Troponin Elevation in Chronic Kidney Disease: An Educational Project

By

David J Sasso Jr

A Major Paper Submitted in Partial Fulfillment

of the Requirements for the Degree of

Master of Science in Nursing

in

The School of Nursing

Rhode Island College

2018

Abstract

Many patients may present to Emergency Departments (ED) daily for a multitude of medical issues that may include chest pain, shortness of breath, nausea, vomiting, elevated troponin levels in the presence of CKD, abnormal serum BUN and creatinine levels, or an abnormal renal ultra sound. Troponin levels that are elevated within the presence of CKD with no other signs and symptoms is not concerning for ACS or MI, but for cardiovascular death and mortality. The purpose of this project was to develop, create and deliver an educational program designed to increase nursing knowledge of elevated troponin levels in the presence of Chronic Kidney Disease. A pre-&post-test design was developed and implemented to measure the nursing staff's knowledge of elevated troponin levels in the presence of CKD. The educational program was designed as a pamphlet that provided information from the literature and relevant clinical experience about signs, symptoms and the diagnosis of CKD, signs & symptoms of Acute Coronary Syndrome, (ACS). Twenty-three nurses (25%) completed both the pre-test with a mean score of 74.7% with total scores ranging from 40%-90%. Twenty-three nurses also (25%) also completed the post-test with a mean score of 76.5% with total scores that ranged from 50%-100% which helped to prove there was an overall increase in learning, therefore suggesting that nurses' knowledge on the topic was improved. Recommendations and implications for APRNs are also discussed.

Acknowledgements

I would like to take the time to acknowledge the overwhelming support I received from the Rhode Island School of Nursing and its faculty during my graduate education. I would like to especially thank Dr. Debra Servello, DNP, ACNP-APRN-BC, who served as my first reader and Principal Investigator for this project. I would also like to thank my second and third readers Dr. Marie Wilks, DNP, and Marianne Woodruff, APRN FNP- BC. It was your support, encouragement, and belief in me that allowed me to succeed in this endeavor.

I would also like to thank my beautiful wife Lindsey for her unwavering support she provided me for not only the duration of this entire program, but also for the others challenges that came before this. You listened and cheered me on persistently no matter how many challenges I faced as I relentlessly pursued my graduate degree.

A very special heart felt thank you to my loving parents David J. Sasso, Sr, & Norma Sasso. I thank you both for all the love you have given me along my journey in life. I appreciate being raised right, learning good morals and values, and being taught the value of hard work. I thank you for teaching me how to care for and respect others which are the cornerstones of my profession. Without your love and support none of this may have been possible.

I would also like to extend many thanks to Retired Captain Albert Peterson NPFD, for believing in me, sharing your wealth of knowledge, and encouraging me with my studies for the years we worked together which has continued right thru until today.

Lastly, I would like to thank everyone who showed interest and supported me through this endeavor.

Table of Contents

Troponin Elevation in Chronic Kidney Disease: An Educational Project

Background/Statement of the Problem

Chronic kidney disease (CKD) affects more than 30 million Americans with many going undiagnosed (Centers for Disease Control and Prevention, 2017). The clinical manifestations of CKD are vague and often, the signs and symptoms are extremely non-specific and can manifest other disease processes. The complications of CKD include hypertension, cardiovascular disease, hyperkalemia, elevated troponin levels at baseline (Mayo Clinic 2018). These complications are enormous and tremendously intimidating, so it is imperative during the initial assessment that providers identify potential complications.

According to Ozieh et al. (2017), CKD is defined as a decreased glomerular filtration rate of less than 60 ml/min, or the presence of one or more markers that indicate kidney damage for three months or greater. CKD is not only burdensome as a medical disease, it is also very costly with non-dialysis CKD patients amassing a total of 18.2% of total Medicare expenditures which amounts to approximately 45.5 billion dollars annually, breaking down to approximately $22,348 per CKD patient annually. Ozich et al. are the first to examine the costs surrounding CKD and the impact it has on the healthcare system as a whole.

Patients who present to the emergency department with acute coronary syndrome (ACS) may have elevated troponin levels. It also important to note is that patients who are not currently experiencing chest pain and have CKD can also present with troponin levels that are elevated. Early detection and differential is imperative, so treatment may begin, which will help to prevent further progression to kidney failure. Medical

professionals, including doctors, physician assistants, advanced practice registered nurses (APRNs) and nurses alike, need to emphasize primary prevention and treatment to preserve and restore health status and stave off disease progression.

Practicing clinicians and nurses alike should be acutely aware that during the evaluation of patients with CKD, the occurrence of potentially high sensitivity assays may result due to non-acute coronary syndromes. Clinical and related medical professionals caring for patients with CKD need to keep in mind the increased risk of developing ACS or myocardial infarction (MI) directly related to acute ischemic heart disease in the CKD patient population.

Troponin assays are used to diagnose potential ACS in all patients within the general population as well as those diagnosed with CKD and chronic renal disease. The baseline troponin values in patients with CKD will likely be elevated above the ninety-ninth percentile of the healthy population despite which troponin assay is utilized. In patients with CKD, high sensitive assays for both troponin levels for T and I will display greater than the ninety-ninth percentile when the high sensitivity assays are utilized. Heart disease is the number one cause of death in the CKD patient population summating up to 50% of deaths Colbert et al. (2015).

The purpose of this project was to develop, create and deliver an educational program to improve quality and increase knowledge of emergency department nurses on the significance of elevated troponin levels in the presence of CKD. The research question was: Do emergency room nurses understand the relationship with elevated troponin levels and patients with CKD? An educational project was developed, created, and delivered to emergency department staff nurses to provide information about

troponin levels are elevated in patients with CKD without the presence of acute coronary syndrome (ACS).

Next, the relevant literature review will be presented and discussed.

Literature Review

A search of the literature was performed using the Cumulative Index to Nursing and Allied Health Literature (CINHAL) and (PubMed) using the search terms: cardiac troponin, troponin testing, CKD, estimated glomerular filtration rate, and acute myocardial infarction. The review of literature was limited to full text articles only, published in English within the past ten years.

Chronic Kidney Disease

According to Rosenberg (2016), CKD is defined as the presence of kidney damage. Kidney damage is detected as excretion of urinary albumin of greater than 30 mg/day or its equivalent. A second identifier would illustrate decreased kidney function as an estimated glomerular filtration rate (eGFR) of less than 60ml/min/1.73m2 for a period of at least three months or more regardless of what caused the condition. The damage or reduction of kidney function delineates CKD from an acute kidney injury (AKI).

Chronic kidney disease is classified into stages which guide providers on how to manage, locate any potential risks, guide treatment to cease progression, and highlight any potential complications that may arise from the progression of the disease. Treatment involves reversing the causes of renal failure, preventing, or stunting the progression of renal disease, treating complications of renal disease, adjusting pharmacotherapy when appropriate to the current level of eGFR, and identifying and preparing the patient when renal replacement therapy will be mandatory (Rosenberg, 2016).

Acute Coronary Syndrome

Miller & Granger, (2016) state that the chief complaint of chest pain is responsible for approximately 6 million annual visits to emergency departments in the United States.

Acute Coronary Syndrome (ACS) is responsible for 12 to 15% of those cases. ACS is a functional term applied to patients where there is an indication of myocardial ischemia or myocardial infarction (MI). There are three different types of ACS: unstable angina, non-ST elevation MI, and ST elevation MI. ST elevation and non-ST elevation MI, diagnosable if elevated troponin levels are present, which will typically rise and fall before, during, and after an event. Unstable angina is classified as myocardial ischemia with no elevation in biomarkers like troponin. Most often the clinical diagnosis is made based on the patient's story, history of present illness, thorough physical examination, current electrocardiogram, evaluation of basic lab work, and or evidence of ischemia with stress testing (Miller & Granger, 2016).

The immediate focus should be on treatment, because early intervention leads to the best outcomes (Miller & Granger, 2016). Upon presentation to the emergency department, an initial 12 lead EKG should be obtained within ten minutes, and continuous telemetry monitoring initiated. Next, a history and physical exam to correlate with current signs and symptoms exhibited. Laboratory tests should be ordered, to include troponin, electrolytes, bun, creatinine, and complete blood count. A chest x-ray is standard in this patient population, as it can be an asset with differential diagnosis. A risk stratification assessment of the patient presenting with these signs and symptoms is conducted (Miller & Granger, 2016).

Troponin Sensitivity and the Correlation to CKD & ACS

Troponin is the preferred biomarker to diagnose acute myocardial infarction which may or may not be present with presentation of ACS. Troponin is a macromolecular complex that consists of three polypeptides closely intertwined and are

actively related to the contraction of heart muscle. The three types of troponin are cTnC which are responsible for calcium binding, cTnI for inhibiting actin-myosin collaboration and lastly cTnT which represents tropomyosin that is required to enable contraction (Mohammed & Januzzi, 2010).

According to Mohammed & Januzzi, (2010), troponin is discharged when irreparable damage to the myocyte is about to occur. Quantifiable release of troponin begins typically 4-6 hours after cell death, and crests at approximately eighteen to twenty-four hours. Troponin levels can remain detectible in serum levels for the subsequent fourteen days post event. Typically, troponin levels are drawn at specific intervals every three, six, or eight hours depending on policy of each individual institution (Mohammed & Januzzi, 2010).

The elevation of troponin can occur without the presence of ACS Mohammed & Januzzi, (2010). The authors identify a multitude of causes for the potential rise in troponin without the presence of ACS in their review that encompassed mainly quantitative research from eight studies. The elevation should be thoroughly investigated and not be discarded as a "false positive." The authors concluded that the adoption of the 99th percentile of a healthy patient population to diagnose MI. With newly available ultra-sensitive blood testing methods in place and the increased use in patient care, the conclusion will be an increase in troponin levels in patients presenting without the presence of ACS. The authors caution providers that the elevation of troponin does not identify the mechanism of myocardial injury and addresses the importance of utilizing differential diagnosis for the elevated troponin value.

Wang, et al. (2017) conducted a review of current literature searching several databases for evolving biomarkers now available, and those that are considered up and comers within the realm of myocardial necrosis. The authors reviewed studies on high sensitivity reactive protein (hsCRP) and noted an association between elevated inflammation levels and potential cardiac events with hsCRP being a predictor of these events. The researchers reviewed 55 studies and analyzed other evolving biomarkers that included natriuretic peptides, troponins, uric acid, and galectin-3 all of which show correlations with cardiovascular events. Cardiac troponin I (cTnI) and T (cTnT) are proteins that are exclusive to myocardial function and are extremely sensitive biomarkers that signify damage to the myocardium upon their release (Wang et al., 2017). Furthermore, troponins are classified as the most sensitive biomarkers indicating myocardial injury perpetually more than its creatinine kinase counterpart. The researchers looked at a variety of biomarkers, including troponin, natriuretic peptides, and amino acids, that may be indicative of myocardial injury. The authors conclude that more research is needed to further apply the newer biomarkers that will proliferate rapidly. These biomarkers should not be exclusively acted upon, rather that they be utilized in conjunction with other clinical information to include thorough history, physical, and risk stratification along with radiographic findings to accurately treat and diagnose patients.

Van der Linden et al. (2016), conducted a meta-analysis aimed to quantify and compare the relationship between cTnT and cTnI troponin levels with cardiovascular and all-cause mortality in the general population. The researchers' analysis included 2585 reviewed citations, 11 studies, with data on 65,019 participants. Random pooling

illustrated substantial relations between basal cardiac troponin levels and all-cause mortality. There was a significance in the difference of the meta-regression analyses for cardiovascular mortality but showed no statistical difference for all-cause mortality ($P<0.01$). The authors concluded that an elevation of baseline cTnT and cTnI show strong links for an increased risk of cardiovascular and all-cause mortality during follow up in the general population. The correlation is even stronger for cardiovascular mortality than all-cause mortality, but that troponin T is stronger than troponin I but will require further research.

Jaffe & Morrow (2017) delineate between the use of cTnI, and cTnT. The authors describe the assays as being sensitive, and that higher sensitive assays are available, but not in the United States. Jaffe & Morrow highlight guidelines for troponin testing and list a variety of clinical conditions where it is essential to include possible acute myocardial infarction, ACS, after revascularization therapy, and after myocardial infarction which can help determine the magnitude of the infarct and prognosis. The initial troponin level is drawn upon presentation to the health care system and typically re-drawn and compared to the initial result within three to six hours depending on facility policy. In the general population, there is even a small window where elevated troponins can be measured without an acute event, and the typical rise and fall of troponin will not be seen in this population. Troponin is the preferred biomarker to aid in the diagnosis of myocardial cell damage or death as seen with myocardial infarction. Values that register above the 99^{th} percentile in the healthy population and in conjunction with clinical information and electrocardiographic changes seen on EKG may be because of structural heart damage without any acute presentation. The more sensitive the assay, the more

vital to investigate if the troponin level has changed which can assist in the confirmation of myocardial infarction. The recommendation of the authors is to use troponin as preference to creatinine kinase MB both for diagnostic and prognostic means, as it is not cost-effective care to obtain both.

Gibson & Morrow (2017) discuss the possible causes of troponin release in the absence of ACS. The authors found in one study that several patients with specific conditions may cause patients to present with elevated troponin levels to including tachycardia (28%), pericarditis (10%), heart failure (5%), no clear precipitating event (47%), and even participating in strenuous exercise, (10%). Several other studies were included in the review to include an additional 6 studies with a combined sample size of 54,000 study participants and confirmed that a small amount of elevated troponin levels can be linked to structural heart disease in the absence of any acute process. When these authors reviewed troponin levels in patients with stable ischemic heart disease, an additional 6 studies with a combined sample size of 19,560 it was found that elevated troponin levels were associated with irregularities of cardiac structure and functionality nearly 37% higher, and in cases of critical illness a worse prognosis was highly probable. The authors' state that troponin elevation without ACS is a significant finding and that further work up may be justified solely on that finding. Uncovering the underlying cause of the troponin elevation through a comprehensive history and detailed physical examination, which can illuminate conditions, like myocarditis, pericarditis, cardiac contusion, sepsis, pulmonary embolism, and heart failure, is essential.

Gibson & Morrow, (2017) state there is currently no data from randomized trials that indicate that there is a reduction of risk from current therapeutic regimens for

patients with troponin elevations without the presence of ACS. The authors recommend the use of aspirin unless contraindicated because it is generally harmless, though the use of antiplatelet and antithrombotic medications are not generally used in the management of elevated troponin. Lastly, troponin is an essential part of the decision-making process in the setting of other illnesses like pulmonary embolism, and cardiotoxic chemotherapeutic medication administration.

Chronic Kidney Disease and its Relationship to Coronary Heart Disease

Matsushita et al., (2016) conducted a systematic review in order to clarify the clinical guidelines on the application of predicting the cardiovascular risk of those diagnosed with CKD. Matsushita et al completed an individual level meta-analysis where a creatinine based glomerular filtration rate (eGFR) and albuminuria were used as measures for CKD and applied the precise statistical methods across 24 cohort studies. The meta-analysis showed that eGFR and albuminuria help to improve the prediction of risk of getting cardiovascular disease over outdated risk factors to include coronary heart disease, eGFR, and high-density lipoprotein (HDL) for overall mortality and heart failure. In summary, the two key measures eGFR and albuminuria improve CVD risk estimates beyond traditional risk factors. It is felt that clinical guidelines may require updates about how or when to integrate CKD measures and other mentioned biomarkers in prediction of CVD based on outcomes desired in a specific population and the accessibility of needed biomarkers in the CKD population Matsushita et al., (2016).

Sud & Niamark (2015) conducted a systematic review with the purpose of advancing the understanding of cardiovascular outcomes in patients diagnosed with advanced or progressive CKD. The authors reviewed data from five articles from the

United States and Canada with a focus on describing the dynamics of cardiac death in patients with CKD. The results of the review showed that when eGFR is below 60/ml/min, cardiovascular disease is the most common cause of death (Sud & Niamark, 2015). Patients with advanced CKD are excluded from clinical trials for heart failure therapy. The researchers conclude that the risk of sudden cardiac death is elevated in patients with systolic heart failure as ejection fraction decreases. Renewed calls for increased coordination of efforts among nephrologists and cardiologists to start randomized controlled trails devoted solely to patients with advanced CKD can help to improve outcomes and understanding of the disease pathophysiology (Sud & Niamark, 2015).

Sarnack, Gibson & Henrick (2015) conducted a systematic review on the correlations between CKD and coronary heart disease. A diminished glomerular filtration rate and increased proteinuria raise the potential to develop cardiovascular disease in populations with elevated cardiovascular risk. The authors reviewed a combination of ten studies which varied from meta analyses, two randomized controlled trials, and one longitudinal study. Sarnack, Gibson & Henrick, (2015) recommend a thorough risk stratification assessment with the addition of statin medication to reduce cholesterol in patients with eGFR less than 60ml/min per 1.73 m2. A commitment to the reduction of hypertension in patients with proteinuria and CKD with the use of an angiotensin blocker is recommended (Sarnack, Gibson & Henrick 2015). The studies concluded that decreased eGFR and increased proteinuria increase the risk of developing cardiovascular disease. In addition, patients diagnosed with CKD will require drug dosage adjustments because of the potential for drug related adverse effects. Patients

diagnosed with CKD present with traditional and nontraditional risk factors that contribute to the development of cardiovascular disease such as hypertension, smoking, diabetes, and elevated cholesterol levels (Sarnack, Gibson & Henrick, 2015).

Cardiac Biomarkers in CKD without ACS

Lamb et al., (2007) conducted an observational cohort study that enrolled two hundred and twenty-seven Caucasian patients at East Kent Hospital located in Oxford, United Kingdom. The purpose was to evaluate the prevalence of increased cTnI concentrations in patients diagnosed with CKD to determine clinical associations and the prognostic importance of increased cTnI Ultra assays compared against cTnT and the original cTnI standards. Participants were grouped into CKD stages according to the eGFR using estimated glomerular filtration rate (eGFR) and the simplified Modification of Diet in Renal Disease Study formula. In conclusion, the researchers illustrate that cTnI concentrations are elevated in patients with CKD, although the cause is still unclear (Lamb et al., 2007).

deFilippi et al., (2012) conducted a multicenter observational study to analyze the association between high sensitivity (cTnT), and (cTnI), in patients with cardiovascular disease and stable CKD. The study was conducted in outpatient nephrology clinics at three hospitals. The sample size was 148, all males, ages 18-71 years who had prior myocardial infarction, coronary revascularization, glomerular filtration rate less than 60ml/min, an echocardiography measuring left ventricular ejection fraction, and CT scan to assess level of coronary artery calcification. Patients with CKD had a high sensitivity assay troponin T (deFilippi et al., 2012). The association of high cardiac troponin assays and renal function, specifically the troponin T marker, was significantly higher than that

of its troponin I counterpart (deFilippi, et al., 2012). Conclusively, when troponin is used to confirm suspected acute coronary syndromes in patients diagnosed with CKD, the baseline value should measure above the 99^{Th} percentile of the healthy population.

Balamuthusamy et al., (2007) conducted a retrospective chart analysis with a sample size of 108 patients that underwent coronary angiography. The study took place over a period of three years at the Mount Sinai Medical Center located in Chicago, Illinois. The goal was to analyze sensitivity and specificity of cardiac troponin I in detecting obstructive coronary artery disease in the African American population diagnosed with renal insufficiency. Participants were of African American decent, diagnosed with acute coronary syndrome and had some degree of renal failure, namely creatinine levels elevated >1.1mg/L. The authors found that cTnI has lower sensitivity and specificity in patients with renal failure undergoing hemodialysis secondary to changes in elimination. They also conclude that other methods should be used to arrive at the correct diagnosis and appropriate risk stratification of patients with non-ST elevation myocardial infarction. Further research is essential to understand results of traditional biomarkers used for diagnostic reasons (Balamuthsamy et al., 2007).

Colbert et al., (2014) conducted a review that aimed to summarize fifty-one completed studies of varying design primarily cross sectional and longitudinal study designs with one study being a case control design. The researchers reported associations among used cardio biomarkers like cTnT, B-type Natriuretic Peptide (BNP), NT-Pro-BMP, left ventricular mass index, coronary artery calcium score (CAC), carotid intima-media thickness (cIMT), and clinical outcomes in patients with CKD in patients not

undergoing maintenance dialysis to highlight the strengths and limitations of data that is currently available for use with prognostication.

Colbert et al., (2014) conclude their review stating that there are current knowledge gaps and more data is needed before these biomarkers can be reliably used in the population of patients with CKD. Colbert et al., (2014) state that some of the observational studies reporting associations between cTnT and a decline in eGFR in non-dialysis patient populations with CKD may be affected by a decreased renal clearance in the setting of advanced CKD. While the results signify that these biomarkers can be used to forecast future cardiovascular events in asymptomatic patients with CKD, additional research is needed to confirm a standardized cutoff value for biomarkers as diagnostic tests for patients with CKD.

Prognostic Value of Cardiac Markers in CKD

Michos, et al., (2014) conducted a large systematic review & meta-analysis with the purpose to review literature on troponin testing in patients with CKD without the presentation of ACS. Approximately 98 studies in 105 publications met the inclusion criteria. Michos et al., (2014) state that further work is needed to determine the mechanism for the link between elevated troponin levels and undesirable outcomes. It was also established by these researchers that more research is needed to investigate whether it is solely the troponin level alone, or its presence in combination with other biomarkers that can improve the way CKD patients are positioned in higher and lower risk groups in existing clinical models. The question still remains of how patients with CKD with risk stratification performed by troponin level for dialysis patients with no presentation of ACS their clinical course of treatment. In the conclusion of this review,

the researchers show that elevated troponin levels reveal an association of a worse prognosis in patients with CKD not experiencing ACS. For patients with CKD with no indication of ACS, elevated troponin levels remain potent predictors of mortality, and currently support the current U.S. Food and Drug Administration position that measuring serum troponin levels is an appropriate risk stratification tool in this patient population.

Bueti et al., (2006) completed a study utilizing a retrospective cohort design that enrolled a total sample size of 149 at St. Boniface General Hospital, Winnipeg, Canada that aimed to examine the association between troponin I levels and 30-day outcomes. All patients were evaluated according to their chief complaint, risk factors for cardiac disease, initial troponin level, and any other major cardiac event to include MI, cardiovascular death, or coronary revascularization. Bueti et al., (2006) determined that the troponin level was commonly analyzed in acutely ill patients that presented to the ER. The results showed that troponin I was associated with an adverse 30-day outcome despite the clinical presentation. The chief concern or nature of presenting complaint was not helpful in determining if a major cardiac event (MCE) was going to occur within 30 days. It was found that troponin I with a level of > 0.3 ng/L was strongly correlated to MCE, in fact a level of greater than >2.0 supported the data and was predictive of MCE >25% of the time. Troponin level elevated above >0.3 are clinically significant in patients undergoing dialysis regardless of their clinical presentation.

In a pilot study conducted by Sukonthasarn & Ponglopisit., (2007) researchers aimed to find the diagnostic level and rising pattern of cardiac troponin T (cTnT) with patients diagnosed with chronic renal dysfunction presenting with acute myocardial infarction. The study design was a pilot cross sectional study with a sample size of 46

that compared troponin T levels in adult patients with chronic renal dysfunction that were subsequently admitted and later found to have acute myocardial infarction with age and sex controls and non-coronary diagnosis. Researchers concluded that troponin levels of 0.1 ng/ml drawn in the first 24 hours of admission proved to be diagnostic for AMI in patients with chronic renal dysfunction. Participants were then redrawn at subsequent intervals 6, 12, and 24 hours post initial draw. Sensitivity and specificity of troponin levels were greater if chronic renal dysfunction patients were excluded.

Relationships between Elevated Cardiac Markers in CKD without ACS

Alam et al., (2013) authored a research article that aimed to examine the association of elevated troponin I levels in stable patients undergoing maintenance hemodialysis therapy with cardiac-specific mortality, and to distinguish if any increased risk was autonomous of inflammation status. The design utilized a cohort observational study, plasma troponin I levels were drawn with routine pre-dialysis lab work with C reactive protein. All patient outcomes were closely monitored and determining all deaths as cardiac or non-cardiac.

The study's design was that of an observational single-center cohort with a sample size (N=133), featuring participants classified as chronic, stable non-hospitalized hemodialysis patients where monitoring took place for a three-year period beginning in July/August 2009 and followed until July of 2012. The blood tests were drawn in the hospital's hemodialysis unit and analyzed in the hospital's central laboratory. Alam et al., (2013) conclude that elevated troponin I levels provide prediction of cardiac risk. Elevated troponin levels are life-threatening, and it is essential to get to the underlying pathophysiological progressions that lead to it. The study adds to the research currently

available to back more extensive tactics to conduct more thorough cardiac risk stratification in hemodialysis patients to include stress testing, targeted risk stratification, functional cardiac testing, or conventional medical treatment.

Chen et al., (2013) conducted a study that aimed to assess the results of troponin I in non-acute coronary syndrome patients with a diagnosis of CKD. The study was constructed using a sample size of N= 293 patients with CKD and had a troponin level drawn. The design of the study was shown through retrospective chart review over a two-year period. The results of the study concluded that almost half, 43.34% of the non-acute coronary syndrome patients with CKD, and 26.03% of the patients without ACS and CHF have elevated levels of troponin I. Furthermore, congestive heart failure is linked to elevated troponin levels without the presence of ACS patients with CKD.

In a study, Li, et al., (2015) performed a meta-analysis through a systematic search of studies pertinent published by November 2013 in the MEDLINE database. Studies were included based on 5 inclusion criteria that included published in English, had randomized control trials or observational study design, patients diagnosed with CKD defined as having eGFR <60/mL/min per 1.73m2, had stated long term all-cause mortality or cardiovascular mortality of CKD, patients who had elevated levels of C-reactive protein (CRP), and had estimates of risk ratios (RR's) or Hazard ratios (HR's) within a 95% confidence interval. Exclusion criteria included animal studies, autopsies, phantom studies, and myocardial infarction. A total of 828 articles were returned and after excluding many, it was decided that 20 would be included in the C-reactive protein (CRP) analysis, and 17 would be included within the troponin analysis.

In conclusion, the meta-analysis shows elevated troponin levels and CRP are largely associated with increased risks of all cause and cardiovascular mortality in patients diagnosed with CKD. Future studies with more strict calibration, long term monitoring, and more complex design representing large and representative populations are essential to the investigation of more complex risk stratification of CKD patients.

Next, the Theoretical Framework guiding this project will be introduced and discussed.

Theoretical Framework

Two separate frameworks were identified and discussed for use in this project. The Adult Learning Theory was developed by Malcom Knowles in the beginning of the 1970's and will assist in the development and delivery of an educational program. Knowles' learning theory was created specifically for adults and is largely formulated on six individual principles: the need to know, the learners' self-concept, the role of the learner's experiences, the learners' readiness to learn, orientation to learning, and lastly the learners' motivation to learn (Knowles, Holton, & Swanson, 2011). Adults are intuitive and seek what the reason is before learning something new. Self-concept is explained as being responsible for their own decisions and being capable of self-direction. The role of learners' experiences relies on experimental techniques that delve into the experience of the learner utilizing experiences like group discussions, simulation exercises, and peer to peer helping of one another. Readiness to learn highlights the learners' the ability to accomplish what essentially needs to be done so knowledge can be attained. Orientation to learning occurs based on the perception that lessons being taught will help them to problem solve with real life situations. Motivation directly relates to the adults' responsiveness to internal like increased job satisfaction, and external motivators like promotions and better salaries (Knowles et al., 2011).

Malcom Knowles Adult Learning theory is applicable to this project primarily with the principle of Andragogy which translated means "Man Leading." The use of Knowles Adult Learning Theory will allow nurses to learn at their own pace, at a time and place convenient to them. Adults are primarily lifelong learners and typically participate actively especially in the field of medicine, knowing it will translate into being

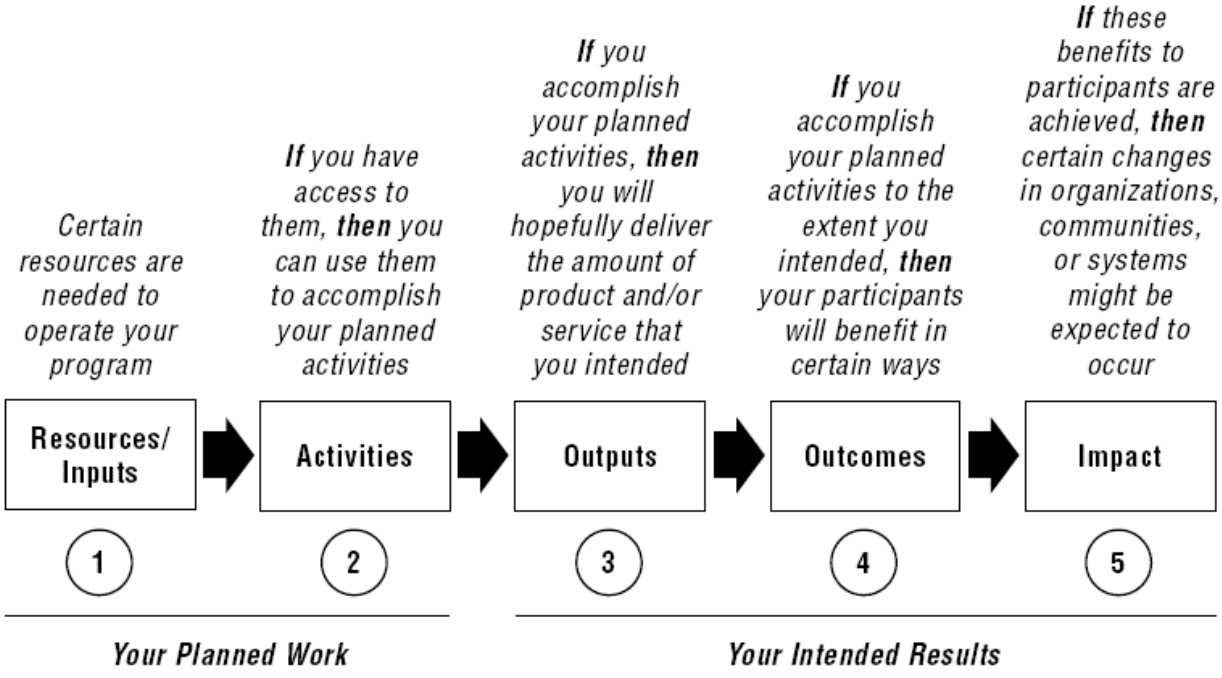
better prepared healthcare workers. Nursing is no different and requires individuals to keep up with current best practices to maintain core competencies with specificity to their nursing specialty. If a nurse discovers a lack of experience with a skill or procedure, they will typically obtain the information needed to complete the task via textbook, resource material or from another college. Registered nurses are more compelled to learn when it will directly benefit their way of clinical practice (Knowles et al, 2011).

The Kellogg Foundation's Logic Model was implemented to assist in the preparation, execution, and evaluation of the educational program that was developed by the researcher. According to the Kellogg Foundation (2004), the Logic Model provides a systematic and visual way to present and share the understanding of relationships among the resources available, operate the program, the activities planned, and the change or results anticipated to achieve. The Logic Model is comprised of five components that are visually depicted on a diagram and are read left to right. The five components included are resources/inputs and activities which are fall under the umbrella of the researchers planned work. The remaining components fall under the researchers intended results and include outputs, outcomes, and impact.

The Logic Model will be utilized in this project implementation. The inputs in the project would be support from emergency department management and the Chief Nursing Officer. The activities would be the educational information provided to ER nurses in both the poster displayed and the pamphlet emailed to participants. The outcomes associated with the project would be an overall knowledge increase after the informational program has been delivered. The impact of the project would be an increased awareness and understanding for elevated troponin levels in the setting of CKD

without ACS. Learning will be assessed by the administration of a 10 question pre-and post-test. The Logic model is illustrated below (Figure 1).

Figure 1. The Logic Model retrieved from https://www.wkkf.org/resource-directory/resource/2006/02/wk-kellogg-foundation-logic-model-development-guide



Next, the methods used to conduct this project will be presented and discussed.

Methodology

Purpose/Question:

The purpose of this project was to develop, create and deliver an educational program to improve quality and increase knowledge of emergency department nurses on the significance of elevated troponin levels in the presence of CKD. The research question was: Do emergency room nurses understand the relationship between elevated troponin levels and patients with CKD?

Design:

An educational program was developed of to determine ED nurses' knowledge on the significance of elevated troponin levels in the presence of CKD. A quantitative pre-test and post-test format (Appendix A) was instituted to adequately measure the emergency department nurses' knowledge of elevated troponin levels in the presence of CKD.

Site:

The proposed project was conducted at a local community teaching hospital with 359 acute care beds located in Warwick, Rhode Island. The Emergency Department has 60 beds with an annual patient census of approximately 70,000 and is Rhode Island's only Level 2 Trauma Center.

Sample Size/Participants:

The study sample was selected using a purposive random sample. The total possible participants was 92 nurses. The target proposed sample size consisted of one third or 33% registered nurses actively working within the emergency department to include full time, part time, per diem and traveler status (n=32). Inclusion criteria

consisted of staff registered nurses (RN's) assigned to the ER, with no exclusions based on age, gender, ethnicity, educational level, or employment tenure. Exclusion criteria was nurses floating to the emergency department for supplemental coverage, or those RNs not directly assigned to the ED, and non-nursing personnel.

Procedure:

Emails were sent to the Chief Nursing Officer and the Director of Emergency Services to garner support for the proposed project. Email responses were received by this author from the Chief Nursing Officer (Appendix B) as well as the Director of Emergency Services granting permission for the project, on a condition that the Institutional Review Board (IRB) at Kent County Hospital also approved it. IRB applications were submitted to both Kent County Hospital and Rhode Island College. Kent County Hospital IRB determined that this project was exempt from IRB approval (Appendix C). Rhode Island College IRB approved this application.

The anticipated timeframe for the project was sometime in February and March of 2018 in the Emergency Department at Kent Hospital in Warwick, Rhode Island. An informational email (Appendix D) and email script (Appendix E) was sent to the Director of Emergency Services, shift managers, as well as all nursing staff to explain the purpose of the project before the educational information was delivered. The staff was informed that participation is voluntary. An incentive for participation was a gift card in the amount of twenty-five dollars. A time allotment of two weeks was allowed to take the pre-test (Appendix A) which was anonymously completed via an online survey platform called *Survey Monkey*. Reminder emails (Appendix E) were sent out to potential participants five and ten days after the pre-test was sent. The educational pamphlet

(Appendix F) was developed with the help of the literature and the clinical experience and expertise of this program developer. The use of educational pamphlet (Appendix F) allowed the material to be viewed via email or in person as it was placed in the break room for staff to review during breaks or meal times. Reminder emails to review the educational pamphlet (Appendix F) and complete the post-test were sent five and ten days after the educational pamphlet (Appendix F) was sent. The pre-& post-test was anonymously completed via an online survey platform called *Survey Monkey* one week after potential participants had time to review the educational pamphlet (Appendix F). The pre-and post-tests (Appendix A) were analyzed for an overall increase in knowledge across the board for all nursing staff that participated. The learning objectives are listed below in Table 1.

Table 1.

Objectives	**Content**
The Nurse will be able to demonstrate knowledge pertaining to signs and symptoms of CKD.	Common Signs & Symptoms of CKD
The Nurse will be able to identify risk factors for CKD.	Risk Factors for CKD
The Nurse will be able to describe how CKD is diagnosed.	Diagnosis of CKD
The Nurse will be able to demonstrate understanding of common signs and symptoms of ACS	Common Signs & Symptoms of ACS
The Nurse will be able to state risk factors for ACS.	Risk factors for Acute Coronary Syndrome
The Nurse will be able to identify both normal & abnormal troponin levels	Normal Troponin Levels
The Nurse will be able to explain the significance of elevated troponin levels in the setting of CKD	How the nurse should respond with elevated troponin levels in the presence of CKD, but with the absence of Acute Coronary Syndrome

Measurement:

A pre-test and a post-test were developed based on the information to be delivered (Appendix A). The project consisted of a design of quantitative data encompassed in the survey. The project compared nurses' responses from the pre-test-to the post-test which occurred after information on the topic has been presented. Comparison was accomplished through standard statistical analysis to include total scores, mean scores, and percentiles taken directly from the number of respondents. The pre-test and post-test (Appendix A) consisted of the same exact identical questions and was piloted with Rhode Island Collage Master's Program students for accuracy, clarity, and ease of understanding prior to use within the educational program There was no identifiable demographic data collected.

Data Analysis

The data collected from the pre-tests and post-tests (Appendix A) were analyzed using descriptive statistics to include total scores, mean, and percentages.

Next, results will be presented and discussed.

Results

Out of the possible total number of 92 RN's working within the Emergency Department at the time of the development and implementation of this informational program, 23 respondents completed the pre-test (Appendix A) (25.0 %). The respondents were categorized by educational level, and years of experience. Ten respondents held associate degrees (43.5 %) and 13 held bachelor's degrees (56.5 %). No RN's with diplomas or advanced degrees responded in the pre-test. Of the respondents, there were three nurses with less than 5 years' experience (13.0%), four nurses with between 6 and 10 years' experience (17.4%), eight nurses with between 11-15 years of experience (34.8%), and eight nurses with over 20 years' experience (34.8%).

Nurse participants in the program completed a pre-test, and post-tests (Appendix A). The question types were multiple choice or select all that apply. The completed pre-tests scores ranged from 40% to 90% with a mean score of 74.7%. Roughly 21.7% of the nurses (n=5) scored ninety percent on the pre-test, 30.4% (n=7) scoring in the eightieth percentile, 30.4% (n=7) scoring in the seventieth percentile, 13.0 (n=3) percent scoring in the sixtieth percentile, and lastly 4.3% (n=1) scoring in the fortieth percentile.

The number of nurses that completed the post-test (Appendix A) was also (n=23). The respondents were categorized by educational level, and years of experience. Those with associate degrees were 4 respondents, (17.2%), bachelor's degree, 18 respondents (78.3 %). One respondent has a master's degree which represented (4.4%). No respondents with diploma certificates responded to the post test. Of the respondents there were eight nurses with less than 5 years' experience (34.8%), five nurses with between 6 and 10 years' experience (21.8%), one nurse with between 11-15 years of experience

(4.4%), and eight nurses with over 20 years' experience (34.8%). All the respondents got question 3 incorrect which asked how CKD is diagnosed and was a multi response question requiring participants to pick more than one answer.

The completed post-test (Appendix A) scores ranged from 50% to 100% with a mean score of 76.5% therefore demonstrating an overall increase in learning. Two of the questions (questions 4 & 5) asked the participants if they could identify normal glomerular filtration rate in a healthy adult and risk factors for CKD. There was no change in the score on these questions. One question of note experienced a significant decline from the pre-test to the post-test (question 11). The question asked participants what the significance of an elevated troponin level meant in the presence of CKD with the absence of presenting notable cardiac symptoms. Participants responded correctly 52% of the time (n=12) on the pre-test and only 17% (n=4) on the post-test regardingM question 11. Question 3, which asked how CKD is diagnosed improved from 0% correct on the pre-test to 65% (n=15) correct on the post-test. Most of the nurses were able to correctly identify the appropriate signs & symptoms of ACS in both the pre-test 91.3% (n=21) and post-test 95.6% (n=22).

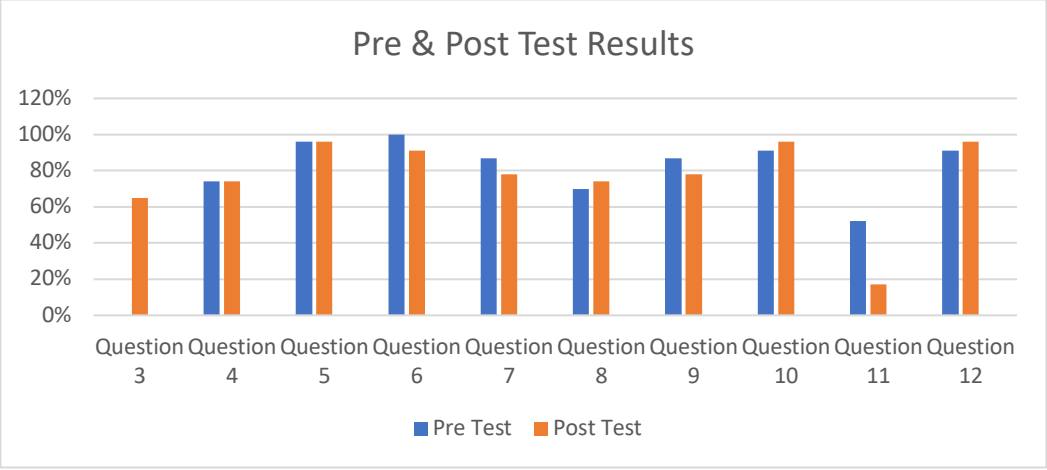


Figure 1. Pre-Test & Post-Test Results by Question, n= 23

Next., the summary and conclusions will be presented and discussed.

Summary and Conclusions

Chronic kidney disease (CKD) affects more than 30 million Americans with many going undiagnosed (Centers for Disease Control and Prevention, 2017). The clinical manifestations of the disease are common and often the signs and symptoms are extremely non-specific and can manifest other disease processes. The complications of CKD are vast, and tremendously intimidating, so it is imperative during the initial assessment that providers identify potential complications. CKD is not only burdensome as a medical disease, it is also very costly with non-dialysis CKD patients amassing a total of 18.2% of total Medicare expenditures which amounts to approximately 45.5 billion dollars annually, breaking down to approximately $22,348 per CKD patient annually.

A review of current relevant literature was conducted, and models were selected to guide this project to include the Logic Model, and The Adult Learning Theory. The purpose of this project was to develop, create and deliver an educational program to improve quality and increase knowledge of emergency department nurses on the significance of elevated troponin levels in the presence of CKD.

The design was the development of an educational program to determine ED nurses' knowledge on the significance of elevated troponin levels in the presence of CKD. A quantitative pre-test and post-test format (Appendix A) was instituted to assess the emergency department nurses' knowledge of elevated troponin levels in the presence of CKD. The twelve question pre- & post-test (Appendix A) was developed by this program developer and was piloted to demonstrate ease of use and understandability. ER nurses were asked to complete a pre-test, read an educational pamphlet (Appendix F) and

then take a post-test. The pre and post-test (Appendix A) were distributed through online survey platform of *Survey Monkey.* An invitation with a link to the survey was emailed nurses via their work email (Appendix E). After the pre-test was completed, an educational packet was emailed, and a hard copy was placed on bulletin boards in the break room within the emergency department for the nurses to review at their convenience.

The identified target population for this educational program was 92 nurses who actively work in the Emergency Department at Kent County Hospital in Warwick, Rhode Island. A total number of (n=23) or 25% completed both the pre-test and post-test with mean scores of 74.7 and 76.5 respectively. One question of note experienced a significant decline when the pre-test was compared to the post-test (question 9). Question 9 asked participants the what significance of an elevated troponin level meant in the presence of CKD, with the absence of presenting notable cardiac symptoms. Participants responded correctly 52% of the time (n=12) on the pre-test compared to just 17% (n=4) on the post-test. The most improved score came on question (question 5) which refers to how CKD is diagnosed. On the pre-test, all of the nurses thought that CKD was diagnosed analyzing serum BUN and Creatinine results, not realizing there are two other diagnostic tools that aid in the diagnosis which are renal ultra sounds, and microalbumin levels.

Limitations to the project included a low response rate. The goal was to have 33% of the possible 92 nurses respond (n=33). The response rate was only 23%. The lack of participation can potentially be tied to an increase in patient acuity, census and missed meal breaks at the time of implementation, and as a result a lack of time to complete the

pre-test, educational packet, and the post-test. Another identified limitation was lack of time to complete the pre-test, educational packet, and post-test which resulted in the initial allotment of two weeks to be extended into three weeks to garner the most participants. The method of announcing the project could be identified as a potential limitation. Nurses receive countless emails daily and the possibility exists that emails about this program were skipped over or deleted in error even though there was enthusiasm and support for the educational program. Many nurses do not check their work email from home. Respondents in the post-test included one APRN and four Associate degree nurses which could have altered the results. Another limitation involved some participants not completing all of the questions on the pre or post-test which resulted in those responses having to be discarded.

The main objective of this educational program to improve knowledge of nurses in the emergency department was met. There was an increase in overall learning by about 1.8% as illustrated in the pre-& post-test mean scores.

Next, Recommendations and Implications for Advanced Nursing Practice will be presented and discussed.

Recommendations and Implications for Advanced Nursing Practice

Advanced Practice Registered Nurses (APRN'S) now more than ever will be called upon to be a more active player in the United States Healthcare System as a change agent and leader when it comes to advocating for patients and providing care. For APRN's working in any setting, it will be essential for them to discern between the patient that presents with an elevated troponin in the presence of CKD versus the patient that presents with an elevated troponin and the constellation of signs and symptoms concerning for ACS with or without the presence of CKD. The APRN will begin to stratify the patient's risk more comprehensively to identify potential incidences of increased risk like that of the troponin level, but the emphasis of future research should be placed on understanding the pathophysiological processes that precede troponin elevation in the CKD patient population Alam, et al. (2013).

Furthermore, the APRN that quantifies patient risk using CKD measures like eGFR and albuminuria will help to improve cardiovascular disease risk prediction far beyond traditional risk factors resulting in better metrics as they have already been measured in most CKD patients Matsushita et al., (2016). Patients with CKD that present without suspected ACS can present with elevated troponin levels represent a more potent predictor of mortality Michos, et al. (2014). The APRN, along with nurses and other members of the healthcare team, should respond appropriately when any patient presents with symptomology concerning for ACS such as chest pain, shortness of breath, nausea, vomiting, pain that radiates to the jaw, arm, back, or the epigastric area.

The APRN should position themselves at the bedside to gather the history of the present illness, background information, and a complete physical examination. The next

steps would involve the implementation of diagnostic testing like an EKG, appropriate lab tests to include Complete Blood Count, Basic Metabolic Profile, Brain Natriuretic Peptide (BNP), Procalcitonin, Pro Thrombin Time (PT), Partial Thromboplastin Time (PTT), INR, Creatine Phosphokinase (CPK), C-Reactive Protein (CPK), Arterial Blood Gas (ABG), as well as developing an appropriate working list of dynamic differential diagnoses that will cast a wide net to ensure nothing will be overlooked. In many cases, the above events will be taking place simultaneously to provide the most effective and appropriate treatment modalities to ensure the best outcome for the patient. At this crucial point in the patient's care, it will be up to the APRN and multidisciplinary team to determine if troponin elevation identifying as true myocyte necrosis, or not the true mechanism of the myocardial injury if any at all Mohammed & Januzzi, (2010).

Michos, et al. (2014) concluded that patients with CKD without suspected ACS, were associated with a worse prognosis when accompanied by elevated troponin levels. More research is needed in regarding the elevated troponin levels in patients with CKD and should focus on which biomarker is the most appropriate prognosticly for this patient population. The possibility exists for the APRN to be immersed in this type of research which would help to increase current knowledge and to upgrade current evidence-based guidelines. The APRN operates as a change agent to function as a leader, active member of the multidisciplinary team, and helping to institute measures that will improve overall outcomes with providing holistic care, discharge planning, follow up appointments, and the integration of technology in today's high-tech world.

References

Alam, A., Palumbo, A., Mucsi, I., Barré, P. E., & Sniderman, A. D. (2013). Elevated troponin I levels but not low grade chronic inflammation is associated with cardiac-specific mortality in stable hemodialysis patients. *BMC Nephrology*, *14*(1). doi: 10.1186/1471-2369-14-247

Balamuthusamy, S., Khosla, S., Meka, S., Saha, S. Srinivasan, L., Ahmed, A., Arora, R (2007). Clinical utility of cardiac troponin I in the diagnosis of acute coronary syndrome in patients with renal failure. *American Journal of Therapeutics, 14*(4), 356-360. doi: 10.1097/01.mjt.0000212700.86872.3c

Bueti, J., Krahn, J., Karpinski, M., Bohm, C., Fine, A., & Rigatto, C. (2006). Troponin I Testing in Dialysis Patients Presenting to the Emergency Room: Does Troponin I Predict the 30-Day Outcome? *Nephron Clinical Practice*, *103*(4), c129-c136. doi:10.1159/000092909

Centers for Disease Control and Prevention. (2017, March). National chronic kidney disease fact sheet, 2017. Retrieved from https://www.cdc.gov/diabetes/pubs/pdf/kidney_factsheet.pdf

Chaudry, S. (2012, October 20). Chronic kidney disease (CKD) | McMaster Pathophysiology Review. Retrieved November 15, 2017, from http://www.pathophys.org/ckd/

Chen, S., Huang, C., Wu, B., Lian, X., Mei, X., & Wan, J. (2013). Cardiac troponin I in non-acute coronary syndrome patients with chronic kidney disease. *PLoS ONE*, *8*(12), e82752. doi: 10.1371/journal.pone.0082752

Colbert, G., Jain, N., De Lemos, J. A., & Hedayati, S. S. (2014). Utility of traditional circulating and imaging-based cardiac biomarkers in patients with pre-dialysis CKD. *Clinical Journal of the American Society of Nephrology*, *10*(3), 515-529. doi:10.2215/cjn.03600414

Coven, D., & Yang, E. (2016, December 11). Acute Coronary Syndrome Clinical Presentation: History, Physical Examination, ACP Screening Guidelines for CHD. Retrieved September 11, 2017, from https://emedicine.medscape.com/article/1910735-clinical

deFilippi, C., Seliger, S. L., Kelley, W., Duh, S., Hise, M., Christenson, R. H., Januzzi, J. (2012). Interpreting cardiac troponin results from high-sensitivity assays in chronic kidney disease without acute coronary syndrome. *Clinical Chemistry*, *58*(9), 1342-1351. doi:10.1373/clinchem.2012.185322

Gibson, C. M., & Morrow, D. A. (2017, January 1). Elevated cardiac troponin concentration in the absence of an acute coronary syndrome. Retrieved from https://www.uptodate.com/contents/elevated-cardiac-troponin-concentration-in-the-absence-of-an-acute-coronary-syndrome

Jaffe, A., & Morrow, D. (2017). Troponin testing: Clinical use. Retrieved from http://www.uptodate.com/contents/troponin-testing-clinical-use

Knowles, M. S., Holton, E. F., & Swanson, R. A. (2011). *The adult learner: The definitive classic in adult education and human resource development* (7th ed.). Burlington, MA: Elsevier.

Lamb, E. J., Kenny, C., Abbas, N. A., John, R. I., Webb, M. C., Price, C. P., & Vickery, S. (2007). Cardiac troponin I concentration is commonly increased in non-dialysis patients with CKD: Experience with a sensitive assay. *American Journal of Kidney Diseases*, *49*(4), 507-516. doi: 10.1053/j.ajkd.2007.01.015

Li, W., Chen, X., Nie, X., Zhang, J., Cheng, Y., Lin, X., & Wu, S. (2015). Cardiac troponin and C-reactive protein for predicting all-cause and cardiovascular mortality in patients with

chronic kidney disease: A meta-analysis. *Clinics*, *70*(4), 301-311 doi:10.6061/clinics/2015(04)14

Mayo Clinic. (2018, March 8). Chronic kidney disease - Symptoms and causes. Retrieved April 10, 2018, from https://www.mayoclinic.org/diseases-conditions/chronic-kidney-disease/symptoms-causes/syc-20354521

Matsushita, K., Ballew, S. H., & Coresh, J. (2016). Cardiovascular risk prediction in people with chronic kidney disease. *Current Opinion in Nephrology and Hypertension*, *25*(6), 518-523. doi:10.1097/mnh.0000000000000265

Michos, E. D., Wilson, L. M., Yeh, H., Berger, Z., Suarez-Cuervo, C., Stacy, S. R., & Bass, E. B. (2014). Prognostic value of cardiac troponin in patients with chronic kidney disease without suspected acute coronary syndrome. *Annals of Internal Medicine*, *161*(7), 491. doi:10.7326/m14-0743

Miller, C., & Granger, C. B. (2016, May 11). Evaluation of patients with chest pain at low or intermediate risk for acute coronary syndrome. Retrieved from https://www.uptodate.com/contents/evaluation-of-patients-with-chest-pain-at-low-or-intermediate-risk-for-acute-coronary syndrome?source=machineLearning&search=acute%20coronary%20syndrome&selectedTitle=6~150§ionRank=1&anchor=H2#H2

Mohammed, A. A., & Januzzi, J. L. (2010). Clinical applications of highly sensitive troponin assays. *Cardiology in Review*, *18*(1), 12-19. doi:10.1097/crd.0b013e3181c42f96

Ozieh, M. N., Bishu, K. G., Dismuke, C. E., & Egede, L. E. (2017). Trends in healthcare expenditure in United States adults with chronic kidney disease: 2002–2011. *BMC Health Services Research*, *17*(1). doi:10.1186/s12913-017-2303-3

Rosenberg, MD, M. (2016). Overview of the management of chronic kidney disease in adults. Retrieved from https://www.uptodate.com/contents/overview-of-the-management-of-chronic-kidney-disease-in-adults?source=search_result&search=CKD&selectedTitle=1~150

Sarnack, M., Gibson, M., & Henrich, W. (2015, December 9). Chronic kidney disease and coronary heart disease. Retrieved from https://www.uptodate.com/contents/chronic kidney disease-and-coronary-heart-disease

Sud, M., & Naimark, D. M. (2015). Cardiovascular disease in chronic kidney disease in 2015. *Current Opinion in Nephrology and Hypertension*, *25*(3), 203-207. doi:10.1097/mnh.0000000000000213

Sukonthasarn, A., & Ponglopisit, S. (2007). Diagnostic level of cardiac troponin T in patients with chronic renal dysfunction: A pilot study. *J Med Asoka Thai 2007*, *90*(9), 1749-58.

Van der Linden, N., Klinkenberg, L. J., Bekers, O., Loon, L. J., Dieijen-Visser, M. P., Zeegers, M. P., & Meex, S. J. (2016). Prognostic value of basal high-sensitive cardiac troponin levels on mortality in the general population. *Medicine*, *95*(52), e5703. doi:10.1097/md.0000000000005703

Wang, J., Tan, G. J., Han, L., Bai, Y., He, M., & Liu, H. (2017). Novel biomarkers for cardiovascular risk prediction. *Journal of Geriatric Cardiology*, *14*, 135-150. doi: 10.11909/j.issn.1671-5411-2017.02.008

W.K. Kellogg Foundation. (2004, January 1). W.K. Kellogg Foundation logic model development guide. Retrieved from https://www.wkkf.org/resourcedirectory/resource/2006/02/wk-kellogg-foundation-logic-model-development-guide

Appendix A

Troponin Elevation in Chronic Kidney Disease Patients'

Pre-and Post-Test

1. What is your current level of education?
   A. Associates Degree
   B. Diploma
   C. Bachelor's Degree
   D. Master's Degree
2. How many years have you been a Nurse?
   A. 0-5 Years
   B. 6-10 Years
   C. 11-15 Years
   D. 16-20 Years
   E. Over 20 Years
3. How is Chronic Kidney Disease (CKD) diagnosed? Please Select All That Apply
   A. Serum BUN and Creatinine Levels
   B. Microalbumin level
   C. Complete Blood Count
   D. Fasting Blood Glucose
   E. Renal Ultrasound
4. What is the normal glomerular filtration rate of a healthy adult?
   A. > 60 ML/Min
   B. < 60 ML/Min
   C. < 40 ML/ Min
   D. > 50 ML/Min

5. Which of the following are risk factors for Chronic Kidney Disease (CKD)?
   A. Hypertension
   B. Diabetes
   C. Cardiovascular Disease
   D. Familial History of CKD
   E. All the above

6. Which of the following are considered signs and symptoms of Acute Coronary Syndrome? Please select all that apply.
   A. Chest Pain
   B. Dizziness or Lightheadedness
   C. Nausea
   D. Diaphoresis
   E. Dyspnea

7. Which of the following are NOT considered risk factors for ACS?
   A. Smoking
   B. Elevated Cholesterol
   C. Hypertension
   D. Abnormal Blood Glucose Level

8. Which of the following values is considered a normal troponin level?
   A. < 0.010
   B. < 0.03
   C. > 0.414
   D. > 0.003

9. Which of the following is a sign of Chronic Kidney Disease?
   A. Foaming, tea colored, bloody cloudy urine
   B. Lower Back Pain
   C. Low Grade Temperature
   D. Yellow colored straw like urine

10. Which of the following are considered risk factors of Acute Coronary Syndrome? Select all that apply

A. Hypertension

B. Elevated cholesterol

C. Obesity

D. Smoker

E. Diabetes

11. What does an elevated troponin in the presence of chronic kidney disease with no other cardiac symptoms such as chest pain, shortness of breath, nausea, vomiting, diaphoresis, epigastric pain, back pain, or jaw pain most likely indicate?

A. Acute Myocardial infarction

B. Pancreatitis

C. Increase the risk of cardiac mortality

D. Acute Coronary Syndrome

12. What would an elevated troponin in the setting of Acute Coronary Syndrome with symptoms to include chest pain, shortness of breath, nausea, vomiting, pain with radiation to the jaw, neck, back or epigastric area most likely indicate?

A. a CKD flare up

B. Require the need for immediate action to include monitoring and further diagnostic workup

C. Discharge home with PCP follow up

D. Hypertensive emergency

Appendix B

CNO Support Letter

September 20, 2017

Dear Mr. Sasso,

Thank you for your interest in enhancing the body of knowledge in emergency nursing and providing our staff with a voluntary opportunity to participate in nursing research.

I am happy to endorse and support your efforts in this project and will be looking forward to participating in your research and seeing the outcomes of your education regarding patients with elevated troponin levels with chronic kidney disease without the presence of acute coronary syndrome. Your efforts in this area are to be commended and are wholeheartedly supported.

With best regards,

Darcy Abbott, MS, RN, CEN

Director of Emergency Services

Associate Chief Nursing officer

Appendix C

Kent IRB Letter

TO:	David Sasso, Jr, BSN, RN
FROM.	Kent Hospital Institutional Review Board
PROJECT TITLE:	Troponin Elevation in Chronic Kidney Disease: An Educational Project
SUBMISSION TYPE:	Review
ACTION:	Determination of IRBNetID 1142738
DECISION DATE.	October 18, 2017

Dear Mr. Sasso,

Thank you for your submission of the above-named project to the Kent Institutional Review Board.

Dr. Jonathan Gates, Kent IRB Chair, has determined this project is not subject to Institutional Review Board regulations, as this is a Performance Improvement Project.

Please retain a copy of this correspondence within your records.

If you have any questions, please contact Donna Coppola, Kent Hospital IRB Coordinator at 401-7377010, extension 31879 or dmcoppola@carene.org. Please include your project title in all correspondence with this committee.

Sincerely,

Jonathan Gates, MD Kent IRB Chair

Appendix D

Nurse Recruitment Letter

February 10, 2018

Dear Fellow Nurse,

Hello, my name is David J Sasso Jr. I am currently enrolled in the Master of Science program in Nursing at Rhode Island College. You are being asked to voluntarily participate in an educational program about nurses' knowledge of chronically elevated troponin levels in the setting of chronic kidney disease, and the absence of acute coronary syndrome. This project is being conducted in conjunction with Dr. Debra Servello who serves as the primary investigator. You have been identified as a possible participant because you are employed within the Emergency Department at Kent Hospital.

The format for the education program will be a pre-test which should take no more than 10-15 minutes of your time to complete. The questions on the pre-test will assess your knowledge about elevated troponin levels in patients with chronic kidney disease without acute coronary syndrome. The link embedded at the end of this letter will to take you to the online survey platform.

An educational poster will be placed in the break room and educational pamphlet will be emailed to your work email with the hope that you will be able to take time out of your busy day to review the content.

A link to the post test will be emailed to your work email two weeks after the informational pamphlet was sent. Results from the pre-test and post-test will be anonymous. Data will be reviewed to assess aggregate knowledge increase. No individual data will be shared.

Participation in this program is voluntary. If you do participate you will be entered in a drawing for a gift card in the amount of $25.00. Should you have any questions about this project, you may feel free to contact me directly via the means provided below, Dr. Debra Servello directly at dservello@ric.edu, 401-456-9611 or the Rhode Island College IRB at IRB@ric.edu. Thank you for your time.

Please click this link to be taken directly to the pre-test (Link Inserted Here).

Sincerely,

David J Sasso Jr, BSN, RN
401-255-8003
dsasso_2082@ric.edu
Rhode Island College
Kent Hospital Emergency Department Per Diem RN

Appendix E

Email Script

Hello, my name is David J Sasso Jr. I am a graduate student at Rhode Island College. Part of my curriculum requires that I complete a project. I have chosen to complete an informational program as my project. I created this informational program in conjunction with the principle investigator Dr. Debra Servello which is geared towards emergency department nurses. The project is called Troponin Elevation in Chronic Kidney Disease.

The program will involve you taking a pre-test, reviewing of an informational pamphlet, and conclude with a post-test. The pre-test will assess your knowledge about elevated troponins in patients with Chronic Kidney Disease. The pre-test should take you no longer than 10-15 minutes to complete. Attached to this email is an informational letter which will provide more information about the project. Please click the attachment to review the informational letter. Should you decide to participate, clicking the link embedded in the informational letter will take you to the pre-test.

A link to the post test will be emailed to your work email two weeks after the informational pamphlet was sent. Results from the pre-test and post-test will be anonymous. Data will be reviewed to assess aggregate knowledge increase. No individual data will be shared.

If you choose to participate, you will be entered in a drawing to receive a $ 25.00 gift card. Your participation is voluntary. Results will be anonymous.

Thank you for taking the time to read this email, informational letter, and for your potential participation.

Sincerely,

David J Sasso Jr BSN, RN
dsasso_2082@email.ric.edu
Rhode Island College

Appendix F

Elevated Troponin in Chronic Kidney Disease Program Information

- Chronic kidney disease (CKD) affects more than 30 million Americans with many going undiagnosed (Centers for Disease Control and Prevention, 2017).
- CKD is defined as having a decreased Glomerular Filtration Rate of less than 60ml/min or the presence of elevated biomarkers that may indicate kidney damage for three months or greater (Ozieh, et al. 2017).
- CKD Pathophysiology is best described as initial hyperfiltration that activates the RAAS (Renin Angiotensin Aldosterone System) which causes the protein-uria. Angiotensin II and protein uptake at the tubules causing inflammation and fibrosis of the glomerulus and the tubules. This leads to a progressive decline in GFR and more systemic complications occur (Chaudry, 2012)
- CKD risk factors include Diabetes, High Blood Pressure, Heart Disease, Familial History of CKD, and Obesity (CDC, 2017).
- CKD signs and symptoms are generally nonspecific, and most people don't feel ill at all (CDC, 2017).
- Diagnosing CKD is accomplished by checking BUN, Creatinine, and microalbumin level in urine. A renal ultrasound may also be ordered. (CDC, 2017).
- Kidney damage is detected as excretion of urinary albumin of greater than 30 mg/day or its equivalent (Rosenberg, 2016).
- A decreased eGFR and increased proteinuria increase the risk of developing cardiovascular disease (Sarnack, Gibson & Henrick, 2015).

- Patients diagnosed with CKD present with traditional and nontraditional risk factors that contribute to the development of cardiovascular disease such as hypertension, smoking, diabetes, and elevated cholesterol levels (Sarnack, Gibson & Henrick, 2015).
- Heart disease is the number one cause of death in the CKD patient population summating up to 50% of deaths Colbert et al., (2015).
- Miller & Granger (2016) state that the chief complaint of chest pain is responsible for approximately 6 million annual visits to emergency departments in the United States. Acute Coronary Syndrome (ACS) is responsible for 12 to 15% of those cases.
- Risk factors for ACS include advancing age, elevated blood pressure, elevated cholesterol, cigarette smoking, lack of physical activity, unhealthy diet, diabetes, obesity, and known familial history of chest pain, heart disease or stroke. (Mayo Clinic, 2017)
- ACS is a functional term applied to patients where there is an indication of myocardial ischemia or myocardial infarction. (Miller & Granger, 2016)
- ACS refers to a spectrum of clinical presentations ranging from ST-Segment elevation myocardial infarction (STEMI) to presentations commonly found in non-ST Segment elevation infarction (NSETMI) or unstable angina (Coven & Yang, 2016)
- There are three different types of ACS: unstable angina, non-ST elevation MI, and ST segment elevation MI. ST segment elevation and non-ST elevation MI,

diagnosable if elevated troponin levels are present, which will typically rise and fall before, during, and after an event. (Miller & Granger, 2016)

- Patients experiencing ACS may describe their symptoms as palpitations, pain in the chest described as pressure, squeezing, or a burning sensation primarily in the precordium with potential radiation to the neck, shoulder, back, upper abdomen, or either arm. Exertional dyspnea that resolved with pain or rest. Nausea, Vomiting, or profuse diaphoresis may also be complaints. (Coven & Yang, 2016)
- Unstable angina is classified as myocardial ischemia with no elevation in biomarkers like troponin. (Miller & Granger, 2016)
- The immediate focus should be on treatment, because early intervention leads to the best outcomes. (Miller & Granger, 2016)
- Upon presentation to the emergency department, an initial 12 lead EKG should be obtained within ten minutes, and continuous telemetry monitoring initiated. (Miller & Granger, 2016)
- Next, a history and physical exam to correlate with current signs and symptoms exhibited. Laboratory tests should be ordered, to include troponin, electrolytes, bun, creatinine, and complete blood count. (Miller & Granger, 2016)
- A chest x-ray is standard in this patient population, as it can be an asset with differential diagnosis. A risk stratification assessment of the patient presenting with these signs and symptoms is conducted. (Miller & Granger, 2016)
- Troponin is the preferred biomarker to diagnose acute myocardial infarction which may or may not be present with presentation of ACS. (Januzzi & Mohammed, 2010)

- Troponin is a macromolecular complex that consists of three polypeptides closely intertwined and are actively related to the contraction of heart muscle. (Januzzi & Mohammed, 2010)
- A normal troponin level is < 0.03 as referenced Januzzi & Mohommad, 2010
- Michos (2014) Elevated troponin levels reveal an association of a worse prognosis in patients with CKD not experiencing ACS. For patients with CKD with no indication of ACS, elevated troponin levels remain potent predictors of mortality, and currently support the current U.S. Food and Drug Administration position that measuring serum troponin levels is an appropriate risk stratification tool in this patient population.