

THE ROLE OF HEMOGLOBIN A1C TESTING IN UNDIAGNOSED
DIABETES AND MYOCARDIAL INFARCTION IN EMERGENCY
AND INTENSIVE CARE SETTINGS

by

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ABSTRACT

Statement of the Problem: The disease of diabetes is insidious. Its complications can be devastating and, if left untreated, often leads to early mortality. With the effects of diabetes being so extensive within body systems, complications like myocardial infarction are all too common. To complicate the matter further, a large portion of the population of diabetics is undiagnosed. Having no knowledge of this disease process allows the disease to progress unfettered for an indeterminate amount of time. If diabetic status is unknown, an increased risk of mortality from MI exists. Systematic Hgb A1C testing for myocardial infarction patients may provide prognostic data for undiagnosed diabetics and increase our ability, as providers, to develop treatment plans to address the increased risk of mortality posed to these individuals. **Methods:** All MI patients admitted to ED and ICU charts were screened for hemoglobin A1C testing and diabetic care planning as evidenced in their discharge summary. **Results:** This project found that testing with Hgb A1C only occurred in 40% of MI patients. Of those tested, 8% were found to be new diabetics. This project also found that 16.3% of the patients tested were pre-diabetic and that this was only noted in 1.8% of these patients' discharge summaries. **Conclusions:** Currently, Hgb A1C testing is underutilized in MI patients. Identification of new diabetics in this population allows providers to address this diagnosis in a manner that can prevent the complications all too common to diabetics with heart disease.

INTRODUCTION

The disease of diabetes is insidious. So insidious, in fact, that it may progress for years undetected and undiagnosed. The effects of diabetes are far reaching in the body, and the complications of this disease are many. All too frequently, these individuals suffer from complications of diabetes such as myocardial infarction, often landing them in a hospital. An estimated 1.4 million Americans are diagnosed with diabetes every year (American Diabetes Association (ADA), 2012). In 2012, of Americans 20 years and older, 86 million were determined to be pre-diabetic (ADA, 2014). As we can see, this is a disease that is not slowing, but becoming more and more common in our society. This can only mean that we will be dealing with this disease and its complications more and more frequently in future practice.

Diabetes is independently the seventh leading cause of death in the United States and increases the rates of cardiovascular-related death by 1.7 times (ADA, 2014). In addition, diabetes increases the likelihood of myocardial infarction by 1.8 times, when compared to healthy adults age 20 and older (ADA, 2014). This is a major increase in risk and can have profound effects on an individual's lifespan and quality of life. Diabetes is a major risk factor contributing to myocardial infarction (MI) (Liu, Yang, Tan, Liang, & Li, 2011). Higher hemoglobin A1C (Hgb A1C) levels correlate to higher mortality risk (Liu, Yang, Tan, Liang, & Li, 2011). Without the knowledge of an individual's Hgb A1C, they may have a higher risk of developing complications, namely myocardial infarction.

The physiological complications associated with diabetes contribute to the comorbidities of cardiovascular disease and to the fact that cardiovascular disease is one of the leading causes of death in the United States (National Institute of Health [NIH], 2013). Being diabetic increases risk as we have discussed. Being an undiagnosed diabetic leaves an individual in the ether of medical treatment because they cannot have their diabetes addressed without having knowledge that they have it. This means that they have no way to control their blood sugars in a way that may minimize their risk of suffering complications of the disease, like myocardial infarction.

Diabetes has been described as an epidemic (WHO, Diabetic Fact Sheet, 2016). In 2012, 29.1 million Americans or 9.3% of the population had diabetes and 8.1 million of those individuals were undiagnosed (ADA, 2014). Undiagnosed diabetics account for about 10% of all myocardial infarctions and these newly diagnosed diabetics are only recognized about one-third of the time (Arnold, et al., 2015). This is a substantial portion of our population. It stands to reason that we may be missing many of these individuals in our own communities, which leaves them at risk.

There are several ways to screen for diabetes, including oral glucose tolerance testing and fasting plasma glucose, with Hgb A1C testing being the most convenient (ADA, 2014). The main benefit of using Hgb A1C in testing is that it requires only one blood draw from the patient and it requires no burdensome time commitment from the patient or fasting. Hemoglobin A1C is an indicator of the average blood sugar of an individual over the course of the past two to three months and is often used diagnostically to screen for diabetes (Liu, Yang, Tan, Liang, & Li, 2011). This offers a reliable snapshot

of the individual's blood sugar level from day to day (Liu, Yang, Tan, Liang, & Li, 2011). Diagnosis of diabetes is indicated with a Hgb A1C level of 6.5% or greater while a diagnosis of pre-diabetes correlates to Hgb A1C levels of 5.9-6.4% (ADA, 2014). Hgb A1C levels of 4.8-5.9% are physiologically normal (ADA, 2014). This becomes important in an inpatient setting because monitoring Hgb A1C can overcome the issues of inpatient glycemic variability by looking at a longitudinal snapshot of the individual's glycemic state (Gomez-Peralta, et al., 2016). Studies have shown that Hgb A1C is an independent predictor for mortality, showing that mortality increases as Hgb A1C increases (Liu, Yang, Tan, Liang, & Li, 2011). Increased Hgb A1C levels correlate to increased mortality rates by as much as 84% in individuals with undiagnosed diabetes and coronary artery disease (Liu, Yang, Tan, Liang, & Li, 2011). This further shows the importance of implementing this testing in this population. In contrast, increased Hgb A1C levels showed only neutral effects on individuals with known diabetes and coronary artery disease (Liu, Yang, Tan, Liang, & Li, 2011).

Hemoglobin A1C levels provide reliable information regarding compounding health factors which have been shown to increase morbidity and mortality in patients with cardiovascular disease. This information can assist patients and providers in planning care to mitigate the effects of diabetes on coronary health. Through this testing, undiagnosed diabetics can be diagnosed and education and therapy can be initiated in order to mitigate their increased risk of cardiovascular complications.

The question remains, in myocardial infarction patients, why is hemoglobin A1C not used more often to discover these undiagnosed diabetics? The evidence linking MI

and diabetes appears to be substantial and leaving these diabetic individuals undiagnosed puts them at greater risk of the complications of diabetic heart disease. The Joint Commission (2016) has measures in place to decrease the burden of mortality on myocardial infarction patients, but screening for diabetes is not currently on this set of guidelines. The MI CORE Measures provide a care path for MI patients (The Joint Commission, 2016). This care path includes therapies and medications that are designed to prevent further myocardial dysfunction, giving these patients the best chance of recovery (The Joint Commission, 2016). When screening for diabetes is not utilized in new MI patients, this leaves undiagnosed diabetics without a plan of care that would prevent further cardiovascular disease. This is especially problematic when we know that common diabetic therapies, like metformin, have been shown to be cardio-protective (Bromage & Yellon, 2015). This may represent a gap in current practice guidelines that could be addressed with Hgb A1C screening.

This was a practice-improvement project, aimed at establishing a targeted-care regimen, which first identifies previously undiagnosed diabetics through Hgb A1C screening and, second, provides plans of care that are similar to those in place with CORE measures for MI for this population. This improvement in practice will establish initial guidelines for care regarding this population post MI, including adding Hgb A1C screening to current order sets and amendments to current DC summaries to address testing and education/treatment of diabetes.

Theoretical Framework

This project used the Synergy Model for Patient Care put forth by The American Association of Critical Care Nurses (AACN) (1995). This particular nursing theory best fits the areas of interest of this project. There are several components of this theory and several of them fit the style of nursing practice that guided the decisions that were made in developing this project. These include the patient characteristics (resiliency, stability, and predictability) and the nursing characteristics (advocacy and caring practices). These specific components acted as a guide for this project, ultimately addressing the key issue of helping patients obtain optimal outcomes through helping the development of nurses' competency on this subject as described by Masters (2015). The major benefit of this theory is that it represents a true opportunity to implement a project that offers the chance to collaborate, as patient and provider, in order to grow together to obtain an optimum level of wellness. The problem in question, as described by this project, directly interferes with this optimum level of wellness and was addressed by the data provided by this project with this model used as a guide.

REVIEW OF THE LITERATURE

Through the review of literature, many studies linked diabetes to cardiovascular disease and mortality. Research suggests that an increasing number of these individuals were undiagnosed people living with diabetes. One study noted that unknown diabetes patients accounted for 9.3% of all ICU admissions (Carpenter, Gregg, Xu, Buchman, & Coopersmith, 2015). This was echoed by Arnold et al. (2015), stating that around 10% of MI patients were undiagnosed with diabetes and they are only testing one-third of the time. This is a significant portion of admits to critical care areas, indicating uncontrolled diabetic states lead to severe health issues, including myocardial infarction. Several studies found that, while people with known diabetes showed a noted increased risk in mortality in myocardial infarction, undiagnosed diabetic patients tend to remain in the shadows of treatment (Liu, Yang, Tan, Liang, & Li, 2011). Undiagnosed diabetes is quite common in these individuals, and they share the same or increased risk profiles for cardiovascular disease and mortality when compared to known diabetics (Giraldez, et al., 2013). This information shows that the population of people with undiagnosed diabetes may share a disproportionate risk for severe health events, like MI, when compared to individuals with known diabetes. Individuals with diabetes were also more at risk for in-hospital mortality than their non-diabetic counterparts (Kompoti, Michalia, Salma, Diogou, Lakoumenta, & Clouva-Molyvdas, 2015).

Complications of Diabetes

Newly diagnosed or undiagnosed people with diabetes experienced mortality rates in the same clinical situation approximately identical to their known diabetic counterparts (Aggarwal, Shah, Randhawa, Ellis, Lincoff, & Menon, 2015). This is significant because it shows how fragile patients with diabetes are. Also, they assume a more substantial risk profile when compared to the nondiabetic community. Adding a comorbid condition like MI further complicates their wellness and increases the likelihood of negative health outcomes.

Cardiovascular Disease and Diabetes

Myocardial infarction patients with diabetes, regardless of whether their diabetes was known or unknown to them, were often found to either be in an ICU setting or have some cardiovascular disease leading to an acute admission. The most common themes of the articles reviewed were mortality, diabetes, hemoglobin A1C, undiagnosed diabetes, and myocardial infarction. Several of these studies contained most of these themes; however, no one study contained all of the themes. These common themes were often discussed in their relationship to patient cardiovascular outcomes or regarding mortality in studies by Aggarwal, Shah, Randhawa, Ellis, Lincoln, and Menon (2015), Giraldez et al. (2013), Hopper, Billah, Skiba, and Krum, (2011), Kompoti et al. (2015), Lonborg et al. (2014), Merrill and Jones (2011), Singh et al. (2015), Tomaszuk-Kazberuk et al. (2012), and Wannamethee et al. (2011). This literature further solidifies the correlation between diabetic states and cardiovascular disease, showing the significance of this

problem in our society. This means the link between diabetes and cardiovascular disease is irrefutable.

Glycemic Variability, Mortality, and Potential for Recovery

Several other themes presented in the review of research. In addition to discovering undiagnosed people with diabetes, many of the studies noted increased glycemic variability (hypoglycemia and hyperglycemia), which was noted to show correlation to mortality rates (Ladeira, Simioni, Bafi, Nascente, Freitas, & Machado, 2012), (Merrill & Jones, 2011), (Mi, et al., 2012), (Tomaszuk-Kazberuk, et al., 2012). Hemoglobin A1Cs were frequently discussed with some mention of the level of Hgb A1C and its effects on cardiovascular outcomes or mortality in most of these articles. This suggests that knowledge of an individual's diabetic status may assist in developing a plan of care that mitigates these effects to decrease mortality in these individuals. Diabetic control, as determined by a person's hemoglobin A1C value, corresponds to a mitigation of risk of health complications.

Preferred Testing for Presence of Diabetes

Hemoglobin A1C was determined to be a reliable diagnostic for diabetes or pre-diabetic states in several studies. The study by Kodama, Horikawa, Fujihara, Hirasawa, Yachi, et al. (2013) determined that Hgb A1C was as effective as the traditional oral glucose tolerance test at diagnosing the presence of diabetes. Hemoglobin A1C was stated to be preferred to other methods of diagnosing diabetes because it can be done at

any time and is convenient for both patients and providers (Kodama, et al., 2013). This is important because a major hurdle of testing for diabetes is time and patient ability to engage in testing. This literature suggests that testing Hgb A1C may be the most useful for the inpatient population because it can be drawn at any time, making it convenient, and it is a reliable measure of diabetic states. This may be ideal in an inpatient, emergent situation. Blood draws are common in this area and adding this testing to testing that is already performed may ease the therapy burden on the patient.

Physiological Effects of Hyperglycemia

Hyperglycemic states were explored by Lonberg et al. (2014) to determine if they affected the size of infarct and rates of tissue recovery. This study found hyperglycemia did have a negative effect on both of those issues (Lonborg, et al., 2014). Hyperglycemic states were shown to be associated with increased infarct area size and longer time associated with tissue recovery after an MI (Lonborg, et al., 2014). Also, tight glyceemic control was explored to attempt to find a range of blood glucose that was affected with improved outcomes for hyperglycemic MI and ICU patients (Merrill & Jones, 2011). Again, the literature suggests that knowledge of an individual's diabetic status can assist providers in making an individualized plan of care to best mitigate the sequelae of MI in diabetic patients. The diabetic population continues to show that they suffer unique problems associated with MI. Having the knowledge of their diabetic state can assist in development of care pathways that best address these complications.

About half of the studies in this review did deal with myocardial infarction, undiagnosed diabetes, and mortality. One-third of the studies of this review were ICU-specific and also covered several other themes in addition; most commonly diabetes, undiagnosed diabetes, and mortality.

Guideline Recommendations

The National Clearinghouse Guidelines suggest that clinicians may screen individuals for diabetes who have known atherosclerotic cardiovascular disease (Redmon, et al., 2013). This is further echoed by the ADA's (2016) treatment guidelines for inpatient diabetics. The above research is important for a couple of reasons; it projects information about the nature of the problem in question and its scope in our society, and it demonstrates a lack of information regarding this specific issue. The literature reviewed was able to bear out a strong correlation of diabetes to myocardial infarction and mortality. While undiagnosed diabetes was frequently noted, it was infrequently explored. This is curious because these studies noted differences in health outcomes for this population. Many of these studies were done to track mortality rates or instances of complications from the disease rather than to find new diabetics. However, the presence of this population and difference of health outcomes seem to suggest that there is currently a gap in care guidelines regarding this population. Furthermore, when these conditions were noted, the newly diagnosed diabetic individuals were seldom sent home with a care plan or treatment regimen in place. This does seem to be an avenue worthy of further study, especially when considering the outcomes faced by these individuals. If the

estimates of the studies are correct about undiagnosed diabetes, then this is a large portion of critical care patients, myocardial infarction patients, and the population at large. The population of undiagnosed diabetic individuals who suffer myocardial infarction appears to be massively underserved. Especially in terms of research specifically about mortality prevention and recovery plans of care as seen for other groups like MI.

As there isn't one single guideline that covers this study population, the AGREE II tool was used on the National Guideline Clearinghouse (2012) Summary of Diagnosis and management of type 2 diabetes mellitus in adults. This guideline does provide specific recommendations with graded evidence for many of the treatments and tests used in diabetic care. This guideline did not specify how best to manage patients in a critical-care setting, but does provide general recommendations for inpatient management. While this guideline does not specifically provide a treatment guideline for myocardial infarction patients in critical-care areas, it does give a fairly detailed idea about the use of hemoglobin A1C testing for individuals with known coronary artery disease. This can be extrapolated for use in inpatient settings for these patients. The guideline does help to identify key populations of risk, known risk factors associated with developing diabetes, and when to test individuals who suffer from cardiovascular disease. These same recommendations are also put forth and supported by the American Diabetes Association's 2016 patient-care guidelines. The above listed patient population certainly fits these guidelines' criteria for hemoglobin A1C testing. Making standardized

hemoglobin A1C testing for myocardial infarction patients in an ED/ICU appears to be within the recommendations of these guidelines.

METHODOLOGY

In completing this project, chart reviews were performed and several other demographic data points were collected. The data of primary importance was whether Hgb A1C levels were collected or not on MI patients in an ED/ICU setting to determine their diabetic status. Determination of MI was determined by diagnostic criteria including elevated cardiac troponin levels, changes on electrocardiogram suggestive of ischemia, and identification of thrombus by angiography (Reeder & Kennedy, 2017). Additionally, this project attempted to uncover the rate at which testing of these individuals was done, how many of these individuals were diagnosed with diabetes, and how many of these individuals were provided treatment or follow-up care for this disease, as ordered at the patient's time of discharge or dictated in the patient's discharge summary. Newly diagnosed diabetic individuals were considered those who showed a Hgb A1C level of 6.5% or higher with mention of, education for, or the initiation of treatment for their new diabetic diagnosis. The patient metrics of age, race, gender, and BMI were collected as well. These data points assisted in creating a more complete patient risk profile and assisted in developing a plan of care to address this area of need.

This project was approved by both the college and study facility's IRB council. In order to protect information that was personal identification, each patient chart was given a random, five-digit, numerical identifier. All data for this project were pulled from the facility electronic health record with the assistance of a clinical informatics liaison. The data collection was done by chart review for a period of five years prior with the addition of all patients up to the requested data date for the year of this project. As the data used in

this project were from past patient encounters, the data collected did not impact patient care during their stay and no ethical conflicts were noted.

This resulted in 1,777 patient charts to be reviewed; 1,199 men and 578 women. The age range for this project was 30 years old to 90 years old. The facility from which this data was examined is one of the largest hospital facilities in the state. It services a large geographical area, as many of the communities in the surrounding area are sparsely populated with limited health resources, and provides a number of medical services including medical outreach to medically underserved areas, which makes it a medical hub for the region.

It was hypothesized that collecting this information would provide a realistic and reliable look at the current practice of this community regarding the project population. As previously stated, Hgb A1C is a reliable and simple method of determining diabetic status. By understanding the current practice, it was hypothesized that any noted deficiencies in practice would be noted and could be addressed by implementing new interventions. From reviewing the literature, it was expected that Hgb A1C testing rates would be low in this population. If the project data matched data from the literature as noted above, testing would occur more in males and those whose BMI matched current testing recommendations.

Additionally, data about current practice at other facilities within the state regarding this population were collected for comparison. Healthcare facilities in Great Falls, Helena, Missoula, Kalispell, Billings, and Bozeman were contacted and asked if they routinely test all MI patients with Hgb A1C. None of the facilities that were

contacted stated they routinely test MI patients with Hgb A1C. Though this testing is recommended in the literature, it has not yet been implemented as routine testing for this population in the state of Montana. This is consistent with what was found in the literature.

This data was analyzed by this author with the assistance of a statistical analysis consulting group. Analysis of testing and discharge summaries was completed by this author. Complete statistical analysis of all of this project's data was performed by the consulting group, including rates of Hgb A1C testing compared with subject demographic information. Microsoft Excel was used for data storage and analysis. Testing done by the statistical consulting group included the Chi-squared test of independence, the non-parametric version of the Chi-squared test, and the Cochran-Armitage trend test. These tests were felt to best fit the data in order to produce the most usable and applicable results for practice. The results of these tests are discussed in the following section.

RESULTS

The sample size for this project ended up including 1,777 MI patients. Four of these patients' charts presented no information regarding demographics, Hgb A1C, or discharge summary and were subsequently removed from the data set. This is a large sample and serves as a reflection of the current practice of this facility. Of the 1,773 patients in the data sample, 1,257 were not diabetic or assumed not to be and 1,054 of them were not tested with Hgb A1C. This may be reflective of the lack of provider value for this testing in acute-care situations. This left 719 (40%) patients who were tested with Hgb A1C. Of the 719 patients tested with Hgb A1C, 33 (4.5%) were newly diagnosed diabetics, 470 (65.3%) were previously known diabetics, and 13 (1.8%) were diagnosed as pre-diabetic. Testing with Hgb A1C is more commonly done for individuals who are previously known to be diabetic. Of all the patients tested, 257 of them were shown to be nondiabetic with a Hgb A1C within the normal range of 4.8-5.9%. These 257 individuals only represent about 35% of this patient group. This shows that diabetes and heart disease are closely related, as suggested by the literature. One hundred seventeen patients showed Hgb A1C levels consistent with prediabetes, ranges 6-6.4%. With only 13 patients being diagnosed as pre-diabetic, it appears that the results of Hgb A1C testing are not always used in developing patient-care plans. Three hundred forty patients showed Hgb A1C levels of 6.5% or greater, which is consistent with a diagnosis of diabetes. This accounted for 46.7% of all the tested individuals., further showing the strength of association between diabetes and MI.

Among the individuals who were tested with Hgb A1C, 31 out of the 387 (8%) were previously undiagnosed as diabetics and diagnosed during their stay. This left 903 individuals who were not tested with Hgb A1C, leaving no evidence for the presence or not of diabetes. These untested individuals may share an increased risk because it is unknown if the disease of diabetes contributed to their current MI. If we follow the 8% occurrence with the present data in those tested, it can be assumed that an additional 8% of the untested would have been undiagnosed diabetics. This would mean that 72 patients were missed with current practice. Table 1 shows the findings of current practice.

Table 1: Patient Testing Breakdown and Presence of Diabetes

	No Diabetes	New Diabetes	Total
No Hgb A1C	901	2	903
Had Hgb A1C	356	31	387
Total	1257	33	1290

During this project, Hgb A1C testing was compared with additional patient demographics in order to determine if any of these variables affected a provider's decision to use Hgb A1C testing amongst this population. These patient demographics included age, race, sex, ethnicity, and BMI. Using the Chi-squared test of independence, the data showed that females were 1.3 times more likely to be tested than men, with an approximate 95% confidence interval for an odds ratio 1.083:1.63 and a p-value of 0.007. This was unexpected as it was assumed that males would be tested more often and females made up a smaller number of subjects in this project. This is shown in Table 2.

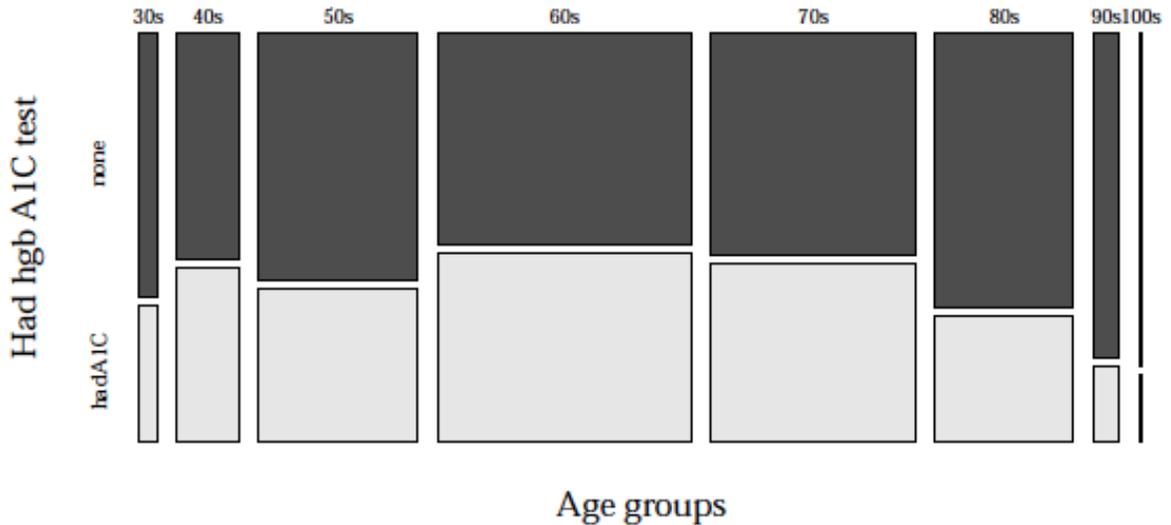
Table 2: Hemoglobin A1C Use and Gender or Patient Sex

	No Hgb A1C Testing	Had Hgb A1C Testing	Total
Male	682	517	1199
Female	368	210	578
Total	1050	727	1777

To determine if ethnicity affected the use of Hgb A1C testing, the non-parametric version of the Chi-squared test was used. This was difficult to accomplish because most or almost all of the patients in the data group were Caucasian. The non-parametric version of the Chi-squared test was unable to discover any correlation between ethnicity and use of Hgb A1C testing. Additionally, no evidence was shown that BMI consistently influenced the use of Hgb A1C testing. This was surprising as BMI is an indicator for the use of Hgb A1C testing and was anticipated to be a factor in current testing practice (ADA, 2016).

The Cochran-Armitage trend test was used to determine if Hgb A1C testing was influenced by patient age. The patients were grouped into age groups; 30s, 40s, 50s, etc. Testing appears to occur most often in individuals in their 60s and 70s. The testing revealed a trend in Hgb A1C use and age that is represented in table 3. Unfortunately, there was no other means to determine any further causal link between age and Hgb A1C testing. This trend may be influenced by the patient's previous diabetes diagnosis and/or a decreased sense of the need for testing as an individual ages. This is an area that may need further research to determine if a causal link is present.

Table 3: Hemoglobin A1C Use and Age



Education Component

The results of this project were shared with the institution’s Research Council as a PowerPoint presentation. This discussion included ways to implement Hgb A1C testing into current practice for this patient population. This presentation used only preliminary data that focused on rates of Hgb A1C use and current practice. The members of the research council thought that the data was compelling. This facility expressed interest in continuing this project forward for a year in order to monitor testing and trend compliance. They felt that this would be a useful addition to other work this facility is currently undertaking in seeking MAGNET status for this facility. Since this facility uses an electronic health record, it was decided that the best way forward would be amending current order sets and discharge summary templates to include the addition of HgbA1C testing and beginning diabetic care for newly diagnosed diabetics. Implementation of this plan to update current practice is anticipated in the future. The research council

concluded that this plan, with the finalized project data, should be presented to the ED/ICU physician group.

The education about the projects results was shared with ED and ICU providers. This was accomplished by providing a short, ten-minute in-service about the importance of Hgb A1C testing for this patient population as well as the need to ensure that newly diagnosed diabetics receive an initial intervention. This was accomplished by use of an additional PowerPoint presentation. This presentation was a means to engage providers in further determining the best way forward in creating this change in practice.

DISCUSSION

This project shows a deficiency in Hgb A1C testing in current practice for this population that is consistent with what was found in the literature. The large size of the data set provides a reliable measure of this practice. The majority of MI patients were not tested for diabetes with Hgb A1C. Testing at this facility showed a testing rate of 40%. This is slightly higher than the estimated one-third of the time from literature. This could be explained by the inclusion of individuals who underwent coronary artery bypass grafting, for which Hgb A1C testing is a gold standard. The data also shows a propensity for testing only individuals who were previously known to have diabetes, though the data does show that even some of these individuals were untested. Perhaps this is because Hgb A1C is not seen as useful for acute-care issues as it cannot be corrected during an acute hospital stay. The data also shows a deficiency in identifying individuals as pre-diabetic. One hundred seventeen individuals showed Hgb A1C levels consistent with prediabetes, but only 13 were identified at the time of discharge. This seems to be an ideal opportunity to introduce education that could prevent the development of diabetes, potentially decreasing these individuals' lifetime risk of further cardiovascular complications. It shows that adding this testing to this population may close the loop of care for this population preventing future complications.

The 33 newly diagnosed individuals with diabetes account for 4.5% of all the project's patients. When these new diabetic individuals were compared to all the subjects tested with Hgb A1C, a testing rate of 8% was shown. This is very near the 10% undiagnosed individuals with diabetes rate found in literature, which suggests that the

assumption of a 10% undiagnosed individuals with diabetes rate is correct. This percentage is close to the state diabetes level of 6.4%, which is further evidence that this population exists here and is underserved (The Department of Health and Human Services, 2007). If we apply the 8% diabetic rate to the untested portion of this study, we are left with 72 individuals who were left without addressing their diabetes. These individuals then assume a larger risk for cardiovascular events than the other individuals that were tested, when they may not need to. It is apparent that implementing standardized Hgb A1C testing for MI patients would be helpful in identifying new diabetics and providing them a plan of care that ensures that their risks from diabetes are addressed. It would also appear that there is an opportunity to address prediabetes in this population in a way that may prevent them from developing diabetes, preventing an increase in cardiovascular risk that is seen in diabetic patients. It may also offer further opportunity for study. The population with prediabetes in this project was substantial and yet it was hardly noted by providers in the discharge summary. This is interesting and could potentially offer avenues for development of future practice-improvement projects.

While adding this testing will increase costs associated with MI admissions, identifying a new chronic disease in this fragile population can also save money long-term. By offering the patient an opportunity to gain control of this new condition, they have the opportunity to decrease their risks of developing the associated complications through lifestyle modifications and regular follow-up care. These complications are commonly known to increase an individual's lifetime healthcare cost. Therefore, the

addition of cost of adding this testing to practice is offset by potential decreases in cost in future care.

This project has shown that a gap in care for undiagnosed individuals with diabetes with MI does exist and that the implementation of standardized testing in this group would help to identify those individuals. As noted in the above literature, individuals with controlled diabetes experience less complications and mortality from MI. It stands to reason then, that these newly identified diabetics would be more likely to gain control over the disease of diabetes than an individual without knowledge of their condition. This in turn would decrease the likelihood that these new diabetics would experience further complications, i.e., subsequent MI or congestive heart failure, when compared to individuals without knowledge of their disease.

While this project does show that a gap in care exists at this facility, it may not be appropriate to implement practice change at all facilities as it may not reflect practice at other facilities. If this project was attempted in another facility, this project may reveal results that are similar. As noted in the hospital survey completed with this project, this testing is not standardized in practice. This would mean that testing would only be done when a provider deemed it to be necessary. Individual practice preference, then, would remain a key variable in how often this testing is implemented. The likely result is that testing in these facilities leaves undiagnosed diabetics with MI without a diagnosis of diabetes, but rates at which this happens most likely differ amongst facilities.

Additionally, this project only looked at MI patients in an ICU and ED setting. MI can occur in-hospital and MI patients do not necessarily always admit through an ED or

ICU. At times, patients are transferred from one facility to another based on services provided and need, and, at other times, patients are directly admitted to care areas by their provider. Therefore, practice and testing rates may be different if this was to be explored. The inclusion of these patients and assessments of practice in medical units, including coronary-care units, may be appropriate for future study. Additionally, exploring the practice of providers in the specialty areas of cardiology, endocrinology, and hospital medicine may provide a more complete assessment of this practice in regard to Hgb A1C testing in MI. These providers commonly care for MI patients and differences in practice between these provider groups may exist. These differences in practice, then, would directly impact testing rates and the rates of discovery of new diabetic individuals.

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