombin time |
| Qual | qualitative |
| Quan | quantitative |
| SABM | Society for the Advancement of Blood Management |
| TBICU | trauma and burn intensive care unit |
| TPB | theory of planned behavior |
| TRA | theory of reasoned action |
| VAMP | venous arterial blood management |
| WB:AC | whole blood to anticoagulant ratio |
| WBC | white blood cell |
| WHO | world health organization |

# INTRODUCTION

Anemia is a condition in which there is a decreased quantity of functional red blood cells which can lead to increased morbidity and mortality (Kassebaum, 2014). The World Health Organization (WHO) estimates that 1.62 billion people worldwide are affected by anemia (2008). This corresponds to 24.8% of the population. Anemia is pathophysiologically diverse and can be divided into three broad categories: blood loss, lack of red blood cell production, and increased rates of red blood cell destruction (NHLBI, 2014). Anemia can have a profound impact on quality of life (Kraai, 2012). People with anemia often experience fatigue, headache, depression, shortness of breath, tachycardia, and cognitive impairment (Yellen, 1997). They also experience compromised functional ability especially reduced exercise tolerance, less social interactions, and decreased pursuit of leisure activities (Cella, 2002).

Unfortunately, anemia can be a consequence of medical treatment or diagnostic procedures. When a new anemia develops after hospital admission, it is called iatrogenic or hospital-acquired anemia (HAA). The prevalence of HAA for inpatients is 74%, raising a large concern for medical facilities (Koch, 2013). HAA is especially common in critically ill patients in the intensive care unit (ICU). Corwin et al (2004) determined that within 48 hours of admission, nearly 70% of patients had a hemoglobin level of less than 12 g/dl. Optimal oxygen delivery occurs when hemoglobin levels are maintained above 12 g/dl. Proper oxygen delivery is essential for tissue healing, a process vital to most ICU patients. It is clear that decreasing rates of anemia should be a priority of our

healthcare system. Individual healthcare institutions need to assess the practices of healthcare providers which contribute to iatrogenic anemia.

## Etiology of Hospital-Acquired Anemia

HAA itself is multifaceted. It can result from hemodilution, procedural blood loss, or diagnostic phlebotomy (Lyon, 2013). For example, the infusion of intravenous (IV) fluids decreases the percentage of red blood cells in the blood. This percentage is called the hematocrit. A lower percentage of red blood cells carrying oxygen to the tissues as a result of increased fluids causes a type of pseudoanemia called dilutional anemia. It is the result of a relative decrease in hematocrit, not an absolute decrease. Acute normovolemic hemodilution (ANH) is another route of anemia. This intentional dilution is sometimes preferred in surgery so that when a patient bleeds during an operation, they are losing less red blood cells because the blood has been diluted (Parasa, 2016). With respect to procedural blood loss, some bleeding is expected during surgery. Institutions must ensure surgeons and operating room staff are using evidence-based practices known to minimize blood loss during surgery. Anemia due to diagnostic blood loss has been well studied (Vincent, 2002; Elzik, 2006; Kurnialia, 2014), small amounts of blood drawn for each diagnostic laboratory test ordered can results in a significant cumulative blood loss. Vincent et at found that an average of 285 ml/week was drawn from patients in the ICU. That is the same volume as a unit of packed red blood cells used for transfusion.

## Statement of the Problem

Diagnostic blood loss contributes to HAA, especially in the acute care setting. Unfortunately, a portion of the phlebotomy performed for laboratory tests is not necessary. According to the Institutes of Medicine (IOM), as much as 30% of US healthcare is duplicative or unnecessary (Smith, 2013). This includes laboratory testing. The American Board of Internal Medicine has partnered with over 70 medical specialty societies to create the Choosing Wisely® initiative. The Choosing Wisely® campaign was developed to support evidence-based care and decrease unnecessary testing (Mordon, 2014).

A review of the literature revealed several initiatives to decrease diagnostic blood loss through educational interventions (Thakkar, 2015) and computerized provider order entry (Procop, 2014). However, there have not been any studies analyzing HAA and diagnostic blood loss grounded in health behavior theory. Likewise, previous studies have not sought to understand behaviors associated with laboratory ordering practices. Despite a national awareness of unnecessary testing, the University in this study maintains higher frequencies of testing than comparable institutions (Sherry Polhill, personal communication June 1, 2016).

## Purpose of the Study

The purpose of this study was to assess perceptions of hospital-acquired anemia of providers in the medical intensive care unit and to explore the behavioral factors that influence test ordering by healthcare providers on the MICU. To accomplish this,

researchers designed, piloted, and utilized a new instrument grounded in the Theory of Planned Behavior to explore these behavioral factors. This instrument assessed knowledge, attitudes, subjective norms, and perceived behavioral control of HAA due to diagnostic blood loss of attending physicians, fellows, residents, and nurse practitioners who practice in an intensive care unit setting. A mixed methods approach was used to elucidate the factors influencing the decision to order clinical laboratory tests in relation to HAA.

## Rationale

Theory has been used to assess decision-making by healthcare providers, but it has not been used with test ordering practices and HAA. Dr. Patricia Goodson, in her text, *Theory in Health Promotion, Research, and Practice* (2010) describes how theory and practice should be linked in order better understand relationships of the researched phenomena. As an extension to this proposition, it is essential to determine which theory is best suited for gaining an understanding of the research problem. In this study, the researchers assessed the intention of healthcare providers to decrease the potential for HAA in their patients through decreasing the amount of blood drawn for diagnostic tests. The Theory of Planned Behavior uses the constructs of attitudes, subjective norm, and perceived control to predict intention to perform a certain behavior (Azjen, 1977). Azjen posits that the intention to perform a certain behavior is the biggest predictor of actual behavior change.

## Specific Aims

The specific aims of this research are to:

1. Assess perceptions of hospital-acquired anemia in the MICU.

2. Determine the behavioral factors that influence test ordering by healthcare providers on the MICU.

## Research Questions

*Quantitative evaluation will answer the following questions:*

1. For healthcare providers in the MICU, what is the knowledge, attitudes, subjective norm, and perceived control of HAA due to diagnostic blood loss?

*Qualitative evaluation will answer the following questions:*

1. How do healthcare providers attitudes, subjective norm, and perceived behavioral control of HAA due to diagnostic blood loss influence test ordering in the MICU?

2. What common themes about test ordering and HAA due to diagnostic blood loss are revealed during interviews with healthcare workers in the MICU?

*Mixed methods research will answer the following question:*

1. What do the qualitative and quantitative data together reveal about test ordering practices and the perceptions of HAA due to diagnostic blood loss of healthcare providers in the MICU?

## Significance of the Study

The development of a new instrument addressed the need for an instrument to assess beliefs about HAA due to diagnostic blood loss of healthcare providers. The new instrument may be used by healthcare providers and researchers to collect data and determine the intentions of healthcare providers to decrease HAA due to diagnostic blood loss. It can also be used to identify target areas for intervention to influence appropriate test-ordering practices to decrease HAA due to diagnostic blood loss.

## Summary and Preview

HAA due to diagnostic blood loss is a major public health problem. A majority of ICU patients develop anemia within 48 hours of admission to the ICU. Healthcare providers are well-intentioned and aim to provide superior care for their patients. However, poor test utilization remains a concern in the hospital setting. The purpose of this mixed methods study was to assess perceptions of HAA and determine the behavioral factors which influence test ordering by healthcare providers on the MICU. The next section will review literature on theory-based decision-making by healthcare providers, HAA, phlebotomy best practices, and previously implemented interventions to decrease blood loss from diagnostic tests.

# REVIEW OF LITERATURE

## Anemia

Proper red blood cell number and function are essential for oxygenation of the tissues. Anemia results if red blood cells are not able to carry an adequate amount of oxygen to the tissues. Red blood cells are non-nucleated cells that circulate in the blood, deliver oxygen to the tissues, and remove carbon dioxide as a waste product. Within the red blood cell there is a protein called hemoglobin. A hemoglobin molecule consists of two alpha and two beta globin chains. Within each of these globin chains, there is a heme group that contains iron. Iron is what oxygen and carbon dioxide bind to in order to be transported between the lungs and the tissues (Harmening, 2009). The reference range for hemoglobin in women is 12-15 g/dl and 13.5-18 g/dl for men (Rodack, 2016). If a person's hemoglobin level drops below this reference range, tissue hypoxia occurs. Decreased hemoglobin levels lead to decreased tissue oxygenation and improper function of the body's organs and muscles.

## Anemia Associated with Morbidity and Mortality

Anemia is common in critically ill patients. Within 48 hours of ICU admission, nearly 70% of patients had a hemoglobin <12 g/dl (Corwin, 2004). Anemia is associated

with poor quality of life (Lucca, 2008), as well as, increased morbidity and mortality in hospitalized patients (Koch, 2013).

Evidence demonstrates increased length of stay (LOS) for patients who develope hospital acquired anemia. Koch et al (2013) calculated a 1.88-fold increase in LOS associated with hospital-acquired anemia when controlling for all comorbidities. In a large, multicenter study of patients with coronary artery bypass graft (CABG) the researchers established a primary association between preoperative anemia and increased postoperative cardiac and non-cardiac events (Kulier, 2007). They identified a low preoperative hemoglobin as an independent predictor of poor renal and central nervous system outcomes.

Studies have also established a relationship between anemia and mortality. Salisbury et al (2011) studied patients with acute myocardial infarction and hospital acquired anemia and found that the risk-adjusted odds ratio for in-hospital death was greater with moderate and severe anemia. Culleton et al studied over 17,000 older adults found an inverse relationship between hemoglobin and all-cause mortality. In this same study, researchers emphasized that the risk for adverse outcomes was higher in patients with normal kidney function, alerting clinicians to be mindful of anemia in the presence of normal renal function tests. Choi et al (2013) performed a retrospective review of medical record data for nearly 2,300 patients with acute myocardial infarction (AMI). Of the patients with AMI who developed HAA, acute kidney injury and chronic kidney disease were independent risk factors for long term mortality. Clearly, anemia is a concern, therefore, prevention of anemia should be a priority within our healthcare system.

## Hospital Acquired Anemia

Anemia may result from one or more of three possible etiologies: decreased red blood cell production, increased red blood cell destruction, and blood loss. When anemia develops due to medical treatment or diagnostic procedures, it is called hospital-acquired or iatrogenic anemia. Hospital-acquired anemia (HAA) is multifaceted and may result from hemodilution, procedural blood loss, and/or diagnostic blood loss (Lyon, 2013). HAA is not a new problem. In fact, in the 1970s, doctors described a nosocomial anemia that did not have an obvious cause (Eyster, 1973). Eyster et al sought to determine whether it was the result of "bloodletting" for diagnostic studies. They were correct in considering that phlebotomy was causing the anemia. The problem of HAA continues in the 21st century. In a study of 188,447 adult hospitalizations in the Cleveland Clinic Health System, Koch et al (2013) identified the prevalence of HAA to be 74%. Other iatrogenic diagnoses, such as infections and falls, occur in lower numbers, but receive more attention. This is possibly because anemia is considered an anticipated consequence of surgical procedures, intravenous fluids, and phlebotomy. It is vital to evaluate measures that can decrease the chances of HAA to increase patient safety and provide better care for patients.

### *Procedural Blood Loss*

Blood loss is common during surgery. Many methods are employed to decrease bleeding such as the use of tourniquets when dealing with extremities or with biomedical advances like minimally invasive robotic surgery. However, in major thoracic and

orthopedic surgeries, increased blood loss is inevitable. Acute anemia in the operating room is associated with increased morbidity and mortality (McEnvoy, 2013).

*Hemodilution*

Hemodiltuion is simply a decreased concentration of blood cells, electrolytes, and proteins resulting from an increase in fluid. This can occur through the infusion of intravenous fluids to increase intravascular volume and blood pressure, especially in critical care or through the process of acute normovolemic hemodilution (ANH) in the operating room. Fluid resuscitation ANH is a blood conservation modality used during major surgery (Parasa et al, 2016; Weber et al, 2007). The Society for the Advancement of Blood Management (SABM) defines ANH as a process where "whole blood is drained by gravity into blood collection bags containing anticoagulant. As blood is collected, asanguinous fluid, either colloid and/or chrystalloid, is infused to maintain hemodynamic stability and normovolemia" (2016). This dilution has the positive affect of decreasing the number of red cells that are lost during surgery. However, the processes of diluting the blood decreases the packed cell volume or the percentage of red blood cells that are available for the critical function of oxygen delivery to the tissues creating a HAA (Van et al, 2011).

*Phlebotomy*

Blood draws for laboratory analysis are essential for the diagnosis, treatment, and monitoring of patients. Additionally, advances in laboratory medicine and a greater

understanding of genetics and molecular diagnostics, have increased the number of laboratory tests from around 50 tests in 1970 to greater than 3,500 tests available through hospital and outreach laboratories (Hickner, 2014). With laboratory diagnostics playing such a large role in healthcare, it is no surprise that phlebotomy has been consistently implicated as one of the major causative factors for HAA.

Blood for the majority of these tests are drawn into tubes with either anticoagulants or clot activators, depending on the test to be performed. Each of these tubes requires between 1 mL and 10 mL of blood. Blood cultures, for the evaluation of sepsis, require 10-15 ml in each of two culture bottles (aerobic and anaerobic) for a total of 20-30 ml. Often blood cultures are drawn "times two" meaning two sets of two bottles are drawn for a total of 40-60 ml of blood loss. These small volumes quickly accumulate to a total volume that many intensive care unit (ICU) patients cannot tolerate without requiring pharmacologic intervention or transfusion. The volume of blood drawn for each patient varies by acuity and diagnosis. Corwin and Colleagues determined that an average of 70 ml of blood was drawn per day in ICU patients (1995). This was strictly for diagnostic blood tests. Another study found that patients in the ICU lose 25-40 ml daily from phlebotomy, this is more than three times the average daily blood loss of patients on the ward (Woodhouse, 2001). Vincent et al examined 1,136 patients and found that the mean blood loss due to phlebotomy was 41 ml/day/patient. This equates to approximately 285 ml/week. An average unit of packed red blood cells is between 250 and 350 ml. Anemia due to diagnostic blood loss is not a new concern. In 1986, Smoller et al determined that 762.2 ml of blood per patient was drawn during hospital stays in the

ICU vs 175.0 ml drawn on the ward (Smoller, 1986). These data highlight that HAA is especially a concern for ICU patients.

Blood for most laboratory analyses can be drawn directly from a peripheral vein or from a vascular access device in a larger, more central vein.

*Peripheral phlebotomy*

The preferred and most common site for peripheral phlebotomy is the antecubital fossa, or the area on the inside of the elbow (Strasinger, 2011). Peripheral phlebotomy in this area is relatively simple and requires minimal skill with either an evacuated tube or syringe (Appendix A). Evacuated tubes contain a vacuum which draws a specified amount of blood into the tube.

The proper amount of blood in the tube is essential for maintaining the required whole blood to anticoagulant ratio (WB:AC). If too little blood is collected in the tube, the result is an decreased WB:AC altering the results and subsequent interpretation of some laboratory tests. For example, hemostasis of a patient is assessed through tests such as the prothrombin time (PT) and activated partial thromboplastin time (aPTT). If under-filled tubes are analyzed, the patient would appear to be over-anticoagulated. Treatment would subsequently be adjusted to decrease the anticoagulation of the patient to decrease the chances of bleeding. This would be an incorrect adjustment based on an incorrect result caused by improper blood collection. If tubes are over-filled with whole blood, there will not be enough anticoagulant in the tube to prevent the blood from clotting. The clinical laboratory will not accept under-filled or over-filled tubes. The specimen would

have to be collected again, resulting in an increased amount of blood drawn from the patient. Increasing the risk of HAA. Likewise, a clotted specimen resulting from an over-filled or unmixed tube cannot be analyzed.

Blood collection tubes can be filled directly from the needle when using a straight needle (Figure 1). When using a winged infusion set (Figure 2), or butterfly needle, all tubes, with the exception of the light blue top, sodium citrate anticoagulant tube, can be filled without drawing a waste tube. With the light blue top tube collection, a waste tube should be drawn to remove air from the tubing since the volume must be precise for hemostasis testing. Again, increasing the total amount of blood drawn from the patient.

Figure 1. Straight needle with multi-tube adaptor for peripheral phlebotomy.

Figure 2. Winged infusion set with multi-tube adaptor for peripheral phlebotomy.

*Vascular access device*

If blood is drawn from an existing intravenous catheter, which is common in the ICU setting, a greater volume of blood is lost from phlebotomy. When drawing blood from a central venous access device (CVAD), the first sample of blood cannot be used due to contamination with fluid in the catheter. CVADs are often flushed with saline or heparin, an anticoagulant, to keep the line open and preventing clotting of the device. The amount discarded depends on the dead space volume in the line and the specimen type (Figure 3). For non-coagulation specimens, twice the dead space volume must be discarded. For coagulation specimens, six times the dead space volume or 5 mL should be drawn and discarded (Warekois and Robbins, 2015). These volumes of discarded blood must be considered when determining the amount of blood that has been lost due to diagnostic tests.

Figure 3. Central venous access device.

Blood drawn through CVADs and peripheral intravenous lines provide results equivalent to venipuncture when proper "waste" protocols are followed (Himberg, 2001). If a patient is receiving intravenous fluids, the blood drawn for analysis must be drawn from the opposite arm, or distal to (below) the IV insertion site. If the specimen is

collected above the IV, the analytes will be diluted which can affect the monitoring and treatment of the patient. Watson et al (1980) found that several analytes were greater than 2 standard deviations from baseline results on hematologic and biochemical profiles assessed in blood drawn proximal to (above) the IV site. Years later, Read et al (1988) analyzed the effect of discontinuing IV fluids for 3 minutes prior to drawing proximal to (above) an IV site. This practice resulted in a clinically negligible dilutional affect, but substances present at high levels in the infused solution may still be detectable.

These various pre-analytical complications with specimen collection contribute to the number of specimens which must be recollected in order to obtain a specimen which reflects the patient's pathophysiological status versus an incorrect picture due to specimens contaminated with IV fluids.

*Blood conservation device*

To decrease the amount of blood discarded prior to drawing from a central venous catheter, a device may be used that returns the blood which would normally be discarded immediately prior to blood sampling. One such device is the VAMP, the venous arterial blood management protection system. Several studies have demonstrated that this system decreases the amount of blood drawn for diagnostic tests, however, in some studies, they failed to decrease the number of transfusions required (Rezende, 2010; Mukhopadhyay, 2010). Other studies have found that the rate of decrease in the hemoglobin was not altered by the use of a blood conservation device and there is, therefore, no benefit to implementing the use of such a device (Mukhopadhyay, 2011).

*Small Volume Tubes*

In response to documented HAA due to diagnostic blood draws, tube manufacturers have designed small volume tubes to decrease the amount drawn with each phlebotomy. Clinical laboratory analyzers are expensive and require a certain size tube. Therefore, manufacturers have begun producing tubes which are the same size (12x75 mm or 12x100 mm), but contain less vacuum to fill the tubes. These tubes must also contain a lower volume of anticoagulant in order to maintain the proper anticoagulant to whole blood ratio. Less blood is collected in each tube resulting in less total blood drawn throughout each day. Dolman et al found a statistically significant decrease in the volume of blood drawn from ICU patients when using small-volume phlebotomy tubes in comparison to convention-volume phlebotomy tubes (2015). In this same study, the researchers determined there were fewer transfusions, but the decrease was not statistically significant.

## Contributions of Test Over-Utilization to HAA

Nationally, there has been a focus on decreasing the number of unnecessary tests, treatments, and procedures (Zhi et al, 2013). Laboratory testing is a high volume activity that is included in this national focus. The American Board of Internal Medicine, along with over 70 medical society partners began the landmark Choosing Wisely® campaign to decrease wasteful testing and procedures and promote evidence-based decision making.

There is wide variation in usage of diagnostic tests between providers, regions, and specific institutions (Busby et al, 2013) which challenges clinicians, researchers, and

administration to question if these tests are being used appropriately. Zhi and colleagues performed a 15 year systematic review of studies published 1997-2012 that assessed appropriateness of laboratory testing. They determined the mean overutilization rate to be 20.6% (95% CI 16.2-24.9%). That is, 20.6% of blood drawn for laboratory analysis should not have occurred.

Due to the variation in patient presentation and progression through a medical diagnosis, firm guidelines for testing intervals have not been established. However, in a study assessing redundancy of test orders, Bates et al (1998) asserted that a chemistry profile should be ordered no more frequently than every 12 hours. They also determined that a complete blood count with differential (CBC w/diff) should only be performed every 36 hours. Through evaluation of test ordering on the Trauma and Burn Intensive Care Unit (TBICU) at UAB, it was determined that 36% of the CBC w/diff orders occurred at intervals less than 22 hours (Sherry Polhill, personal communication June 1, 2016). There needs to be an in depth study of test ordering behaviors of healthcare providers to understand their level of knowledge related to HAA due to diagnostic blood loss.

## Increased Transfusion Requirements

In addition to increased morbidity and mortality, blood loss from diagnostic phlebotomy is associated with increased transfusion requirements (Thavendiranathan, 2005; Chant, 2006). One means of increasing a person's oxygen carrying capacity is with transfusion of red blood cells. The transfusion of red blood cells can be a lifesaving

therapy, but it comes with risks. The causes of many of these risks are poorly understood and are therefore not preventable. Clinicians must carefully weigh the risks and benefits in order to make the best treatment decision for the patient. The decision to transfuse must be based on the patient's clinical condition paired with hemoglobin and hematocrit (Brown, 2012). Studies have demonstrated increased morbidity and mortality in patients who are transfused at a higher than recommended hemoglobin threshold (De Oliveira, 2012; Hebert, 1999; Paone, 2012). Therefore, the clinician ordering the transfusion must ensure that the decision is evidence-based, encompassing both clinical and laboratory data. Armed with this knowledge, the clinician must also consider the volume of blood drawn for diagnostic tests.

## Risks Associated with Transfusion

Researchers have extended studies beyond the impact of total volume of blood lost to evaluating the effect of phlebotomy on the need for transfusion. Kurnialia et al (2014) determined that iatrogenic blood loss due to phlebotomy can be severe enough to require transfusion and therefore the complications that come with blood components.

The general public is most likely concerned with infectious complications of transfusion such as the human immunodeficiency virus (HIV) or hepatitis when considering the risks of transfusions. Infectious complications are what the media emphasizes. Books like Bad Blood: Crisis in the American Red Cross (1998) detailed the transmission of viruses and bacteria through transfusion raised concerns with testing in donor centers. More recently it has been identified that more than 2,200 people in the

past 17 months have contract HIV through transfusion in India (Leonard, 2016). The Food and Drug Administration (FDA) recently lifted the lifetime ban on blood donation from gay men, again bringing the risk of disease transmission to the forefront of transfusion discussions. Though virus transmission is possible, the risk has greatly diminished with nucleic acid testing (NAT). Currently, the risk of transfusion-transmitted HIV and Hepatitis C (HCV) are 1:2 million, Hepatitis B (HBV) is 1:200,000 (NIH, 2012). It is important to think of transfusion as a liquid transplant. Though it may seem simple, it is complex. Severe, even fatal reactions can occur. Some of the risks associated with transfusion are incompatibility, acute lung injury, allergic reactions, graft vs host disease, and circulatory overload.

With consideration of the seriousness of these adverse effects of transfusion, the decision to transfuse must be evidence-based. This choice must not be determined out of habit or hurry. A patient should not receive a transfusion because she usually receives one during dialysis, nor should a patient be transfused in order to facilitate a quicker discharge. Patients will, on occasion, request a transfusion of packed red blood cells, because they are chronically anemic and feel tired. In this case alternatives with fewer risks and side effects should be considered.

Transfusion-related immunomodulation (TRIM) results from a person mounting an immune response to transfused blood components. This is mediated by allogenic mononuclear cells, soluble mediators derived from white blood cells (WBC), and soluble (human leukocyte antigen) HLA peptides in allogenic plasma (Vamvakas, 2007). Patient outcomes associated with TRIM range from mild to severe. Each unit transfused increases the risk of hospital acquired infection by 50% (Taylor, 2002) and increases the

patient's length of stay by 16-32% (Corwin, 2007). In addition, hospital acquired conditions will no longer be reimbursed unless they were present on admission (CMS, 2014). Additional adverse outcomes include myocardial infarction, atrial fibrillation, thrombotic events, renal failure, stroke, increased bleeding, delayed wound healing, increased time on ventilator support, among others.

Fatalities that result from transfusion are required to be reported to the FDA (CFR, 2014). The two leading causes of transfusion-related fatalities are from transfusion related acute lung injury and transfusion associated circulatory overload. These cannot be decreased or prevented with increased testing, increased funding, or more deliberate bedside safety measures, but only through decreasing transfusions. Decreasing transfusions can also affect the morbidity associated with transfusion - studies have shown a dose-response relationship (Niv, 2011). In other words, each unit transfused increases risk to the patient.

## Ordering of Laboratory Tests

The frequency and number of laboratory tests ordered directly affects the volume of blood drawn for diagnostic tests and therefore impacts the prevalence of HAA. With the number of laboratory tests expanding aggressively in recent years, several studies have been performed to assess the challenges in ordering and interpreting these tests. Hickner et al (2014) surveyed 1,768 internal medicine and family practice physicians and found that they were uncertain about *ordering* the tests in 14.7% of the diagnostic encounters and uncertain about the *interpretation* of the results in 8.3% of them.

Confusion about which test to order and what the result means for the diagnosis and treatment of the patient can lead to subsequent orders for tests to aid in this diagnosis or treatment. More tests equals more blood drawn from the patient.

Uncertainty in test ordering impacts anesthesiologists and surgeons as well. Routine pre-surgery laboratory orders have been found to be largely unnecessary (Haug, 1999; Chung, 2009; Bryson, 2006). However, preoperative labs continue to be drawn, increasing the volume of blood lost from phlebotomy. In one study, a chart review of 1,000 consecutive patients revealed that 52% of the records contained at least one unnecessary test (Katz, 2011). This prompted a national survey based on four standardized clinical scenarios. Through this national survey, it was determined that 46% of the scenarios had at least one unnecessary test ordered. Tests that do not contribute to the care of the patient, unfortunately still contribute to HAA without the added value of improve diagnosis and treatment.

## Duplicate testing

A 2016 study performed by the College of American Pathologists (CAP) evaluated test cancellations and their effect on patient care (Darcy, 2016). The study incorporated 52 institutions, and 1,118,845 specimens. They identified 3,471 canceled tests for a median cancellation rate 6.7 per 1000 accessioned tests. The primary reason cancellation occurred was due to a duplicate test request. Duplicate test orders were considered when a lab received orders for the same test twice within a short window or if an individual analyte is ordered and it was already determined to be part of a previously

ordered panel. For example, a test for potassium can be ordered individually or as part of a basic metabolic panel (BMP). The second most common reason for rejection was specimen quality – the pre-analytical variables discussed earlier. This emphasizes the need for thorough education and assessment on proper blood collection techniques. In each of these cases, no matter the reason, blood was collected and discarded without performing any laboratory analysis. Again, increasing blood loss and risk for HAA.

Institutions have tested and, in some cases, implemented policies to decrease over ordering of blood tests on patients. Stanford Children's Health took advantage of computerized provider order entry and limited the ability to schedule repeat complete blood counts, coagulation studies, and chemistry analysis to once per 24 hour period (Pageler, 2013). They significantly decreased the number of laboratory tests ordered without an increase in mortality or length of stay. While this was a simple and relatively easy intervention, some providers may feel they should have complete autonomy in caring for their patients and would resist a hard stop computer intervention requesting them to modify their order to ensure it fits with once-daily guidelines. The Cleveland Clinic implemented a similar intervention to the one at Stanford. They used a computer decision support tool (CDST) for 1,259 individual tests (Procop, 2014). In 2 years, 11,790 duplicate orders were avoided by using the CDST. With this CDST, the most recent test result was displayed so the provider could easily obtain the information she was seeking.

To impact the decision-making of practitioners, one institution documented the cumulative daily blood loss from phlebotomy (Foulke, 1989). They found that daily recording of the amount of blood drawn for laboratory testing significantly decreased the

total blood lost from phlebotomy. This study used manual documentation in the patient's medical record. Perhaps this could be accomplished through current electronic medical records, since this has been shown to be useful to providers in decision-making of diagnostic blood tests.

## Proposed Theoretical Framework

The Theory of Planned Behavior (TPB) posits that, collaboratively, the constructs of attitudes toward behavior, subjective norm, and perceived behavioral control shape an individual's intention (Ajzen, 1985). Intention is the strongest predictor of behavior. TPB expands the Theory of Reasoned Action (TRA) (Ajzen& Fishbein, 1977) to assess behaviors for which people do not have complete control. The TPB pairs perceived behavioral control with behavioral intention to predict behavioral achievement (Ajzen, 1991). Attitude toward the behavior provides a personal evaluation of the behavior and determines whether and individual perceives it as good, neutral, or bad. Subjective norm identifies beliefs about whether key people approve or disapprove of the behavior. Perceived behavioral control is the amount of power an individual feels they have over a choice (Glanz, 2008).

## Use of Theory in Provider Decision-Making

The Theory of Planned Behavior has been used to predict intention with decision-making in healthcare. Cote at al used the TPB to evaluate the intentions of 336 nurses to integrate research evidence into clinical decision-making (2011). They found that moral norm, normative beliefs, behavioral control, and past behavior supported intention to integrate research into clinical practice. Likewise, this theory has been used to assess healthcare professional's intention to use clinical guidelines (Kortteisto, 2010). The researchers determined that the factor most associated with intention for physicians was perceived control. For nurses and other healthcare professionals, it was subjective norm. The authors concluded that the theory of planned behavior was a suitable theoretical basis for implementing guidelines in clinical practice. Patient safety has been evaluated utilizing the theory of planned behavior as well. Paralleling the findings of Kortteisto et al, Javadi et al (2013) determined that subjective norms were the most influential factor in patient safety behavior of nurses in a healthcare setting. A systematic review by Godin and colleagues (2008) determined that TPB was the most widely used theory for assess in behaviors and intentions. The key theme that emerged was that TPB was the most relevant theory for studying the behaviors of healthcare professionals.

Anemia from diagnostic blood loss has been recognized for decades, however, it remains a source of morbidity and mortality in the ICU. These studies support the use of psychosocial theory to determine health behavior change by clinicians. It is important to understand these constructs and how they may affect the implementation of behavior change in clinical practice.

## Specific Aims

The specific aims of this research are to:

1. Assess the perceptions of hospital-acquired anemia in the MICU.
2. Determine the behavioral factors which influence test ordering by healthcare providers on the MICU.

## Research Questions

*Quantitative evaluation will answer the following questions:*

1. For healthcare providers in the MICU, employing a theoretical framework, what is the knowledge, attitudes, subjective norm, and perceived behavioral control of HAA due to diagnostic blood loss?

*Qualitative evaluation will answer the following questions:*

1. How do healthcare provider attitudes, subjective norm, and perceived behavioral control of HAA due to diagnostic blood loss influence test ordering in the MICU?
2. What common themes about test ordering and HAA due to diagnostic blood loss are revealed during interviews with healthcare workers in the MICU?

*Mixed methods research will answer the following question:*

1. What do the qualitative and quantitative data together reveal about test ordering practices and the perceptions of HAA due to diagnostic blood loss of healthcare providers in the MICU?

## Summary of Literature and Methods Preview

HAA increases morbidity and mortality of patients in the ICU. HAA can be decreased through lowering the amount of blood lost to phlebotomy. In order to decrease diagnostic blood loss, healthcare providers need to decrease the number unnecessary laboratory tests ordered. The next chapter provides details on the explanatory sequential mixed methods study designed to better understand the behavioral factors which influence test ordering and to examine techniques which may decrease unnecessary test ordering by healthcare providers

# METHODOLOGY

## Introduction

An exploration of the literature reveals that anemia from diagnostic blood loss is well-recognized. Some facilities have established interventions with varying success and sustainability (Pageler, 2013; Thakkar, 2015; Procop, 2014; Dolman, 2015; Kurniali, 2014). There are no theory-based studies which have sought to better understand clinician's perceptions of the effects of HAA on morbidity and mortality, clinician's perceptions of their contribution to hospital-acquired anemia, their ability to prevent or decrease it, or their normative beliefs relative to effective laboratory test utilization.

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## Research Questions

*Quantitative evaluation will answer the following questions:*

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4. What common themes about test ordering and HAA due to diagnostic blood loss are revealed during interviews with healthcare workers in the MICU?

*Mixed methods research will answer the following question:*

1. What do the qualitative and quantitative data together reveal about test ordering practices and the perceptions of HAA due to diagnostic blood loss of healthcare providers in the MICU?

This chapter examines the methodology used to construct an instrument to assess knowledge, attitudes, subjective norms, and perceived behavioral control of HAA due to diagnostic blood loss and clinical laboratory test ordering practices. As described in chapter two, theory has been used to assess decision-making by healthcare providers, but it has not been used with test utilization and HAA. A mixed methods approach was used to elucidate the factors influencing the decision to order clinical laboratory tests in relation to HAA.

This chapter discusses (a) the description and justification of the sequential explanatory design, (b) the study phases, sample selection, data collection procedures, data analysis plan, and the integration of the two phases of the study, and (c) study validity and reliability, and (d) the ethical considerations important to the proposed study methodology.

## Sequential Explanatory Mixed Methods Design

Teddlie and Tashakkori (2009) emphasized that a mixed methods approach is more advantageous than using qualitative or quantitative methods alone. Morse and Niehaus (2009) describe mixed methods as enriching and expanding the researchers understanding of the research problem by merging the distinct perspectives.

Mixed methods research design can differ in timing, priority, and integration (Ivankova, 2014). With respect to timing, data can be collected either sequentially or concurrently. Sequential designs are implemented as steps within distinct phases. In concurrent study designs quantitative and qualitative data are collected simultaneously. For this study, the researcher used a sequential mixed design. The findings from each phase lead to the creation of the components used in the subsequent phase.

Creswell and Plano Clark describe quantitative and qualitative methods as varying in their relative importance to answer a research question (2011). This is called priority or weighing. Either the quantitative or qualitative strand can be given priority, or the researchers may determine that each strand equally shares importance.

The research design for this study was also an explanatory mixed methods design. An explanatory design consists of first collecting quantitative data, then collecting qualitative data to provide a more robust explanation of the research phenomenon (Creswell, 2014). In this study, researchers used data from the quantitative survey to inform the development of the interview questions for the qualitative piece. Thematic analysis was used to better understand the actions (test ordering) of the providers. Through the interviews, researchers will seeks a deeper understanding of the behavioral factors associated with the decision to order laboratory tests.

Creswell (2009) emphasizes 4 key decisions used in determining the design of a mixed methods study:

1. What is the implementation sequence of the quantitative and qualitative data collection in the proposed study?
2. What priority will be given to the quantitative and qualitative data collection analysis?
3. At what stage in the research project will the quantitative and qualitative data findings be integrated?
4. Will an overall theoretical perspective be used in the study?

*Decision 1 – Implementation Sequence*

A sequential quantitative → qualitative design (QUAN → qual) was used for this study. A broad understanding of the factors associated with test ordering practices, HAA, and diagnostic blood loss was obtained through the newly designed instrument.

Understanding of these factors informed the generation of interview questions for various levels of practitioner – attending physicians, fellows, residents, physician assistants, and nurse practitioners. The qualitative portion provided a more in depth comprehension of the decision-making of the practitioners.

*Decision 2 – Priority*

The researchers anticipated placing greater emphasis on the quantitative phase, with the qualitative data playing a secondary role to refine the data gathered in the quantitative strand. However, as described by Teddlie and Tashakkori (2009) priority could not be completely determined before the study was implemented. Priority shifted to better understand the studied constructs. Quantitative data gave an understanding from a broad perspective, but the qualitative data provided the detail necessary to thoroughly understand the behavioral influences with HAA and test ordering practices.

*Decision 3 – Integration*

A connecting technique was used to integrate data in this study. The qualitative data was collected based on the results of data analysis in the initial quantitative strand. Final inferences were based on both phases of the study.

*Decision 4 – Theoretical Perspective*

As stated in chapter two, the foundation for this study was derived from the Theory of Planned Behavior (Azjen, 1997). TPB uses the constructs of attitudes, subjective norm, and perceived behavioral control to predict behavioral intention. Azjen proposed that intention is the immediate antecedent to behavior.

The researchers designed a two stranded explanatory mixed methods study (Table 1). The purpose of this study was to assess perceptions of HAA and determine the behavioral factors which influence test ordering by healthcare providers and to examine the feasibility of implementing techniques to decrease unnecessary test ordering by attending physicians, fellows, residents, physician assistants, and nurse practitioners on the MICU.

Table 1

*Phases, Procedures, and Products of a Mixed Methodology Study to Determine Behavioral Factors Associated with Test Utilization*

| PHASE | PROCEDURE | PRODUCT |
|---|---|---|
| **1 INSTRUMENT GENERATION** (3 WEEKS) | (1) Literature review<br>(2) Instrument generation<br>1) Domain identification<br>2) Item generation<br>3) Instrument formation<br>Note: Instrument grounded in the Theory of Planned behavior | (1) HAA-DBL Instrument |
| **2 INSTRUMENT REVIEW AND REVISION** (3 WEEKS) | (1) Instrument piloted with purposefully selected content experts<br>(2) Data calculations<br>(3) Thematic data analysis<br>(4) Peer debriefing<br>(5) Instrument revision | (1) Assess validity – face, content, construct<br>(2) Assess internal consistency<br>(3) Revise instrument |
| **3 QUANTITATIVE DATA COLLECTION** (8 WEEKS) | (1) Obtain buy-in from stakeholders and participants on medical intensive care unit (MICU) at UAB<br>(2) Recruit participants on MICU: attending physicians, fellows, residents, physician assistants, and nurse practitioners | (1) Quantitative data |
| **4 QUANTITATIVE DATA ANALYSIS** (4 WEEKS) | (1) Statistical data analysis (SPSS)<br>(2) Descriptive and inferential statistics | (1) Exploratory factor analysis<br>(2) Assess TPB construct relative to HAA-DBL |

| | | |
|---|---|---|
| | | (3) Determine interview question themes |
| **5 CONNECTING STAGE** (2 WEEKS) | (1) Interview question generation | HAA-DBL, MICU-specific questions |
| **6 QUALITATIVE DATA COLLECTION** (8 WEEKS) | (1) Conduct interviews informed by quantitative data | (1) Raw qualitative data |
| **7 QUALITATIVE DATA ANALYSIS** (4 WEEKS) | (1) Organize and transcribe data<br>(2) Code data and examine for themes | (1) Theme development and categorization |
| **8 INTERPRETATION OF QUANTITATIVE AND QUALITATIVE DATA** (4 WEEKS) | (1) Synthesize findings | (1) Determine potential areas for education on test utilization |

## Quantitative Phase

The initial two phases of the study describe the development of the instrument to assess knowledge, attitudes, subjective norms, and perceived behavioral control of hospital acquired anemia related to diagnostic blood (HAA-DBL). The researcher thoroughly reviewed literature on hospital-acquired anemia, phlebotomy practices and procedures, and theory-based decision-making by healthcare providers. Azjen's *Constructing a Theory of Planned Behavior Questionnaire* was used to guide the drafting of questions (2006). Through this process, domains of inquiry were established, theory-guided instrument items were drafted, and the full instrument was entered into Qualtrics. Questions were grouped by construct to create flow within the survey. The researcher

purposefully selected content experts to field test the instrument. Face validity, content validity, and construct validity were determined through this field test. The data was analyzed and critiques of the survey were used to revise the instrument.

The quantitative strand is represented in phases 3 and 4 of table 1. Prior to administering the new instrument, the researchers obtained buy-in from key stakeholders in the MICU at UAB. Support for the study was solidified, the instrument was distributed, and was data collected. At the end of the survey, researchers asked participants if they were willing to be contacted by phone or in person to be interviewed in order to gain a deeper understanding of their beliefs.

During the connecting stage, phase 5, the data from this quantitative phase was used to inform the generation of questions for the qualitative interview portion.

## Qualitative Phase

Phases 6 and 7 represent the qualitative portion of the study which provided a more robust understanding of ordering practices and clinician beliefs about HAA. Interviews were recorded and transcribed. Data was then coded and examined for themes.

In the final stage, phase 8, researchers considered data obtained through both phases of the design to interpret both quantitative and qualitative data.

## Study Population

Literature clearly delineates that patients in the ICU have more blood drawn than patients on the general ward (Smoller, 1986). Therefore, clinicians practicing in the ICU at UAB were targeted for this study. UAB is a 1,157-bed medical center in central Alabama (UAB, 2016). The largest academic medical center in Alabama and one of the largest in the country. The MICU was selected as the site from which to draw participants since it is an ICU that has been identified as having a large number laboratory tests ordered per patient (Sherry Polhill, personal communication June 1, 2016). Also, the patients are likely more stable than in other ICUs such as the trauma and burn unit and the surgical ICU. Multiple levels of practitioners were recruited to include valuable information on perceived control relative to rank in the healthcare system. Physician and advanced practice practitioner leadership on the MICU were asked to promote participation in the study.

## Survey Development

The survey was drafted to address the constructs of knowledge, attitudes, subjective norm and perceived control of diagnostic blood loss from laboratory tests. The survey that was sent to the content experts for the field test was 15 questions. Three questions addressed the construct of knowledge, four questions were related to attitudes, four related to subjective norm, and three for perceived behavioral control. The questions related to knowledge were multiple choice. The questions addressing the constructs of the theory of planned behavior were 7-point Likert scale questions modeling the design

prescribed by Icek Ajzen in the guide, *Constructing a Theory of Planned Behavior Questionnaire* (2006).

Content experts chosen for the field test were from professions identical to those of the participants that would complete the survey. They were also from the same institution. Three practitioners from each profession, nurse practitioners, residents, fellows, and attending physicians were contacted by email to solicit their participation in the instrument field test. They were asked to complete the survey and to provide feedback with the following questions:

- How long did it take you to complete the survey?
- Did you feel it was too long, too short, or about the right length?
- Were there any questions that were not very clear, if so which were they and how were they not clear?
- Are the answer options appropriate?
- Is there some I should add or delete?

Their feedback and subsequent modifications to the survey are summarized in table 2.

Table 2: Feedback and actions from field test of the TPB-based survey

| Pilot Participant | Concern | Action |
|---|---|---|
| **MW Attending Physician** | • Q6 not sure why asking about institution – do you mean because it would decrease costs<br>• Q8 and Q9 are similar | • To better understand enabling and reinforcing factors associated with behavior – no change to survey<br>• Q8 is about self-efficacy, Q9 perceived control – no change to survey |

| | | |
|---|---|---|
| | • Q11 asking about peers really isn't helpful<br>• Would switch the question about attending, fellow, resident, nurse practitioner, and put before licensed and use skip logic | • Assesses subjective norm – no change to survey<br>• Will move current Q17 ahead of current Q16 |
| **MM Attending Physician** | • Q3 I think they are more familiar with cc rather than ml<br>• For Q4-6 can you make it clearer that 1 is the strongest agreement? Could you add words such as strongly or weakly?<br>• The first word of the second line of Q 4-6 is capitalized and it should not be.<br>• In Q16, the interns do not have full license yet. Should you include that it is ok if they have limited license? | • Standard terminology is ml - no change to survey<br>• Discussed with experts, no modification made<br>• These are the answer choices, not part of the sentence, will be more clear in Qualtircs – no changes made to survey<br>• Modified question to include limited license |
| **JM Attending Physician** | • Residents may get temporarily tripped up on Q16 with the term "licensed" healthcare provider (interns are not yet licensed), but the answer will be 0-5 for all of them.<br>• Consider adding "years" to each response (a, b, c, d) | • Modified question to include limited license<br>• Modified survey to include the word years |
| **SL Nurse Practitioner** | • Q10 maybe add always. Not always indicated | • This would be inconsistent with Ajzen's design for TPB-based questionnaires |
| **AM Nurse Practitioner** | • No concerns | • No modifications made to survey |

| | | |
|---|---|---|
| **AP Nurse Practitioner** | • No concerns | • No modifications made to survey |
| **SS Fellow** | • It assumes I order labs in the MICU which is not true<br>• Perhaps a place for me to explain I am not a lab ordering provider | • Comment noted – comments solicited as a content expert in pathology<br>• No change to survey - actual survey will be distributed to ordering providers, comments solicited as a content expert in pathology |
| **JT Fellow** | • Would switch scale to where higher # = more benefit<br>• Add PGY level 7 in Q 18 | • Modification made<br>• Modification made |
| **TW Fellow** | • Q5 this is essentially true by default<br>• Q6 this is also true – tough to give a 1-7 value for this | • Opinion is specific to individual, need to capture this data for all participants – no changes made to survey<br>• Opinion is specific to individual, need to capture this data for all participants – no changes made to survey |
| **LR Resident** | • No concerns | • No modifications made to survey |
| **MS Resident** | • No concerns | • No modifications made to survey |
| **BC Resident** | • No concerns | • No modifications made to survey |

An amendment was submitted to the IRB describing the modifications to the survey.

IRB approval to distribute the final survey was obtained January 27, 2017. Modifications

to the survey were made in Qualtrics. The survey was reassessed for face validity by two health behavior and critical care medicine experts.

## Survey Distribution

The final 18- question survey was distributed to attending physicians, fellows, residents, and nurse practitioners via email with a link to the survey in Qualtrics (Appendix B and C). Leadership in the MICU were asked to support and encourage participation. All prospective participants have access to email and the internet through their worksite.

Contact information for the nurse practitioners, fellows, and attending physicians were obtained from MICU administration. The survey was distributed through Qualtrics February 14th. One week after distribution, there were zero surveys completed. After discussion with the lead nurse practitioner, it was determined that the institution blocked the surveys sent from Qualtrics. Subsequently, personal links were created and emailed from the principle investigator's personal email account February 21st. Invitations to complete the survey went to 12 nurse practitioners, 15 fellows, and 17 attending physicians. Sending the surveys to the residents was delayed because it coincided with UAB's 10-year accreditation by the Accreditation Council for Graduate Medical Education (ACGME). The internal medicine residency director, Dr. Jason Morris, MD, expressed that the residents has just completed many surveys related to the accreditation process. This would likely result in a low response rate. Investigators chose to delay

administering the survey to residents until March 14th. At this time, the survey was sent to 111, residents post graduate year (PGY) 1, 2, and 3.

## Interview Question Development

Interview questions were written based on the constructs of the TPB; attitudes, subjective norm, and perceived behavioral control (Appendix D). The participants identified all three constructs as impacting their test ordering practices. There were also questions in the interview that were written to elicit details on enabling factors and barriers to evidence-based clinical laboratory test ordering practices.

## Interviews

Interviews with those who agreed to be contacted followed the survey. These occurred via telephone May 10th through May 17th at a time convenient for the interviewees between 7:00 am and 10:00 pm. The interviews were recorded and transcribed verbatim after completion of the interview.

## Ethical Considerations

Research methodology for this study adheres to the guiding principles of the UAB Institutional Review Board (IRB): respect for persons, beneficence, and justice. The researcher submitted a data collection plan to the leadership of the MICU at UAB. The study was described and an information sheet was provided to all participants.

Researchers ensured all participant questions were answered prior to initiating the survey and/or interviews. Participants in the study were then asked to provide informed consent for the survey portion of the protocol (Appendix E). All participants who complete the quantitative phase of the study were asked if they were willing to be contacted for a follow up interview to provide greater detail on HAA due to diagnostic blood loss. The interview process had a separate informed consent process (Appendix F).

# HOSPITAL-ACQUIRED ANEMIA DUE TO DIAGNOSTIC BLOOD LOSS: POTENTIAL CAUSES, SOLUTIONS, AND PATIENT CARE IMPLICATIONS

MICHELLE BROWN, LANCE WILLIAMS, SUMMER POWERS, JENNA LACHENAYE, RETTA EVANS, LARRELL WILKINSON

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## Introduction

Anemia is a condition in which there is a decreased quantity of functional red blood cells which can lead to increased morbidity and mortality (Kassebaum, 2014). The World Health Organization (WHO) estimates that 1.62 billion people worldwide are affected by anemia, this corresponds to 24.8% of the population (2008). Anemia is pathophysiologically diverse and can be divided into three broad categories: blood loss, lack of red blood cell production, and increased rates of red blood cell destruction (NHLBI, 2014). Anemia can have a profound impact on quality of life (Kraai, 2012). It has been recognized for a decades that people with anemia often experience fatigue, headache, depression, shortness of breath, tachycardia, and cognitive impairment (Yellen, 1997). They also experience compromised functional ability especially reduced exercise tolerance, less social interactions, and decreased pursuit of leisure activities (Cella, 2002).

Unfortunately, anemia can also be a consequence of medical treatment or diagnostic procedures. When a new anemia develops after hospital admission, it is called iatrogenic or hospital-acquired anemia (HAA). The prevalence of HAA for inpatients is 74%, raising a large concern for medical facilities (Koch, 2013). HAA is especially common in critically ill patients in the intensive care unit (ICU). Corwin et al (2004) determined that within 48 hours of admission, nearly 70% of patients had a hemoglobin level of less than 12 g/dl. Optimal oxygen delivery occurs when hemoglobin levels are maintained above 12 g/dl. Proper oxygen delivery is essential for tissue healing, a process vital to most ICU patients. It is clear that decreasing rates of anemia should be a priority of our healthcare system.

Diagnostic blood loss (DBL) contributes to HAA, especially in the acute care setting. Unfortunately, a portion of the phlebotomy performed for laboratory tests is not necessary. According to the Institutes of Medicine (IOM), as much as 30% of US healthcare, as a whole, is duplicative or unnecessary (Smith, 2013). This includes laboratory testing. Unnecessary utilization has become such an important issue that the American Board of Internal Medicine has partnered with over 70 medical specialty societies to create the Choosing Wisely® initiative. The Choosing Wisely® campaign was developed to support evidence-based care and decrease unnecessary testing and treatment (Mordon, 2014). Despite a national awareness of unnecessary testing, HAA due to DBL remains a major public health problem. This paper will review historical perspectives of HAA and DBL, discuss causes and potential solutions, highlight the implications and impact on patient care, and shine a light on the challenge of implementing evidence-based clinical laboratory test utilization.

## Anemia Associated with Morbidity and Mortality

Anemia is common in critically ill patients. It is associated with poor quality of life (Lucca, 2008) and increased morbidity and mortality in hospitalized patients (Koch, 2013). Evidence demonstrates increased length of stay (LOS) for patients who developed hospital acquired anemia. Koch et al (2013) calculated a 1.88-fold increase in LOS associated with hospital-acquired anemia when controlling for all comorbidities. In a large, multicenter study of patients with coronary artery bypass graft (CABG) the researchers established a primary association between preoperative anemia and increased postoperative cardiac and non-cardiac events (Kulier, 2007). They identified a low

preoperative hemoglobin as an independent predictor of poor renal and central nervous system outcomes.

Studies have also established a relationship between anemia and mortality. Salisbury et al (2011) studied patients with acute myocardial infarction and hospital acquired anemia and found that the risk-adjusted odds ratio for in-hospital death was greater with moderate and severe anemia. Culleton et al (2006) studied over 17,000 older adults found an inverse relationship between hemoglobin and all-cause mortality. In this same study, researchers emphasized that the risk for adverse outcomes was higher in patients with normal kidney function, alerting clinicians to be mindful of anemia in the presence of normal renal function tests. Choi et al (2013) performed a retrospective review of medical record data for nearly 2,300 patients with acute myocardial infarction (AMI). Of the patients with AMI who developed HAA, acute kidney injury and chronic kidney disease were independent risk factors for long term mortality. Clearly, anemia is a concern therefore, prevention of anemia should be a priority within our healthcare system.

**Hospital Acquired Anemia (HAA)**

Anemia may result from one or more of three possible etiologies: decreased red blood cell production, increased red blood cell destruction, and blood loss. When anemia develops due to medical treatment or diagnostic procedures, it is called hospital-acquired or iatrogenic. HAA is multifaceted and may result from hemodilution, procedural blood loss, and/or diagnostic blood loss (Lyon, 2013).

HAA is not a new problem. In fact, in the 1970s, doctors described a nosocomial anemia that did not have an obvious cause (Eyster, 1973). In 1973, Eyster et al. reported that "bloodletting" / phlebotomy for diagnostic studies was indeed a significant cause of HAA. The problem of HAA continues in the 21st century. In a study of 188,447 adult hospitalizations in the Cleveland Clinic Health System, Koch et al (2013) reported a 74% prevalence for HAA. Ironically, other iatrogenic diagnoses, (e.g infection and falls) occur in lowers number, but receive more attention. This is possibly because anemia is considered an anticipated consequence of surgical procedures and therapeutic interventions. Given the aforementioned negative effects of anemia, one can understand the initiative to evaluate measures for decreasing HAA, in particular HAA due to unnecessary DBL.

*Phlebotomy*

Blood draws for laboratory analysis are essential for the diagnosis, treatment, and monitoring of patients. Additionally, advances in laboratory medicine and a greater understanding of genetics and molecular diagnostics, have increased the number of laboratory tests from around 50 tests in 1970 to greater than 3,500 tests available through hospital and outreach laboratories (Hickner, 2014). With laboratory diagnostics playing such a large role in healthcare, it is no surprise that phlebotomy has been consistently implicated as one of the major causative factors for HAA.

Blood for the majority of these tests are drawn into tubes with either anticoagulants or clot activators, depending on the test to be performed. Each of these tubes requires between 1 mL and 10 mL of blood. Blood cultures, for the evaluation of sepsis, require 10-15 ml in each (aerobic and anaerobic) culture bottle for a total of 20-30

ml. Often blood cultures are drawn "times two" meaning two sets of two bottles are drawn for a total of 40-60 ml of blood loss. These small volumes quickly accumulate to a total volume that many patients in the intensive care unit (ICU) cannot tolerate without requiring pharmacologic intervention or transfusion. The volume of blood drawn for each patient varies by acuity and diagnosis. Corwin and colleagues determined that an average of 70 ml of blood was drawn per day in ICU patients (1995). This was strictly for diagnostic blood tests. Another study found that patients in the ICU lose 25-40 ml daily from phlebotomy, this is more than three times the average daily blood loss of patients on the ward (Woodhouse, 2001). Vincent et al examined 1,136 patients and found that the mean blood loss due to phlebotomy was 41 ml/day/patient. This equates to approximately 285 ml/week. An average unit of packed red blood cells is between 250 and 350 ml. Anemia due to diagnostic blood loss is not a new concern. In 1986, Smoller et al determined that 762.2 ml of blood per patient was drawn during hospital stays in the ICU vs 175.0 ml drawn on the ward (Smoller, 1986). These data highlight that HAA is especially a concern for ICU patients.

As blood loss from laboratory tests is discussed, it is important to review methods used for phlebotomy. Blood for most laboratory analyses can be drawn directly from a peripheral vein or from a vascular access device in a larger, more central vein.

*Peripheral phlebotomy*

The preferred and most common site for peripheral phlebotomy is the antecubital fossa, or the area on the inside of the elbow. Peripheral phlebotomy in this area is relatively simple and requires minimal skill with either an evacuated tube or syringe.

Evacuated tubes contain a vacuum which draws a specified amount of blood into the tube.

The proper amount of blood in the tube is essential for maintaining the required whole blood to anticoagulant ratio (WB:AC). If too little blood is collected in the tube, the result is an increased WB:AC altering the results and subsequent interpretation of some laboratory tests. For example, hemostasis of a patient is assessed through tests such as the prothrombin time (PT) and activated partial thromboplastin time (aPTT). If under-filled tubes are analyzed, the patient would appear to be over-anticoagulated. Treatment would subsequently be adjusted to decrease the anticoagulation of the patient to decrease the chances of bleeding. This would be an incorrect adjustment based on an incorrect result caused by improper blood collection. If tubes are over-filled with whole blood, there will not be enough anticoagulant in the tube to prevent the blood from clotting. The clinical laboratory will not accept under-filled or over-filled tubes. The blood would have to be collected again, resulting in an increased amount of blood drawn from the patient. Increasing the risk of HAA. Likewise, a clotted specimen resulting from an over-filled or unmixed tube cannot be analyzed.

*Vascular access device*

If blood is drawn from an existing intravenous catheter, which is common in the ICU setting, a greater volume of blood is lost from phlebotomy. When drawing blood from a central venous access device (CVAD), the first sample of blood cannot be used due to contamination with fluid in the catheter. CVADs are often flushed with saline or heparin, an anticoagulant, to keep the line open and preventing clotting of the device. The amount discarded depends on the dead space volume in the line and the specimen

type. For non-coagulation specimens, twice the dead space volume must be discarded. For coagulation specimens, six times the dead space volume or 5 mL should be drawn and discarded (Warekois and Robbins, 2015). These volumes of discarded blood must be considered when determining the amount of blood that has been lost due to diagnostic tests.

Blood drawn through CVADs and peripheral intravenous lines provide results equivalent to venipuncture when proper "waste" protocols are followed (Himberg, 2001). If a patient is receiving intravenous fluids, the blood drawn for analysis must be drawn from the opposite arm, or distal to (below) the IV insertion site. If the specimen is collected above the IV, the analytes will be diluted which can affect the monitoring and treatment of the patient. Watson et al (1980) found that several analytes were greater than 2 standard deviations from baseline results on hematologic and biochemical profiles assessed in blood drawn proximal to (above) the IV site. Years later, Read et al (1988) analyzed the effect of discontinuing IV fluids for 3 minutes prior to drawing proximal to (above) an IV site. This practice resulted in a clinically negligible dilutional affect, but substances present at high levels in the infused solution may still be detectable.

These various pre-analytical complications with specimen collection contribute to the number of specimens which must be recollected in order to obtain a specimen which reflects the patient's pathophysiological status versus an incorrect picture due to specimens contaminated with IV fluids.

## Test Over-Utilization

Nationally, there has been a focus on decreasing the number of unnecessary tests, treatments, and procedures (Zhi et al, 2013). Laboratory testing is a high-volume activity in the medical setting that influences decisions for the patient that is included in this national focus. The American Board of Internal Medicine, along with over 70 medical society partners began the landmark Choosing Wisely® campaign to decrease wasteful testing and procedures and promote evidence-based decision making.

There is wide variation in usage of diagnostic tests between providers, regions, and specific institutions (Busby et al., 2013) which makes healthcare officials question if these tests are being used appropriately. Zhi and colleagues performed a 15-year systematic review of studies published 1997-2012 that assessed appropriateness of laboratory testing. They determined the mean overutilization rate to be 20.6% (95% CI 16.2-24.9%). That is, 20.6% of blood drawn for laboratory analysis should not have occurred.

Due to the variation in patient presentation and progression through a medical diagnosis, firm guidelines for testing intervals have not been established. However, in a study assessing redundancy of test orders, Bates et al (1998) asserted that a chemistry profile should be ordered no more frequently than every 12 hours. They also determined that a complete blood count with differential (CBC w/diff) should only be performed every 36 hours. There needs to be an in depth study of test ordering behaviors of healthcare providers to understand their level of knowledge related to HAA due to diagnostic blood loss.

## Implications of HAA for Patient Care

### Increased Transfusion Requirements

In addition to increased morbidity and mortality, blood loss from diagnostic phlebotomy is associated with increased transfusion requirements (Thavendiranathan, 2005; Chant, 2006). One means of increasing a person's oxygen carrying capacity is with transfusion of red blood cells. The transfusion of red blood cells can be a lifesaving therapy, but it comes with risks. The causes of many of these risks are poorly understood and are therefore not preventable. Clinicians must carefully weigh the risks and benefits in order to make the best treatment decision for the patient. The decision to transfuse must be based on the patient's clinical condition paired with hemoglobin and hematocrit (Brown, 2012). Studies have demonstrated increased morbidity and mortality in patients who are transfused at a higher than recommended hemoglobin threshold (De Oliveira, 2012; Hebert, 1999; Paone, 2012). Therefore, the clinician ordering the transfusion must ensure that the decision is evidence-based, encompassing both clinical and laboratory data. Armed with this knowledge, the clinician must also consider the volume of blood drawn for diagnostic tests.

### Ordering of Laboratory Tests

The frequency and number of laboratory tests ordered directly affects the volume of blood drawn for diagnostic tests and therefore impacts the prevalence of HAA. With the number of laboratory tests expanding aggressively in recent years, several studies have been performed to assess the challenges in ordering and interpreting these tests. Hickner et al (2014) surveyed 1,768 internal medicine and family practice physicians and

found that they were uncertain about *ordering* the tests in 14.7% of the diagnostic encounters and uncertain about the *interpretation* of the results in 8.3% of them. Confusion about which test to order and what the result means for the diagnosis and treatment of the patient can lead to subsequent orders for tests to aid in this diagnosis or treatment. More tests equals more blood drawn from the patient.

Uncertainty in test ordering impacts anesthesiologists and surgeons as well. Routine pre-surgery laboratory orders have been found to be largely unnecessary (Haug, 1999; Chung, 2009; Bryson, 2006). However, preoperative labs continue to be drawn, increasing the volume of blood lost from phlebotomy. In one study, a chart review of 1,000 consecutive patients revealed that 52% of the records contained at least one unnecessary test (Katz, 2011). This prompted a national survey based on four standardized clinical scenarios. Through this national survey, it was determined that 46% of the scenarios had at least one unnecessary test ordered. Tests that do not contribute to the care of the patient, unfortunately still contribute to HAA without the added value of improve diagnosis and treatment.

Duplicate testing

A 2016 study performed by the College of American Pathologists (CAP) evaluated test cancellations and their effect on patient care (Darcy, 2016). The study incorporated 52 institutions, and 1,118,845 specimens. They identified 3,471 canceled tests for a median cancellation rate 6.7 per 1000 accessioned tests. The primary reason cancellation occurred was due to a duplicate test request. Duplicate test orders were considered when a lab received orders for the same test twice within a short window or if an individual analyte is ordered and it was already determined to be part of a previously

ordered panel. For example, a test for potassium can be ordered individually or as part of a basic metabolic panel (BMP). The second most common reason for rejection was specimen quality – the pre-analytical variables discussed earlier. This emphasizes the need for thorough education and assessment on proper blood collection techniques. In each of these cases, no matter the reason, blood was collected and discarded without performing any laboratory analysis. Again, increasing blood loss and risk for HAA.

## Potential Solutions to Decrease HAA

### *Computer-Based Solutions*

Institutions have tested and, in some cases, implemented policies to decrease over ordering of blood tests on patients. Stanford Children's Health took advantage of computerized provider order entry and limited the ability to schedule repeat complete blood counts, coagulation studies, and chemistry analysis to once per 24 hour period (Pageler, 2013). They significantly decreased the number of laboratory tests ordered without an increase in mortality or length of stay. While this was a simple and relatively easy intervention, some providers may feel they should have complete autonomy in caring for their patients and would resist a hard stop computer intervention requesting them to modify their order to ensure it fits with once-daily guidelines. The Cleveland Clinic implemented a similar intervention to the one at Stanford. They used a computer decision support tool (CDST) for 1,259 individual tests (Procop, 2014). In 2 years, 11,790 duplicate orders were avoided by using the CDST. With this CDST, the most recent test result was displayed so the provider could easily obtain the information she was seeking.

To impact the decision-making of practitioners, one institution documented the cumulative daily blood loss from phlebotomy (Foulke, 1989). They found that daily recording of the amount of blood drawn for laboratory testing significantly decreased the total blood lost from phlebotomy. This study used manual documentation in the patient's medical record. Perhaps this could be accomplished through current electronic medical records, since this has been shown to be useful to providers in decision-making of diagnostic blood tests.

### Phlebotomy-Based Solutions

To decrease the amount of blood discarded prior to drawing from a central venous catheter, a blood conservation device may be used that returns the blood which would normally be discarded immediately prior to blood sampling. One such device is the venous arterial blood management protection system (VAMP). Several studies have demonstrated that this system decreases the amount of blood drawn for diagnostic tests, however, in some studies, they failed to decrease the number of transfusions required (Rezende, 2010; Mukhopadhyay, 2010). Other studies have found that the rate of decrease in the hemoglobin was not altered by the use of a blood conservation device and there is, therefore, no benefit to implementing the use of such a device (Mukhopadhyay, 2011).

Another potential solution, created by tube manufacturers, in response to documented HAA associated with DBL is small volume tubes, which would theoretically decrease the amount drawn with each phlebotomy. Clinical laboratory analyzers are expensive and require a certain size tube. Therefore, manufacturers have begun producing tubes which are the same size (12x75 mm or 12x100 mm), but contain less

vacuum to fill the tubes. These tubes must also contain a lower volume of anticoagulant in order to maintain the proper anticoagulant to whole blood ratio. Less blood is collected in each tube resulting in less total blood drawn throughout each day. Dolman et al found a statistically significant decrease in the volume of blood drawn from ICU patients when using small-volume phlebotomy tubes in comparison to convention-volume phlebotomy tubes (2015).

**Conclusion and Future Directions**

It is clear that HAA is a major problem in healthcare systems worldwide. While some HAA is unavoidable, such as blood loss associated with surgery, HAA secondary to DBL represents an avoidable cause of HAA, especially when considering the amount of duplicate and unnecessary testing that occurs in the course of medical treatment. Initiatives such as the Choosing Wisely® Campaign and computer-based solutions (i.e. practice alerts on the provider's screen) are important initiatives to combat HAA due to DBL. However, since little progress has been realized in the effort to decrease HAA secondary to DBL, more research and implementation is clearly needed. One such future direction is the study and understanding of provider's perceptions of HAA and their role in decreasing DBL. Though, computer-based solutions may be additive, it is possible that the mindset, perceptions, and beliefs of the ordering providers is what will ultimately lead to a meaningful decrease in HAA due to DBL.

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# DEVELOPMENT OF AN INSTRUMENT TO ASSESS HEALTHCARE PROVIDER ATTITUDES AND BELIEFS ABOUT HOSPITAL ACQUIRED ANEMIA DUE TO DIAGNOSTIC BLOOD LOSS

MICHELLE BROWN, JENNA LACHENAYE, LANCE WILLIAMS, SUMMER POWERS, RETTA EVANS, LARRELL WILKINSON

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Introduction

Anemia is a clinically significant finding in patients that is associated with increased morbidity and mortality (Kassebaum, 2014). Hospital-acquired anemia (HAA) is an anemia that results when a patient has a normal hemoglobin on admission and subsequently develops anemia during hospitalization (Noguez, 2016). Koch et al (2013) determined that 74% of inpatients develop HAA, raising concerns for healthcare facilities and their medical staff. There are three primary causes of HAA: hemodilution, procedural blood loss, and phlebotomy (Lyon, 2013). While all three play a role, the laboratory has the potential to make the most impact on HAA through evaluating blood loss due to diagnostic tests. The contribution of phlebotomy to HAA can be further broken down into many categories including overutilization of lab tests, rejected specimens, large volume tubes, waste when drawn from a central venous line, and the infamous "rainbow" draw utilized when the phlebotomist is unsure in which tube to collect a sample.

From a laboratory perspective, pathologists and medical laboratory scientists need to assess phlebotomy and test ordering practices to be sure that the amount of blood drawn is the minimum amount necessary for diagnosis and monitoring. The implementation of small volume tubes (Dolman, 2015) and blood conservation devices (Mukhopadhyay, 2010) have decreased the amount of blood drawn per test, but overutilization of laboratory tests remains a problem (Zhi, 2013). Efforts to decrease over utilization of laboratory tests have had mixed outcomes. Foulke et al (1989) found that alerting the providers to the amount of blood drawn for laboratory testing significantly decrease the amount of blood loss from phlebotomy. At the Cleveland

Clinic, a clinical decision support tool was used to decrease duplicate testing. The tool displayed the most recent result so the provider could assess the need for additional testing (Procop, 2014). Limiting the ability for providers to schedule repeat testing significantly decreased the number of laboratory tests ordered without an increase in mortality (Pageler, 2013). However, some of these interventions were difficult to sustain or were met with resistance from the ordering providers. An understanding of the attitudes and beliefs of providers is necessary to develop and implement an evidence-based, sustainable intervention.

The purpose of this study was to develop a survey instrument to determine the behavioral factors that influence test ordering by nurse practitioners, residents, fellows, and attending physicians in an ICU.

Theoretical Basis

The Theory of Planned Behavior (TPB) posits that, collaboratively, the constructs of attitudes toward behavior, subjective norms, and perceived control shape an individual's intention (Ajzen, 1985) (Figure 1). Intention is the strongest predictor of behavior. TPB expands the Theory of Reasoned Action (TRA) to assess behaviors for which people do not have complete control. Attitude toward the behavior provides a personal evaluation of the behavior and determines whether and individual perceives it as good, neutral, or bad. Subjective norm identifies beliefs about whether key people approve or disapprove of the behavior. Perceived control is the amount of power an individual feels they have over a choice (Glanz, 2008).

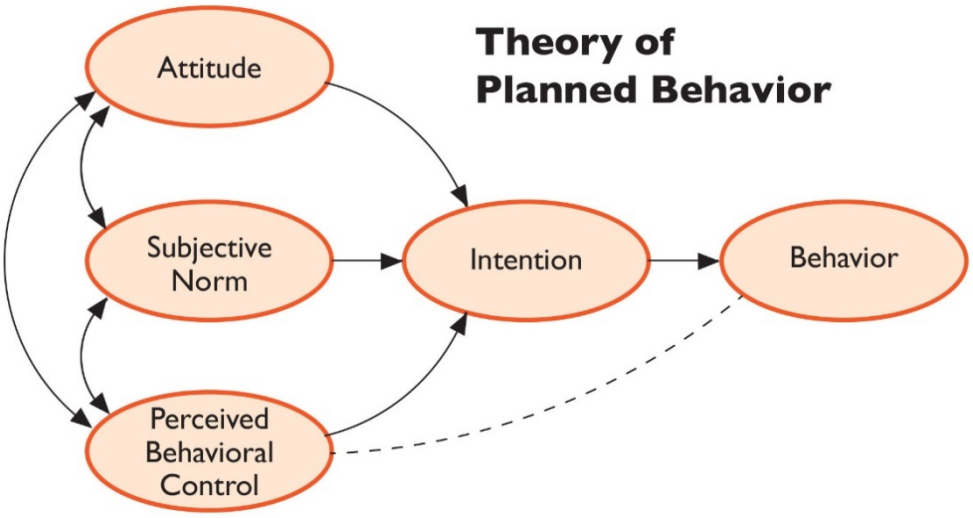


Figure 1: Framework for the Theory of Planned Behavior

The Theory of Planned Behavior has been used to predict intention with decision-making in healthcare. Cote at al used the TPB to evaluate the intentions of 336 nurses to integrate research evidence into clinical decision-making (2011). They found that moral norm, normative beliefs, behavioral control, and past behavior supported intention to integrate research into clinical practice. Likewise, this theory has been used to assess healthcare professional's intention to use clinical guidelines (Kortteisto, 2010). The researchers determined that the factor most associated with intention for physicians was perceived control. For nurses and other healthcare professionals, it was subjective norm. The authors concluded that the theory of planned behavior was a suitable theoretical basis for implementing guidelines in clinical practice. Patient safety has been evaluated utilizing the theory of planned behavior as well. Paralleling the findings of Kortteisto et al, Javadi et al (2013) determined that subjective norms were the most influential factor in patient safety behavior of nurses in a healthcare setting.

Anemia from diagnostic blood loss has been recognized for decades, however, it remains a source of morbidity and mortality in the ICU. These studies support the use of psychosocial theory to determine health behavior change by clinicians.

## Methods

### Design

In order to develop the Hospital-Acquired Anemia due to Diagnostic Blood Loss (HAA-DBL) survey instrument, three individual and sequential phases were undertaken: 1) item generation, 2) validity, and 3) internal consistency (Table 1).

| PHASE | PROCEDURES |
|---|---|
| **1 ITEM GENERATION** | 1) Comprehensive review of the literature<br>2) Item generation grounded in the TPB<br>• Attitude<br>• Subjective norms<br>• Perceived behavioral control |
| **2 VALIDITY** | 1) Content validity<br>• Review by experts in pathology and health behavior<br>• Field pretest with 12 experts reflecting the participant population (nurse practitioners, residents, fellows, and attending physicians)<br>2) Face validity<br>• Review by experts in scale development and survey research for completeness, grammar, and ease of use in the web-based application |
| **3 INTERNAL CONSISTENCY** | 1) Pilot test sent to 155 healthcare providers in an ICU<br>2) Determine Cronbach's alpha for each construct<br>3) Modify survey instrument to increase internal consistency |

Table 1: Phases of development of HAA-DBL survey instrument

Phase 1: Item generation

Experts in pathology and health behavior drafted an original 18-question survey to address the constructs of knowledge, attitudes, subjective norm and perceived control of diagnostic blood loss from laboratory tests. Three questions addressed the construct of knowledge, four questions were related to attitudes, four related to subjective norm, and three for perceived control. There were also four questions asking for demographic information. The questions related to knowledge were multiple choice. The questions addressing the constructs of the theory of planned behavior were 7 point Likert scale questions modeling the design prescribed by Icek Ajzen (2006).

Phase 2: Content, construct, and face validity

*Content and construct validity*

Content validity refers to the degree to which a set of items represents a content area (Devellis, 2016). An assessment of content validity was performed by experts in pathology and laboratory medicine and faculty with expertise in health behavior theory to refine questions for the initial field pretest. Subsequently, the instrument was field pretested by experts with a similar background as those who would participate in the survey. There were three people from each of the following provider categories used to review and provide feedback: critical care nurse practitioners, internal medicine and pathology residents, critical care and pathology fellows, and internal medicine, pathology, and emergency medicine attending physicians. The survey was distributed electronically in a Word document format and the providers were asked to provide feedback with the following questions:

- How long did it take you to complete the survey?
- Did you feel it was too long, too short, or about the right length?
- Were there any questions that were not very clear, if so which were they and how were they not clear?
- Are the answer options appropriate?
- Is there some I should add or delete?

They were asked to provide feedback within 3 weeks of receiving the survey. In response to their feedback, researchers modified the survey. Examples of modifications were wording changes to clarify how long the participant has been a licensed provider and reversing the scale so that the higher the number, the more positive or more benefit there is.

*Face validity*

Once the items were finalized, they were entered into Qualtrics and electronically sent to three healthcare professionals with experience in survey research to assess for face validity. The experts had minor corrections to wording and grammar. They confirmed ease of access and desirable user interface with use on a desk top computer, laptop computer, tablet, and phone.

Phase 3: Internal consistency

*Participants and Setting*

Literature clearly delineates that patients in the ICU have more blood drawn than patients on the general ward (Smoller, 1986). Therefore, clinicians practicing in the ICU were targeted for this study. UAB is a 1,157-bed medical center in central Alabama (UAB, 2016). After a review of routinely collected quality metrics of the number of

specimens collected by nursing units, the medical intensive care unit (MICU) was selected as the site from which to draw participants since it is an ICU that has been identified as having a large number laboratory tests ordered per patient. Moreover, the patients in the MICU are likely more stable than in other ICUs such as the trauma and burn unit and the surgical ICU. Physician and advanced practice practitioner leadership on the MICU fully supported the study and promoted staff participation. The research protocol was approved by the UAB Institutional Review Board.

The survey was electronically distributed via the Qualtrics platform to 155 participants: 12 nurse practitioners, 111 internal medicine residents, 15 pulmonary and critical care fellows, and 17 attending physicians. Individual personalized links were emailed to the targeted providers.

The final instrument to pilot consisted of 18 questions (Appendix A). The initial page of the online survey was the consent. Participants were asked to click "I agree" to indicate consent and to continue with the survey. Of the 18 questions, 3 questions assessed knowledge, 4 questions for attitude, 3 questions for behavioral control, and 4 questions for subjective norm. There were 4 demographic questions. The survey concluded by thanking the providers for their participation. They were asked to provide their name and email address if they were willing to be contacted to provide additional details about test ordering practices. Cronbach's alpha was calculated for each of the constructs, attitudes, subjective norms, and perceived control to determine internal consistency of the survey items.

Data analysis

SPSS 24.0 statistical software was used to analyze these data. Descriptive statistics were used for the study sample demographics and response rate. Internal consistency was determined using Chronbach alpha.

Results

Of the 155 surveys that were distributed, we received 106 completed for a response rate of 68.3%. Descriptive statistics of the participants included their job title that resulted in the following classification: 11 attending physicians, 12 fellows, 10 nurse practitioners, and 65 residents, 8 respondents chose not to answer the question. The respondents were primarily male (56 %) with most having 0-5 years experience as a licensed provider. We determined internal consistency of each of the constructs, attitudes, subjective norms, and perceived control, with Chronbach's alpha coefficients. The initial alpha coefficients for each of the constructs were low, therefore, item statistics were evaluated and the survey instrument was modified. Questions that lowered the reliability were removed, increasing the internal consistency for each construct (Table 2). Alpha coefficients are considered reliable at .70 and above. The higher the alpha, the more consistency there is in your items measuring a particular construct. The items that were removed were attitude question 7, behavioral control question 10, and subjective norm question 14. Interestingly, the questions related to Power Plans (test order sets) decrease the internal consistency for two different theoretical constructs; attitude and behavioral control.

The modification made to the number of survey questions based on the alpha scores requires that the survey be retested.

| SUBSCALE | N | # ITEMS | CRONBACH'S ALPHA |
|---|---|---|---|
| **ATTITUDE** | | | |
| **ORIGINAL** | 98 | 4 | .453 |
| **MODIFIED** | 98 | 3 | .696 |
| **BEHAVIORAL CONTROL** | | | |
| **ORIGINAL** | 98 | 3 | .230 |
| **MODIFIED** | 98 | 2 | .693 |
| **SUBJECTIVE NORM** | | | |
| **ORIGINAL** | 98 | 4 | .588 |
| **MODIFIED** | 98 | 3 | .708 |

Table 2: Internal consistency of original and modified surveys

Discussion

Decreasing the amount of blood drawn from patients in the ICU is essential to improving their outcomes. Through a thorough review of the literature, it was determined that there were no assessments or interventions grounded in health behavior theory aimed at decreasing the amount of blood lost due to phlebotomy based on test utilization. Here, we presented the pilot of a scale to assess the knowledge, attitudes, subjective norms, and behavioral control of health providers to make the decision to order clinical laboratory tests. Evaluating the Chronbach's alpha of the items within each of these constructs lead researchers to eliminate items to increase the internal consistency of the items. While dropping these items increased the reliability, it decreased the scale

length. Writing and piloting additional questions to increase scale length can increase reliability as long as the covariation of the items is minimal (Devellis, 2016).

The insight gained through the results of this survey can be used tailor interventions aimed at decreasing behaviors identified on one specific nursing unit. This should increase the success of the intervention.

Adding qualitative inquiry can provide a more comprehensive understanding of the factors that influence test ordering. The complexity of social phenomena and its impact on decision-making would benefit from integrating quantitative and qualitative methods within a mixed methods design. A future direction use of this survey is to incorporate it into a mixed methods study and use the data to inform interventions to improve ordering behaviors of healthcare providers.

Limitations

Limitations associated with the development of this scale include a response rate of 68.3%. A higher response rate would provide a more accurate picture of the factors that affect test ordering behaviors on the ICU. Moreover, the mood and the amount of sleep the participants had recently could have affected their responses. Internal medicine residents complete many rotations on various ICUs and wards. The culture on other ICUs and wards could have biased their perceptions of practices on the ICU that was assessed. This TPB-based study had alpha coefficients lower than what many researchers consider highly reliable. There were only a few items that assessed each of the constructs. Expanding the number of items would increase the reliability of the scale. All behaviors associated with test ordering were not assessed, only behaviors related to TPB.

Additional behaviors such as fear and past experience can greatly impact laboratory test selection and frequency.

## Conclusions

There are no survey instruments designed to assess the behavioral factors associated with the decision to order laboratory tests. This study involved an intentional process to develop a valid scale to provide insight on test ordering behaviors of healthcare providers. This is a short scale that can be administered to busy clinicians. It provides insight into the attitudes and beliefs of test ordering by healthcare providers.

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Appendix A

1. Please rate your knowledge of hospital acquired anemia/diagnostic blood loss due to phlebotomy.

a. no knowledge

b. beginner

c. intermediate

d. advanced

e. expert

2. What percent of patients who enter the ICU with a hemoglobin at or above 12 g/dl have a hemoglobin of less than 12 g/dl within 48 hours of admission?

a. 0% - 25%

b. 25% -50%

c. 50%- 75%

d. 75% - 100%

3. If central venous access is used, what volume of blood must be drawn and discarded prior to obtaining blood samples at UAB?

a. 2.5 ml

b. 5 ml

c. 7.5 ml

d. 10 ml

Please answer the following scale questions by circling the number that represents your opinion.

4. Decreasing the amount of blood drawn from my patients in the MICU would be

Not beneficial for my patients:__1__:__2__:__3__:__4__:__5__:__6__:__7__:Beneficial for my patients

5. Determining if a lab test is essential to the care of my patient before ordering it would be

Not beneficial for my patients:__1__:__2__:__3__:__4__:__5__:__6__:__7__:Beneficial for my patients

6. Decreasing the amount of blood drawn from my patients in the MICU would be

Not valuable to the institution:__1__:__2__:__3__:__4__:__5__:__6__:__7__:Valuable to the institution

7. Power Plans and order sets make patient care more efficient

Disagree:__1__:__2__:__3__:__4__:__5__:__6__:__7__:Agree

8. I am confident I can order lab tests which are indicated by my patient's clinical condition

Disagree:__1__:__2__:__3__:__4__:__5__:__6__:__7__:Agree

9. I am empowered to decide which lab tests are indicated by my patient's clinical condition

Disagree:__1__:__2__:__3__:__4__:__5__:__6__:__7__:Agree

10. I feel there are lab tests ordered based on a power plan or order set that are not indicated by the patient's clinical condition.

Disagree:__1__:__2__:__3__:__4__:__5__:__6__:__7__:Agree

11. My peers expect that I will only order lab tests that are indicated by the patient's clinical condition

Disagree:__1__:__2__:__3__:__4__:__5__:__6__:__7__:Agree

12. Most of the providers on MICU only order lab tests when indicated by the patient's clinical condition

Disagree:__1__:__2__:__3__:__4__:__5__:__6__:__7__:Agree

13. My fellow healthcare providers would agree I order lab tests only when indicated

Definitely false:__1__:__2__:__3__:__4__:__5__:__6__:__7__:Definitely true

14. It is expected that I order lab tests (eg CBC, BMP) prior to rounding

Disagree:__1__:__2__:__3__:__4__:__5__:__6__:__7__:Agree

15. What is your gender?

a. male

b. female

16. Which of the following best describes you?

a. attending physician

b. fellow

c. nurse practitioner

d. resident

17. How long have you been a licensed (including limited licensed) healthcare provider?

a. 0-5 years

b. 6-10 years

c. 11-15 years

d. 16-20 years

e. greater than 20 years

18. Please indicate your PGY level

a. 1

b. 2

c. 3

d. 4

e. 5

f. 6

g. 7

19. Thank you for completing this survey to help us better understand clinical laboratory test ordering and hospital acquired anemia. We would like to gather more detailed information on test ordering practices. If you are willing to be contacted to provide additional details about test ordering practices, please provide your name and email.

Name_____

Email_____

# HEALTHCARE PROVIDER BELIEFS ABOUT CLINICAL LABORATORY TEST ORDERING PRACTICES: A MIXED METHODS DESIGN USING THE THEORY OF PLANNED BEHAVIOR

MICHELLE BROWN, JENNA LACHENAYE, LANCE WILLIAMS
SUMMER POWERS, RETTA EVANS, LARRELL WILKINSON

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Introduction

Hospital-acquired anemia (HAA) is well recognized. Koch et al (2013) performed an epidemiological study of over 400,000 adult hospitalizations in the Cleveland Clinic Health System from 2009 to 2011 and determined that 74% of patients developed hospital-acquired anemia. Causes of HAA are multifactorial, including anemia as result of drawing blood for diagnostic tests. HAA is especially common in critically ill patients in the intensive care unit (ICU). Corwin et al (2004) determined that within 48 hours of admission, nearly 70% of patients had a hemoglobin level of less than 12 g/dl. A variety of interventions including computer order entry modifications (Procop, 2014) and additional education (Thakkar, 2015) have been used to improve test ordering, however poor test utilization remains a problem.

Nationally, there has been a focus on decreasing the number of unnecessary tests, treatments, and procedures (Zhi et al, 2013). Included in this national focus is laboratory diagnostics. Laboratory testing is a high volume activity in the medical setting that influences many patient care decisions. The American Board of Internal Medicine, along with over 70 medical society partners began the Choosing Wisely® campaign to decrease wasteful testing and procedures and promote evidence-based decision-making. Decreasing HAA due to diagnostic blood loss (DBL) from inappropriate or redundant tests requires a culture change. To best effect change, understanding the health behaviors associated with provider test ordering may provide the strongest route to impact HAA due to DBL and, in turn, increase patient safety and positively affect patient outcomes.

The purpose of this study was two-fold, to assess perception of HAA in the ICU setting and to identify behavioral factors of providers in the ICU associated with ordering clinical laboratory tests. This study adds to existing research by using a theory-based, mixed methods design intended to build on previous studies that have identified HAA and over-utilization of laboratory tests as a contributor to increased morbidity and mortality.

## Theoretical Framework

This study used the Theory of Planned Behavior (TPB) to explore factors that influence clinical laboratory test ordering by providers in an ICU. This model has three domains: attitude, subjective norm, and perceived behavioral control. These three domains shape a person's intention. Intentions are the most proximal determinant of behavior (Ajzen, 1985). TPB has strong empirical support for use in healthcare settings (Kortteisto et al, 2010; Javadi et al, 2013; Godin et al, 2008).

## Methods

This study used an explanatory, sequential mixed methods design. First, quantitative survey data was collected, then qualitative interview data was used to provide a more robust explanation of the research phenomenon (Creswell, 2014). Researchers created a survey instrument grounded in the Theory of Planned Behavior to quantitatively assess knowledge and behavioral factors associated with HAA and DBL. The survey was deployed and data analysis from the survey contributed to the development of interview questions. Through the interviews, researchers gained a deeper understanding of the behavioral factors associated with the decision to order laboratory tests. Details of the phases are in table 1.

Table 1: Phases, Procedures, and Products of a Mixed Methodology Study to Determine Behavioral Factors Associated with Test Utilization

| PHASE | PROCEDURE | PRODUCT |
|---|---|---|
| **1 INSTRUMENT GENERATION** | (1) Literature review<br>(2) Instrument generation<br>1) Domain identification<br>2) Item generation<br>3) Instrument formation<br>Note: Instrument grounded in the Theory of Planned behavior | (1) HAA-DBL Instrument |
| **2 INSTRUMENT REVIEW AND REVISION** | (1) Instrument field tested with purposefully selected content experts<br>(2) Peer debriefing<br>(3) Instrument revision | (1) Assess validity – face and content<br>(2) Revise instrument |
| **3 QUANTITATIVE DATA COLLECTION** | (1) Obtain buy-in from stakeholders and participants on intensive care unit<br>(2) Recruit participants: attending physicians, fellows, residents, and nurse practitioners | (1) Quantitative data |
| **4 QUANTITATIVE DATA ANALYSIS** | (1) Statistical data analysis (SPSS)<br>(2) Descriptive statistics | (1) Assess TPB construct relative to HAA-DBL<br>(2) Determine interview question themes |
| **5 CONNECTING STAGE** | (1) Interview question generation with guidance from health behavior and qualitative research experts | Interview questions |
| **6 QUALITATIVE DATA COLLECTION** | (1) Conduct interviews informed by quantitative data | (1) Raw qualitative data |
| **7 QUALITATIVE DATA ANALYSIS** | (1) Organize and transcribe data<br>(2) Code data and examine for themes | (1) Theme development and categorization |

| | | |
|---|---|---|
| **8 INTERPRETATION OF QUANTITATIVE AND QUALITATIVE DATA** | (1) Synthesize findings | (1) Determine knowledge, attitude, subjective norm, and perceived control of providers when ordering lab tests |

*Development of the survey items*

A thorough review of the literature was performed to determine if any theory-based surveys had been used to understand the behaviors that influence laboratory test ordering in the clinical setting. After the literature was reviewed, it was determined there was a gap in this understanding. Researchers with expertise in pathology and laboratory medicine and health behavior gathered and discussed topics and wording of the items that would be used to elicit responses related to attitude, subjective norms, and perceived behavioral control. For content and validity, these items were field tested with 12 healthcare professionals with the same backgrounds as the participants. Modifications were made in response to the feedback received from the field test. The questions were then entered into Qualtrics, a web-based platform for survey distribution. Face validity was assessed by three professionals with expertise in survey research once the survey was entered into Qualtrics. The final survey consisted of questions related to HAA, 3 questions about knowledge of HAA, 4 questions about attitude, 3 about perceived behavioral control, and 4 about subjective norms. Four demographic questions followed at the end of the survey. At the conclusion of the survey, providers were asked if they were willing to be contact for a follow up interview. There was a free text section where they could provide their email if they agreed to participate in the interview portion of the study.

*Participants*

Studies show that patients in the ICU are at greater risk for HAA from DBL (Corwin et al, 1995; Woodhouse, 2001; Smoller, 1986). For this reason, we chose to survey providers on an ICU. Researchers approached the leadership team in the ICU, presented objectives and details of the study, and gained their support. To ensure collaboration with the residents, researchers also spoke with the internal medicine residency program director. For this study, multiple levels of providers were chosen as possible participants in order to get a comprehensive picture of test ordering practices. The ICU that was chosen to be the setting for this study had 155 potential participants. There were 12 nurse practitioners, 111 internal medicine residents, 15 pulmonary and critical care fellows, and 17 attending physicians who were chosen to receive and invitation to participate.

*Survey distribution*

The web-based survey was distributed through Qualtrics. Participants were sent an email with a unique URL for the web survey. There were individual, personalized emails send to 155 potential participants. The personalized emails were time consuming for the researchers to write and send, but it helped create a connection with the respondent. The survey could be taken on a computer, tablet, or smart phone. Once the link is clicked they were routed to a page with a welcome and consent page. If participants clicked "I agree", they advanced to the first question of the survey. The researchers programmed the survey to require a response for each question before it could be submitted. This helped ensure complete data collection.

*Interviews*

Interviews were used to provide a greater understanding of the behaviors that influence test ordering practices. Open-ended interview questions were written based on the results of the survey and on the constructs of TPB. There were 10 questions written for the interview. There was careful planning to include enough questions to elicit quality data, but remain brief enough to be completed in 20-30 minutes. Interviews were recorded using a mobile device app and transcribed verbatim in preparation for analysis.

Data Analysis

For analysis of the survey responses, SPSS v 24 was used. Descriptive statistics were used to portray the variables (frequency, mean, and standard deviation). Internal consistency was tested with Cronbach alpha coefficients. Theoretical thematic analysis was used to describe the qualitative data. Mind maps were created from raw interview data. Qualitative themes were used to provide a more robust explanation of the statistics determined in the quantitative phase.

Results

Quantitative Phase

Of the 155 surveys that were distributed, 98 surveys were completed which corresponds to a 63.2% response rate. Most participants were men and majority of the participants had five or less years of experience as a licensed provider. This reflects the large number of internal medicine residents who were asked to participate in the study. Survey participant characteristics are in Table 2.

Table 2: Demographics of survey participants

| | | N (%) |
|---|---|---|
| **Gender** | | |
| | Female | 39 (39.8) |
| | Male | 59 (60.2) |
| **Years as licensed practitioner** | | |
| | 0-5 | 78 (79.6) |
| | 6-10 | 7 (7.1) |
| | 11-15 | 5 (5.1) |
| | 16-20 | 5 (5.1) |
| | >20 | 3 (3.1) |
| **Position description** | | |
| | Nurse practitioner | 10 (10.2) |
| | Resident | 65 (66.3) |
| | Fellow | 12 (12.2) |
| | Attending physician | 11 (11.2) |
| **Classification of residents and fellows** | | |
| | PGY 1 | 20 (18.9) |
| | PGY 2 | 22 (20.8) |
| | PGY 3 | 24 (22.6) |
| | PGY 4 | 2 (1.9) |
| | PGY 5 | 6 (5.7) |
| | PGY 6 | 3 (2.8) |

PGY – post graduate year (years after completing medical school)

Knowledge

In the survey, there were 3 questions concerning perceptions and knowledge of HAA due to DBL. The participants were asked 1) to rate their knowledge of HAA from phlebotomy, 2) to determine what percent of patients who enter the ICU with a hemoglobin above 12 g/dL have a hemoglobin of less than 12 g/dL within 48 hours of admission, and 3) to choose the volume of blood that must be drawn and discarded if a central venous access device is used for obtaining blood samples. The participant's responses are in figures 1, 2, and 3.

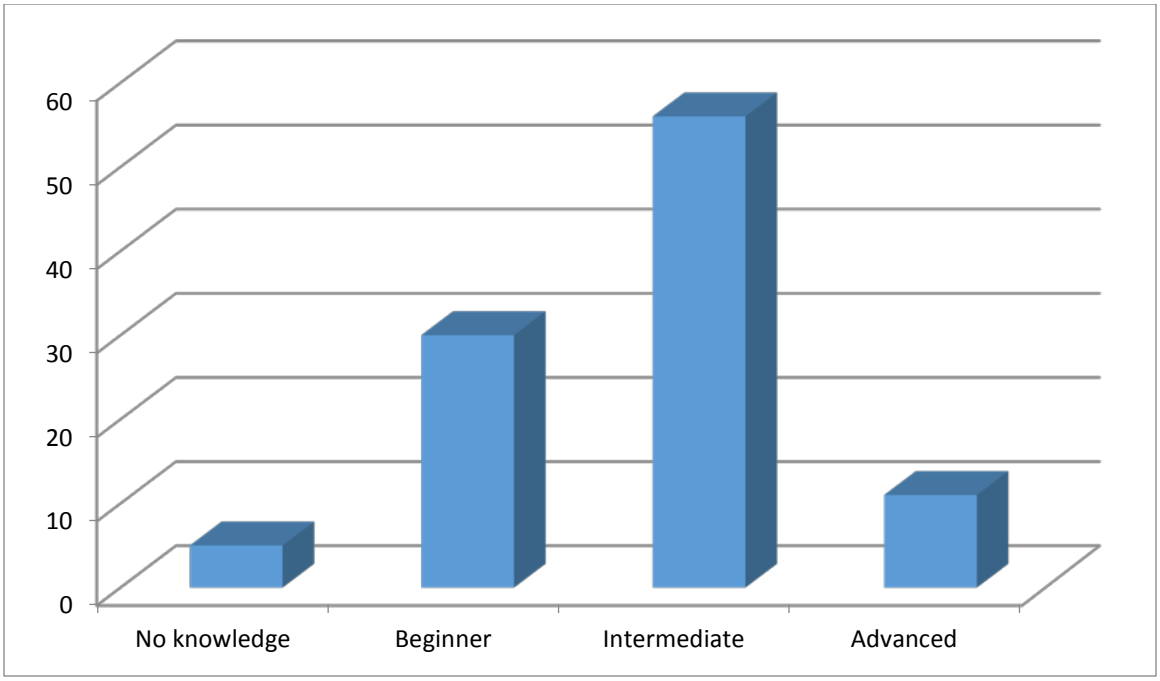

Figure 1. Knowledge of HAA due to phlebotomy

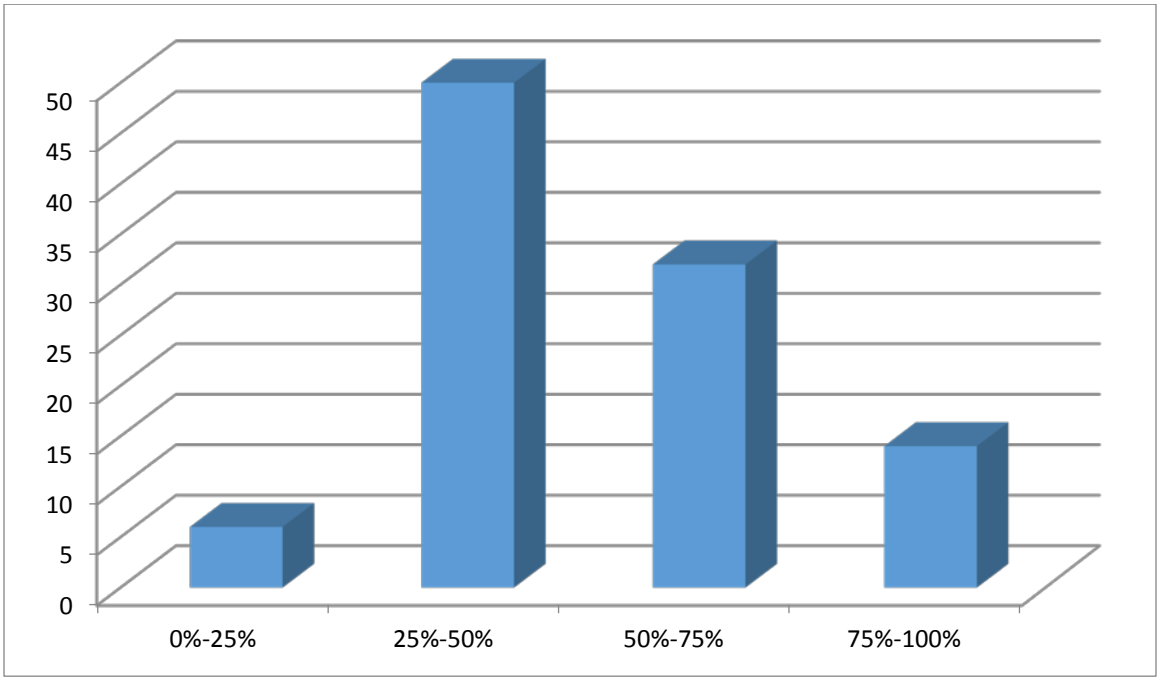

Figure 2. Percent of patients with HAA within 48 hours of admission to ICU (correct answer 50%-75%)

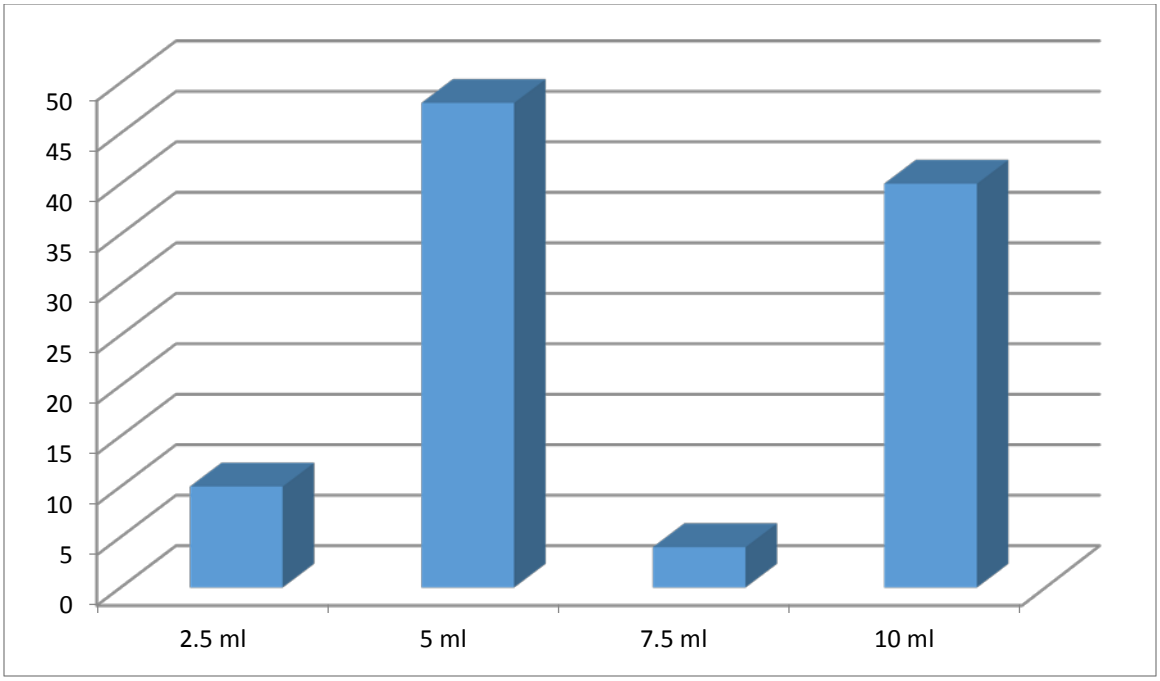

Figure 3. Volume of discarded blood for samples drawn from a central venous catheter

Descriptive statistics were used to evaluate participants views relative to each construct of the theory of planned behavior, attitude, perceived behavioral control, and subjective norm. Of the participants who responded, 98 answered the questions related to the TPB constructs. The questions were asked in a Likert Scale format with the negative given the value of 1 and the most positive given the value of 7. Generally, participants had positive attitudes toward ensuring a minimum amount of blood is drawn from their patients for laboratory tests. Participants felt that determining if a test is essential to the care of the patient *prior* to ordering it was a priority. Power Plans (predetermined order sets) were viewed with mixed reactions. Most participants felt Power Plans were a positive aspect of test ordering, but there was a wide variety of responses indicated by the standard deviation. This mixed perspective continued into the construct of behavioral control. Some respondents felt that there were unnecessary lab

tests ordered because they were part of a Power Plan (predetermined order set). This seemed to impact the amount of control participants felt they had over their test ordering practices. With respect to subjective norm, participants viewed the ordering habits of their peers as sometimes falling outside of what is indicated by the patient's condition. Additionally, there was a wide range of responses by participants to the item "my peers expect that I will only order lab tests that are indicated by my patient's clinical condition". This reflects that some feel their peers have high expectations of their ordering behaviors and others have low expectations. Scores for their attitude, perceived behavioral control, and subjective norm are in Table 3.

Table 3: Survey item scores

| Item | TPB | N | Mean | SD |
|---|---|---|---|---|
| Decreasing the amount of blood drawn from my patients in the MICU would be | A | 98 | 5.65 | 1.301 |
| Determining if a lab test is essential to the care of my patient before ordering it would be | A | 98 | 6.51 | .803 |
| Decreasing the amount of blood drawn from my patients in the MICU would be | A | 98 | 5.88 | 1.186 |
| Power Plans and order sets make patient care more efficient | A | 98 | 5.46 | 1.310 |
| I am confident I can order lab tests which are indicated by my patient's clinical condition | BC | 98 | 5.94 | .940 |
| I am empowered to decide which lab tests are indicated by my patient's clinical condition | BC | 98 | 5.91 | .920 |
| I feel there are lab tests ordered based on a power plan or order set that are not indicated by the patient's clinical condition | BC | 98 | 5.19 | 1.551 |
| My peers expect that I will only order lab tests that are indicated by the patient's clinical condition | SN | 98 | 5.21 | 1.613 |
| Most of the providers on the MICU only order lab tests when indicated by the patient's clinical condition | SN | 98 | 4.18 | 1.562 |
| My fellow healthcare providers would agree that I order lab tests only when indicated | SN | 98 | 5.26 | 1.087 |
| It is expected that I order lab tests (EG CBC, BMP) prior to rounding | SN | 98 | 5.82 | 1.334 |

A – attitude, BC – behavioral control, SN – subjective norm
CBC – complete blood count, BMP basic metabolic panel

Qualitative Phase

From the initial survey, 19 providers agreed to be contacted for an interview. Of the 19 who were contacted, 8 completed the process. Interviews were guided by open-ended questions that would provide details about the behavioral factors that influence laboratory test ordering. Interviews were recorded and transcribed verbatim for analysis. Knowledge of HAA was assessed during the interview. Participants were asked if they has heard about hospital acquired anemia and in what format it had been discussed. Several remarked that it was discussed at schools or hospitals they had previously attended more than it is discussed at their current institution. Generally, attitudes among participants were positive toward limiting the amount of blood drawn from patients. Three primary themes emerged from the analysis: HAA is a concern, HAA is a low priority, and providers feel it is ok for them to over utilize tests. Participants were mixed as it relates to subjective norms. Some shared that they felt the ordering practices of other healthcare providers was appropriate and others shared that their peers order too many unnecessary tests. Themes associated with subjective norms were: norms change with leadership, there are profession-specific perceptions of others, and experience increases selectivity. Regarding behavioral control, participants reported feeling in control, but also reported a need to order additional tests to please upper level health care providers. This reflected the single dominant theme: residents have to please the fellows and attending. These interviews provided a more comprehensive understanding of the attitudes, norms, and behavioral control related to test utilization (Table 4).

Table 4: Illustrative quotes from provider interviews

| Construct | Illustrative Quotes |
|---|---|
| **Attitude** | |
| | P8 “It’s going to hurt your heart to hear, I think, it’s [HAA] perceived as a relatively low priority compared to other things.” |
| | P1 “I try to ensure I am as judicious as I can be, you know, without causing harm to the patient.” |
| | P7 “I’ll discontinue them [recurring labs] and kind of start over with the ones I think will be necessary.” |
| | P2 “…make sure we’re doing only what we need to do.” |
| **Subjective Norm** | |
| | P3 “Knowing the attending and knowing specific orders they may want or ask for definitely affects what you order” |
| | P4 “People just order the lab test just to see the numbers, to make themselves feel better that everything in the patient is ok..” |
| | P2 “I know there are some other providers who just order some tests and order “repeat 20 times” kind of thing.” |
| | P6 “I think a lot of attendings who are conscientious, they try not to [order repeat tests].” |
| **Perceived Behavioral Control** | |
| | P1 “Let’s send that because they’re going to yell at me for not having sent it.” |
| | P8 “When they fail to order a lab because they didn’t think of it, the reaction is harsher.” |

P7 “I have never felt pressured to order something I didn’t think was indicated.”

P3 “The team [needs] to know that their attending will support them.”

P4 “I was told to do it even though I disagree with it.”

Discussion

This study used a mixed methods approach to explore behavioral factors associated with test ordering practices healthcare providers in an ICU. The strength of this study lies in the identification of factors informed by the Theory of Planned Behavior. HAA has been associated with poor patient outcomes (Salisbury et al, 2011; Choi et al, 2013). There are studies that identify that HAA due to DBL is a concern for patient safety, however, there is a paucity of information available regarding behavioral influences on provider test ordering practices. This study thus extends the evidence-based test ordering research paradigm contributing novel information about testing ordering in an ICU.

Attitudes

Attitudes toward HAA were positive according to the survey with providers reporting that decrease the amount of blood drawn from their patients was beneficial. This was especially noted when asked if determining if a lab test is essential to the care of my patient *before* ordering it would be beneficial. The mean score was 6.51 with a narrow standard deviation (.083) indicating most respondents reported this was of high importance. In contrast, during the interviews, providers relayed that decreasing HAA was a low priority in the ICU. There was a distinct awareness of HAA in the ICU, but it

was most often discussed as an explanation for idiopathic anemia in the absence of bleeding. There was a lack of focus on preventing HAA by decreasing the amount of blood drawn for laboratory tests. This discrepancy between the survey results and responses during the interview could be due to social desirability bias. A participant might be prone to choose the answer that would be viewed favorably by others, but when asked to expand on their thoughts in the interview, the participants shared details that were not as positive.

One participant shared that "anything and everything is ok in the ICU because our patients are so sick." Many providers discussed ordering lab tests that were indicated by the patient's clinical condition, but there were also providers who said they ordered tests out of habit before assessing the patient. A participant shared that "there is no time to think, so I just order it." Another said that with the time constraints, he felt the need to "do it all at once." There was also disagreement related to the frequency of routine tests such as a complete blood count (CBC) and basic metabolic panel (BMP). One participant felt that "there are some tests that you're gonna have to use that we check every day…you have to have that." Other felt it was not necessary in a stable patient to check routine labs and often gave their patients a "lab holiday".

Subjective Norms

A full spectrum of subjective norms were expressed in both the quantitative and qualitative data. Participants felt the perception of others about their own ordering practices was that they were aligned with evidence-based medicine. However, there was divergence from this optimistic thought when participants considered the ordering practices of their peers. The mean response for the question, "most providers on the ICU

only order lab tests when indicated by the patient's clinical condition" was 4.18. This is a neutral response when evaluated on a 7-point scale. They felt their peers are not necessarily ordering the lab tests that their patients need.

Participants also feel that years of experience impact the appropriateness of orders. One participant shared that "the level of training matters, the more trained, the more selective." Data demonstrated that norms within the ICU change according the physician attending at that time. Ordering "to please the higher ups" was shared by one participant. Some participants highlighted that the providers on the unit operate in silos and so they are unaware of the way others order laboratory tests. Practicing in an ICU, according to one participant, comes with the belief that providers feel the "freedom to experiment in the ICU because the patients are dying." Providers shared that they felt their peers had low expectation regarding their ability to order the correct tests as indicated by their patient's clinical condition. This question had a mean approaching the neutral zone on a 7-point scale (5.21) with a wide standard deviation (1.613) indicating some had a very low perception of what others expected of them and some had higher expectations. There were profession-specific or siloed perceptions of others. For example, it is perceived that nurse practitioners are regimented and order unnecessary routine tests out of habit rather than basing the orders on the patient's current condition or needs. Likewise, it was reported that fellows were more sophisticated and order fewer unnecessary tests.

Behavioral Control

From the survey results, participants shared that they felt they were in control of their test ordering practices and that they were confident they could order the tests

indicated by their patient's clinical condition. They felt others empowered them to make these choices, but some felt pressured to order additional, unnecessary tests. However, during the interviews, less experienced residents shared that they ordered unnecessary tests out of "fear of getting yelled at" and to "avoid getting into trouble". Paired with this, was the concept that one participant shared, "attendings don't fault you for ordering extra tests." In contrast, nurse practitioners did not express this fear of consequences and felt supported by the supervising physicians to order the tests they deemed necessary.

## Conclusions

### Strengths and Limitations

To our knowledge, this is the first study to assess the test-ordering behaviors of multiple levels of healthcare providers using a mixed methods approach. Data from this study is grounded in TPB allowing researchers to better understand what influences clinical laboratory test ordering behaviors. Outcomes of this study can assist in developing targeted interventions to increase the appropriate use of laboratory tests.

This study had several limitations. First, selection/participation bias. Participation was voluntary and did not equally represent all providers on the ICU. The participants were disproportionately internal medicine residents. However, having such a large response from this portion of providers is helpful for understanding test utilization in that residents do an overwhelming majority of the test ordering. Secondly, this was a pilot of a new survey, additional validity and reliability testing should be performed to ensure construction of a high quality scale. In addition, the survey used in this study was in its first iteration. Reliability of the scale is published in a separate manuscript. Item deletion increased the internal consistency of the scale to a reliable level, but could still

be improved upon through writing additional questions and retesting the survey. Social desirability could have been a factor in this study. Participants knew they were being assessed on the care they provide for their patients. Their responses could reflect what they thought the researchers wanted to hear, rather than representing their true beliefs.

Clinical Implications

This study contributes novel information to what is known about test ordering behaviors of healthcare providers. The subjective norm, or perceived pressure, from fellows and attending physicians to order unnecessary laboratory tests appears to have the largest behavioral impact on test ordering. The diversity of the opinions represented in the data reaffirms the importance of understanding the behavioral factors associated with ordering laboratory tests. Knowledge of the behaviors that influence evidence-based practice can be used to decrease overutilization of tests. Leadership in the ICU should consider making it a priority to decrease HAA due to DBL. Prevention should be emphasized rather than merely a recognized as a result of DBL. These expectations would need to be clearly communicated and to be consistent between providers, especially fellows and attending physicians. Interventions aimed at decreasing HAA due to DBL need to include an assessment of behaviors in order to provide a tailored intervention to promote sustainable behavior change.

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# CONCLUSIONS

The purpose of this mixed methods study was to explore knowledge of hospital-acquired anemia due to diagnostic blood loss and behavioral factors associated with clinical laboratory test ordering. Nationally, over 20% of laboratory testing is deemed unnecessary (Zhi, 2013). Sherry Polhill, administrative director of hospital laboratories stated that she had similar findings at UAB (personal communication June 1, 2016). This exploration included the development of a survey instrument grounded in the Theory of Planned Behavior to elicit the knowledge, attitude, subjective norms, and perceived behavioral control of laboratory test ordering practitioners have in the MICU at UAB. The conclusions from this study will address the specific aims.

## Specific Aim 1

### Perceptions of Hospital-Acquired Anemia in the MICU

To understand the perceptions of HAA by the nurse practitioners, residents, fellows, and attending physicians on the MICU researchers first inquired about their self-reported level of knowledge about HAA due to diagnostic blood loss. The majority of respondents, 53.8%, felt they had an intermediate level of knowledge of the subject. In contrast, only 10.6% felt they had an advanced level of knowledge of HAA due to DBL. This helps researchers understand that their participants do not feel confident in their knowledge of the subject of the study. When asked about the percentage of patients who enter the ICU with a hemoglobin greater than 12 g/dL and subsequently develop a

hemoglobin less than 12 g/dL within 48 hours, the majority of respondent felt that this happened in 25%-50% of ICU patients. This is an underestimation of the rate of HAA of ICU patients. Seventy percent of patients in the ICU develop HAA within 48 hour of admission (Corwin, 2004). Practitioners on the ICU are not aware of the extent of this problem and may not consider this a primary concern when making decisions on the management of their patients. This was confirmed in the interviews as well. One participant said "It's [HAA] perceived as a relatively low priority compared to other things."

Research suggests that blood drawn from central venous access devices (CVADs) are a particularly significant contributor to HAA (Smoller, 1984). Because of the frequent need for blood draws, CVADs are commonly used to provide venous access. Blood drawn for diagnostic testing requires that the first 5 mL of blood be "wasted" or diverted prior to collecting blood in the specified tubes. Ironically, practitioners overestimated the amount of "waste" blood that should be drawn from a CVAD prior to drawing blood for laboratory tests with 38.5% of practitioners stating 10 mL was the proper "waste" volume. This would indicate practitioners feel more blood is drawn with each order they write than is actually needed, compounding the concern with HAA due to DBL being a low priority for ICU practitioners. A lack of knowledge about HAA may be a contributing factor to the overutilization of some laboratory tests.

Specific Aim 2

Behavioral Factors Associated with HAA due to Diagnostic Blood Loss

Attitudes

Attitudes toward reducing HAA were positive according to the survey with providers reporting that decrease the amount of blood drawn from their patients was beneficial. This was especially noted when asked if determining if a lab test is essential to the care of my patient *before* ordering it would be beneficial. The mean score was 6.51 with a narrow standard deviation (.803) indicating most respondents reported this was of high importance. In contrast, during the interviews, providers relayed that decreasing HAA was a low priority in the ICU. One participant shared that "anything and everything is ok in the ICU because our patients are so sick." Many providers discussed ordering lab tests that were indicated by the patient's clinical condition, but there were also providers who said they ordered tests out of habit before assessing the patient. A participant shared that "there is no time to think, so I just order it." Another said that with the time constraints, he felt the need to "do it all at once." There was also disagreement related to the frequency of routine tests such as a complete blood count (CBC) and basic metabolic panel (BMP). One participant felt that "there are some tests that you're gonna have to use that we check every day…you have to have that." Others felt it was not necessary in a stable patient to check routine labs and often gave their patients a "lab holiday". There was a distinct awareness of HAA in the ICU, but it was most often discussed as an explanation for idiopathic anemia in the absence of bleeding. There was a lack of focus on preventing HAA by decreasing the amount of blood drawn for laboratory tests. This discrepancy between the survey results and responses during

the interview could be due to social desirability bias(Van de Mortel, 2008). A participant might be prone to choose the answer that would be viewed favorably by others. However, when asked to expand on their thoughts in the interview, the participants shared details that were not as positive.

## Subjective Norms

A full spectrum of subjective norms were expressed in both the quantitative and qualitative data. Participants felt the perception of others about their own ordering practices was that they were aligned with evidence-based medicine. However, there was divergence from this optimistic thought when participants considered the ordering practices of their peers. The mean response for the question, "most providers on the ICU only order lab tests when indicated by the patient's clinical condition" was 4.18. This is a neutral response when evaluated on a 7-point scale. Participants felt their peers are not necessarily ordering the lab tests that their patients need.

Participants also feel that years of experience impact the appropriateness of orders. One participant shared that "the level of training matters, the more trained, the more selective." Data demonstrated that norms within the ICU change according the physician attending at that time. Ordering "to please the higher ups" was shared by one participant. Some participants highlighted that the providers on the unit operate in silos and so they are unaware of the way others order laboratory tests. Practicing in an ICU, according to one participant, comes with the belief that providers feel the "freedom to experiment in the ICU because the patients are dying." Providers shared that they felt their peers had low expectation regarding their ability to order the correct tests as indicated by their patient's clinical condition. This question had a mean approaching the

neutral zone on a 7-point scale (5.21) with a wide standard deviation (1.613) indicating some had a very low perception of what others expected of them and some had higher expectations. There were profession-specific or segregated perceptions of others among participants during the qualitative interviews. For example, it is perceived that nurse practitioners are regimented and order unnecessary routine tests out of habit rather than basing the orders on the patient's current condition or needs. Likewise, it was reported that fellows were more sophisticated and order fewer unnecessary tests.

### Behavioral Control

From the survey results, participants shared that they felt they were in control of their test ordering practices and that they were confident they could order the tests indicated by their patient's clinical condition. They felt others empowered them to make these choices, but some felt pressured to order additional, unnecessary tests. However, during the interviews, less experienced residents shared that they ordered unnecessary tests out of "fear of getting yelled at" and to "avoid getting into trouble". Paired with this, was the concept that one participant shared, "attendings don't fault you for ordering extra tests." In contrast, nurse practitioners did not express this fear of consequences and felt supported by the supervising physicians to order the tests they deemed necessary. One nurse practitioner shared that he "had no restrictions on the tests that were ordered".

## Strengths and Limitations

To our knowledge, this is the first study to assess the test-ordering behaviors of multiple levels of healthcare providers using a mixed methods approach. Data from this study is grounded in TPB allowing researchers to better understand the attitudes, subject norms, and perceived behavioral control that influence clinical laboratory test ordering

behaviors. Outcomes of this study can assist in developing targeted interventions to increase the appropriate use of laboratory tests, however, the findings should be considered with the following limitations.

First, selection/participation bias should be considered as participation in this study was voluntary and did not equally represent all providers on the ICU. The participants were disproportionately internal medicine residents. However, having such a large response from this portion of providers is helpful for understanding test utilization in that residents do an overwhelming majority of the test ordering. Secondly, this was a pilot of a new survey, additional validity and reliability testing should be performed to ensure construction of a high quality scale. Item deletion increased the internal consistency of the scale to a reliable level, but could still be improved upon through writing additional questions and retesting the survey. Social desirability could have been a factor in this study. Participants knew they were being assessed on the care they provide for their patients. Their responses could reflect what they thought the researchers wanted to hear, rather than representing their true beliefs.

Although there are limitations, this study has several strengths. This is the first theoretically framed study to assess the behavioral factors associated with clinical laboratory test utilization. This study was also grounded in health behavior theory – the theory of planned behavior. The theory of planned behaviors had been identified as the most relevant theory for studying behaviors of healthcare professionals (Godin et al, 2008). A mixed methods approach was used to elucidate the attitudes, subjective norms, and perceived behavioral control of laboratory test ordering practices by practitioners on

an intensive care unit. Both quantitative survey data and qualitative interview data were analyzed for a robust picture of the behaviors that influence test ordering.

## Clinical Implications

This study contributes novel information to what is known about test ordering behaviors of healthcare providers. The subjective norm, or perceived pressure, from fellows and attending physicians to order unnecessary laboratory tests appears to have the largest behavioral impact on test ordering. The diversity of the opinions represented in the data reaffirms the importance of understanding the behavioral factors associated with ordering laboratory tests. Knowledge of the behaviors that influence evidence-based practice can be used to decrease overutilization of tests. Leadership in the ICU should consider making it a priority to decrease HAA due to DBL. Prevention should be emphasized rather than merely a recognized as a result of DBL. These expectations would need to be clearly communicated and to be consistent between providers, especially fellows and attending physicians. Although there are some studies that focus on the prevention of HAA through education and contextual devices such as computer system interfaces, outcomes have been mixed and have rarely been sustainable. This study suggests that interventions aimed at decreasing HAA due to DBL need to include an assessment of behaviors in order to provide a tailored intervention to promote sustainable behavior change.

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# APPENDIX A

## STANDARD OPERATING PROCEDURE FOR PERIPHERAL PHLEBOTOMY

| | |
|---|---|
| **Planning for procedure** | |
| | Verify practitioner's order and Review medical record for allergies |
| | Gather equipment (venipuncture supplies, labels) |
| **Preparing for procedure** | |
| | Clean hands using alcohol-based hand sanitizer or soap and water |
| | Confirm patient identity using two patient identifiers |
| | Explain the procedure to the patient |
| | Determine fasting status or dietary restrictions |
| | Don gloves and other personal protective equipment, if needed |
| | Position the patient, ensure they are comfortable and their arm is secure |
| | Assess the patient's veins to determine best site and needle size |
| **Procedural steps** | |
| | Apply the tourniquet above the intended insertion site (no longer than 1 minute) |
| | Palpate vein |
| | Cleanse venipuncture site for 30 seconds with antiseptic and allow to air dry |
| | Immobilize the vein by pulling skin taught 1"-2" below the venipuncture site |
| | Position the needle bevel up, parallel with the path of the vein, and at a 30 degree angle (if using a winged collection device, grasp the wings and position the bevel up) |
| | Advance the needle into the vein |
| | Insert tube into the tube holder and allow tube to fill completely |
| | If using a winged collection device and a coagulation tube is the first specimen to be drawn, draw a discard tube (another light blue top tube first to remove are in the tubing and to ensure the proper blood to anticoagulant ratio) |
| | Remove the tourniquet as soon as blood appears |
| | When blood flow into the tube stops, remove tube and immediately invert the tube 8 times |
| | Continue to fill required tubes using the correct order of draw |
| | After tubes have been collected, place gauze over puncture site and remove needle |
| | Activate the needle safety device |
| | Apply gentle pressure to the site until bleeding stops and apply a bandage |
| | Label all tubes in the presence of the patient with name, medical record #, date, time, and your initials |
| | Place labeled tubes in a transport bag with test request |
| | Discard needle and tube holder into the sharps container |
| | Remove gloves and dispose in waste receptacle with other used supplies |
| | Perform hand hygiene |
| **Performing appropriate aftercare** | |
| | If hematoma has developed, apply pressure until the bleeding has stopped |
| | Document the procedure |
| | Deliver specimens to the laboratory |

APPENDIX B

THEORY OF PLANNED BEHAVIOR-BASED SURVEY

**Knowledge**

1. Please rate your knowledge of hospital acquired anemia/diagnostic blood loss due to phlebotomy.

a. no knowledge

b. beginner

c. intermediate

d. advanced

e. expert

2. What percent of patients who enter the ICU with a hemoglobin at or above 12 g/dl have a hemoglobin of less than 12 g/dl within 48 hours of admission?

a. 0% - 25%

b. 25% -50%

c. 50%- 75%

d. 75% - 100%

3. If central venous access is used, what volume of blood must be drawn and discarded prior to obtaining blood samples at UAB?

a. 2.5 ml

b. 5 ml

c. 7.5 ml

d. 10 ml

Please answer the following scale questions by circling the number that represents your opinion.

**Attitude**

4. Decreasing the amount of blood drawn from my patients in the MICU would be

Not beneficial for my patients:__1__:__2__:__3__:__4__:__5__:__6__:__7__:Beneficial for my patients

5. Determining if a lab test is essential to the care of my patient before ordering it would be

Not beneficial for my patients:__1__:__2__:__3__:__4__:__5__:__6__:__7__:Beneficial for my patients

6. Decreasing the amount of blood drawn from my patients in the MICU would be

Not valuable to the institution:__1__:__2__:__3__:__4__:__5__:__6__:__7__:Valuable to the institution

7. Power Plans and order sets make patient care more efficient

Disagree:__1__:__2__:__3__:__4__:__5__:__6__:__7__:Agree

**Perceived Behavioral Control**

8. I am confident I can order lab tests which are indicated by my patient's clinical condition

Disagree:__1__:__2__:__3__:__4__:__5__:__6__:__7__:Agree

9. I am empowered to decide which lab tests are indicated by my patient's clinical condition

Disagree:__1__:__2__:__3__:__4__:__5__:__6__:__7__:Agree

10. I feel there are lab tests ordered based on a power plan or order set that are not indicated by the patient's clinical condition.

Disagree:__1__:__2__:__3__:__4__:__5__:__6__:__7__:Agree

**Subjective Norms**

11. My peers expect that I will only order lab tests that are indicated by the patient's clinical condition

Disagree:__1__:__2__:__3__:__4__:__5__:__6__:__7__:Agree

12. Most of the providers on MICU only order lab tests when indicated by the patient's clinical condition

Disagree:__1__:__2__:__3__:__4__:__5__:__6__:__7__:Agree

13. My fellow healthcare providers would agree I order lab tests only when indicated

Definitely false:__1__:__2__:__3__:__4__:__5__:__6__:__7__:Definitely true

14. It is expected that I order lab tests (eg CBC, BMP) prior to rounding

Disagree:__1__:__2__:__3__:__4__:__5__:__6__:__7__:Agree

**Demographics**

15. What is your gender?

a. male

b. female

16. Which of the following best describes you?

a. attending physician

b. fellow

c. nurse practitioner

d. resident

17. How long have you been a licensed (including limited licensed) healthcare provider?

a. 0-5 years

b. 6-10 years

c. 11-15 years

d. 16-20 years

e. greater than 20 years

18. Please indicate your PGY level

a. 1

b. 2

c. 3

d. 4

e. 5

f. 6

g. 7

19. Thank you for completing this survey to help us better understand clinical laboratory test ordering and hospital acquired anemia. We would like to gather more detailed information on test ordering practices. If you are willing to be contacted to provide additional details about test ordering practices, please provide your name and email.

Name_____

Email_____

APPENDIX C

THEORY OF PLANNED BEHAVIOR-BASED SURVEY IN QUALITRICS

Q1 Please rate your knowledge of hospital acquired anemia/diagnostic blood loss due to phlebotomy.

- ❍ No knowledge (1)
- ❍ Beginner (2)
- ❍ Intermediate (3)
- ❍ Advanced (4)
- ❍ Expert (5)

Q2 What percent of patients who enter the ICU with a hemoglobin at or above 12 g/dl have a hemoglobin of less than 12 g/dl within 48 hours of admission?

- ❍ 0% - 25% (1)
- ❍ 25% -50% (2)
- ❍ 50%- 75% (3)
- ❍ 75% - 100% (4)

Q3 If central venous access is used, what volume of blood must be drawn and discarded prior to obtaining blood samples at UAB?

- ❍ 2.5 ml (1)
- ❍ 5 ml (2)
- ❍ 7.5 ml (3)
- ❍ 10 ml (4)

Q4 Choose a point on this sliding scale that represents your opinion.Decreasing the amount of blood drawn from my patients in the MICU would be

| | 1 (1) | 2 (2) | 3 (3) | 4 (4) | 5 (5) | 6 (6) | 7 (7) |
|---|---|---|---|---|---|---|---|
| Not beneficial for my patients:Beneficial for my patients (1) | ❍ | ❍ | ❍ | ❍ | ❍ | ❍ | ❍ |

Q5 Choose a point on this sliding scale that represents your opinion.Determining if a lab test is essential to the care of my patient before ordering it would be

| | 1 (1) | 2 (2) | 3 (3) | 4 (4) | 5 (5) | 6 (6) | 7 (7) |
|---|---|---|---|---|---|---|---|
| Not beneficial for my patients:Beneficial for my patients (1) | ❍ | ❍ | ❍ | ❍ | ❍ | ❍ | ❍ |

Q6 Choose a point on this sliding scale that represents your opinion.Decreasing the amount of blood drawn from my patients in the MICU would be

| | 1 (1) | 2 (2) | 3 (3) | 4 (4) | 5 (5) | 6 (6) | 7 (7) |
|---|---|---|---|---|---|---|---|
| Not valuable to the institution:Valuable to the instituion (1) | ❍ | ❍ | ❍ | ❍ | ❍ | ❍ | ❍ |

Q7 Choose a point on this sliding scale that represents your opinion.Power Plans and order sets make patient care more efficient.

| | 1 (1) | 2 (2) | 3 (3) | 4 (4) | 5 (5) | 6 (6) | 7 (7) |
|---|---|---|---|---|---|---|---|
| Disagree:Agree (1) | ❍ | ❍ | ❍ | ❍ | ❍ | ❍ | ❍ |

Q8 Choose a point on this sliding scale that represents your opinion.I am confident I can order lab tests which are indicated by my patient's clinical condition.

| | 1 (1) | 2 (2) | 3 (3) | 4 (4) | 5 (5) | 6 (6) | 7 (7) |
|---|---|---|---|---|---|---|---|
| Disagree:Agree (1) | ❍ | ❍ | ❍ | ❍ | ❍ | ❍ | ❍ |

Q9 Choose a point on this sliding scale that represents your opinion.I am empowered to decide which lab tests are indicated by my patient's clinical condition.

| | 1 (1) | 2 (2) | 3 (3) | 4 (4) | 5 (5) | 6 (6) | 7 (7) |
|---|---|---|---|---|---|---|---|
| Disagree:Agree (1) | ❍ | ❍ | ❍ | ❍ | ❍ | ❍ | ❍ |

Q10 Choose a point on this sliding scale that represents your opinion.I feel there are lab tests ordered based on a power plan or order set that are not indicated by the patient's clinical condition.

| | 1 (1) | 2 (2) | 3 (3) | 4 (4) | 5 (5) | 6 (6) | 7 (7) |
|---|---|---|---|---|---|---|---|
| Disagree:Agree (1) | ❍ | ❍ | ❍ | ❍ | ❍ | ❍ | ❍ |

Q11 Choose a point on this sliding scale that represents your opinion.My peers expect that I will only order lab tests that are indicated by the patient's clinical condition.

| | 1 (1) | 2 (2) | 3 (3) | 4 (4) | 5 (5) | 6 (6) | 7 (7) |
|---|---|---|---|---|---|---|---|
| Disagree:Agree (1) | ❍ | ❍ | ❍ | ❍ | ❍ | ❍ | ❍ |

Q12 Choose a point on this sliding scale that represents your opinion.Most of the providers on MICU only order lab tests when indicated by the patient's clinical condition.

| | 1 (1) | 2 (2) | 3 (3) | 4 (4) | 5 (5) | 6 (6) | 7 (7) |
|---|---|---|---|---|---|---|---|
| Disagree:Agree (1) | ❍ | ❍ | ❍ | ❍ | ❍ | ❍ | ❍ |

Q13 Choose a point on this sliding scale that represents your opinion.My fellow healthcare providers would agree I order lab tests only when indicated.

| | 1 (1) | 2 (2) | 3 (3) | 4 (4) | 5 (5) | 6 (6) | 7 (7) |
|---|---|---|---|---|---|---|---|
| Disagree:Agree (1) | ❍ | ❍ | ❍ | ❍ | ❍ | ❍ | ❍ |

Q14 Choose a point on this sliding scale that represents your opinion.It is expected that I order lab tests (eg CBC, BMP) prior to rounding.

| | 1 (1) | 2 (2) | 3 (3) | 4 (4) | 5 (5) | 6 (6) | 7 (7) |
|---|---|---|---|---|---|---|---|
| Disagree:Agree (1) | ❍ | ❍ | ❍ | ❍ | ❍ | ❍ | ❍ |

Q15 What is your gender

- Male (1)
- Female (2)

Q16 How long have you been a licensed (including limited license) healthcare provider?

- 0-5 years (1)
- 6-10 years (2)
- 11-15 years (3)
- 16-20 years (4)
- greater then 20 years (5)

Q17 Which of the following best describes you?

- Attending physician (1)
- Fellow (2)
- Nurse practitioner (3)
- Resident (4)

Condition: Fellow Is Selected. Skip To: Please indicate your PGY level.Condition: Resident Is Selected. Skip To: Please indicate your PGY level.Condition: Attending physician Is Selected. Skip To: Thank you for completing this survey ....Condition: Nurse practitioner Is Selected. Skip To: Thank you for completing this survey ....

Q18 Please indicate your PGY level

- 1 (1)
- 2 (2)
- 3 (3)
- 4 (4)
- 5 (5)
- 6 (6)
- 7 (7)

Q19 Thank you for completing this survey to help us better understand clinical laboratory test ordering and hospital acquired anemia. We would like to gather more detailed information on test ordering practices. Please provide your name and email address, if you are willing to be contacted to provide additional details about test ordering practices.

APPENDIX D

INTERVIEW QUESTIONS

INTRODUCTION

Thank you for taking the time to answer my questions today. I am Michelle Brown. I am a PhD student here at UAB working on dissertation research that focuses on gaining a better understanding of the behavioral factors that contribute to a health care provider's decisions to order laboratory tests. In this interview, lab tests refer to tests on blood and body fluids. The interview will last approximately 30 minutes. The interview will be audio recorded and I will take notes as well. The audio recordings will be transcribed, checked for accuracy, and then deleted. The transcript will not identify individuals by name. I am interested in what you think, so please feel free to share your views, impressions, and feelings.

Are you ready to begin?

[Start recording]

[Conduct the interview with the following questions]

QUESTIONS

1. Routine lab tests are sometimes ordered before the healthcare team rounds and before the history and progress of the patient are reviewed. How do you feel about this practice?

2. Do you feel there are lab tests ordered based on a specific lab test order set (called a power plan at UAB) that are *not* indicated by the patient's clinical condition? Why or why not?

3. Let's talk about how *others* order. How would you describe their ordering behavior? What do you think drives others to order the way they do?

4. Do you feel pressured by fellow providers (nurse practitioners, residents, fellows, or attending physicians) to order lab tests that you do not think are indicated? Has there been a time you ordered lab tests when you didn't think it was necessary? What was the issue and what happened?

5. What resources do you rely on when ordering lab tests? For example, education, experience, peers, lab/pathologist, reliable internet sources.

6. Prior to this study, had you heard about hospital-acquired anemia due to diagnostic blood loss? In what format has it been discussed?

7. What issues related to hospital acquired anemia due to diagnostic blood loss would you want/need more education or training? What changes, if any, do you think need to be implemented? Additional education, change in policy, etc.

8. What education method do you prefer? For example, in person, online, written information?

9. Are you familiar with the Choosing Wisely campaign? What do you know about it?

10. What additional information regarding laboratory test ordering would you like to add to this interview today?

APPENDIX E

SURVEY CONSENT

**TITLE OF RESEARCH:** **Behavioral factors associated with clinical laboratory test utilization of healthcare providers in an intensive care unit**

**IRB PROTOCOL #:** E160824005

**INVESTIGATOR:** Michelle R. Brown, MS, MLS(ASCP)$^{CM}$SBB$^{CM}$

**SPONSOR:** Department of Human Studies

## Purpose of the Research

This survey is to fill an important knowledge gap that has been identified in medical and patient safety literature and through routine collection of quality data at UAB by physician and laboratory leadership. Some patients become anemic while in the hospital. Blood draws for laboratory tests contribute to this anemia. This research will seek to understand what behavioral factors contribute to the decision to order laboratory tests.

## Explanation of Procedures

You are being asked to complete a 15-question survey on behavioral factors that contribute to the decision to order laboratory tests. We estimate that completion of this survey will take approximately 20 minutes.

## Risks and Discomforts

There are no known risks associated with this study beyond the potential for loss of confidentiality. The information will be used to assess broad aspects of decision-making for ordering laboratory tests. Only investigators will have access to the data collected.

## Benefits

You will not benefit directly from taking part in this study. However, this study may help us better understand factors that contribute to ordering of lab tests.

## Alternatives

The alternative to participating in this study is not completing the survey.

## Confidentiality

Information obtained through this study will be kept confidential. It will be shared with the Department of Human Studies, and the UAB Office of the Institutional Review Board. Only investigators will have access to data collected. Data will be stored on password-protected computers.

## Voluntary Participation and Withdrawal

Whether or not you participate in this study is your choice. There will be no penalty if you decide not to be in the study. If you decide not to be in the study, you will not lose any benefits you are otherwise owed. You are free to withdraw from this research study at any time. Your choice to leave the study will not affect your relationship with this institution.

If you are a UAB student or employee, taking part in this research is not part of your UAB duties. You can refuse to enroll, or withdraw after enrolling at any time before the study is over, with no effect on your job at UAB. You will not be offered to receive any special consideration if you take part in this research.

**Cost of Participation and Payment for Participation**

There is no cost for participating in this study, nor will you be paid to participate.

**Questions**

If you have any questions, concerns, or complaints about the research, you may contact Michelle Brown. She will be glad to answer any of your questions. Michelle Brown's number is 205-934-5987, and her email is michellebrown@uab.edu.

If you have questions about your rights as a research participant, or concerns or complaints about the research, you may contact the UAB Office of the IRB (OIRB) at (205) 934-3789 or toll free at 1-855-860-3789. Regular hours for the OIRB are 8:00 a.m. to 5:00 p.m. CT, Monday through Friday. You may also call this number in the event the research staff cannot be reached or you wish to talk to someone else.

**Consent**

By clicking "I agree", you indicate you have read the information provided and agree to participate in this study.

APPENDIX F

INTERVIEW CONSENT

**TITLE OF RESEARCH: Behavioral Factors Associated with Clinical Laboratory Test Utilization of Healthcare Providers in an Intensive Care Unit**

| | |
|---|---|
| **IRB PROTOCOL #:** | E160824005 |
| **PRINCIPAL INVESTIGATOR:** | Michelle R. Brown, MS, MLS(ASCP)$^{CM}$SBB$^{CM}$ |
| **SPONSOR:** | UAB Department of Human Studies |

## Purpose of the Research

This interview is to fill an important gap in information that has been found in medical writings and data collection at UAB Hospital. Some patients become anemic while in the hospital. Blood draws for laboratory tests contribute to this anemia. This research will seek to understand what behavioral factors contribute to the decision to order laboratory tests. We hope to interview 19 people for this study.

## Explanation of Procedures

You are being asked to participate in an interview to help us understand behavioral factors that contribute to healthcare provider's decisions to order laboratory tests. The interview will last approximately 30 minutes. The interview will be audio recorded. The audio recordings will be transcribed, checked for accuracy, and then destroyed. The transcript will not identify individuals by name. We ask that you not share what was discussed in this interview with anyone else.

## Risks and Discomforts

There are no known risks associated with this interview beyond the potential for loss of confidentiality. The information will be used to better understand decision-making for ordering laboratory tests. Only investigators (six total faculty from the School of Medicine, School of Nursing, School of Education, and School of Health Professions) will have access to the data collected.

## Benefits

You will not benefit directly from taking part in this interview. However, this interview may help us better understand factors that contribute to ordering of lab tests.

## Alternatives

The alternative to participating in this interview is to choose not to be interviewed.

## Confidentiality

Information obtained through this interview will be kept confidential. It will be shared with the Department of Human Studies, and the UAB Office of the Institutional Review Board. Only investigators will have access to data collected. Data will be stored on password-protected computers. Information from this research may be published for scientific purposes, however, your identity will not be used.

## Voluntary Participation and Withdrawal

Whether or not you participate in this interview is your choice. There will be no penalty if you decide not to be interviewed. If you decide not to be in the study, you will not lose any benefits you are otherwise owed. You are free to withdraw from this research study at any time. Your choice to leave the study will not affect your relationship with this institution.

If you are a UAB student or employee, taking part in this research is not part of your UAB duties. You can refuse to enroll, or withdraw after enrolling at any time before the study is over, with no effect on your job at UAB. You will not be offered to receive any special consideration if you take part in this research.

**Cost of Participation and Payment for Participation**

There is no cost for participating in this interview, nor will you be paid to participate.

**Questions**

If you have any questions, concerns, or complaints about the research, you may contact Michelle Brown. She will be glad to answer any of your questions. Michelle Brown's number is 205-934-5987, and her email is michellebrown@uab.edu.

If you have questions about your rights as a research participant, or concerns or complaints about the research, you may contact the UAB Office of the IRB (OIRB) at (205) 934-3789 or toll free at 1-855-860-3789. Regular hours for the OIRB are 8:00 a.m. to 5:00 p.m. CT, Monday through Friday. You may also call this number in the event the research staff cannot be reached or you wish to talk to someone else.

Signature of participant_____Date_____

Printed name_____

APPENDIX G

IRB APPROVAL

THE UNIVERSITY OF ALABAMA AT BIRMINGHAM

Institutional Review Board for Human Use

Exemption Designation
Identification and Certification of Research
Projects Involving Human Subjects

UAB's Institutional Review Boards for Human Use (IRBs) have an approved Federalwide Assurance with the Office for Human Research Protections (OHRP). The Assurance number is FWA00005960 and it expires on January 24, 2017. The UAB IRBs are also in compliance with 21 CFR Parts 50 and 56.

| | |
|---|---|
| Principal Investigator: | BROWN, MICHELLE R |
| Co-Investigator(s): | EVANS, RETTA R |
| Protocol Number: | **E160824005** |
| Protocol Title: | *Behavioral Factors Associated with Clinical Laboratory Test Utilization of Healthcare Providers in an Intensive Care Unit* |

The above project was reviewed on 10/5/16. The review was conducted in accordance with UAB's Assurance of Compliance approved by the Department of Health and Human Services. This project qualifies as an exemption as defined in 45CFR46.101(b), paragraph 1.

This project received EXEMPT review.

Date IRB Designation Issued: October 5, 2016

Sally Blake Headley, CIP
Designated Reviewer
Chair Designee

Investigators please note:

Any modifications in the study methodology, protocol and/or consent form/information sheet must be submitted for review to the IRB prior to implementation.

470 Administration Building
701 20th Street South
205.934.3789
Fax 205.934.1301
irb@uab.edu

The University of
Alabama at Birmingham
Mailing Address:
AB 470
1720 2ND AVE S
BIRMINGHAM AL 35294-0104