Abdominal aortic aneurysm and acute kidney injury

Christina McDonald

University of New Hampshire
Abdominal aortic aneurysm and acute kidney injury

The human body relies on each organ system to work together to maintain day to day functions. The cardiovascular system and renal system are two closely intertwined systems of the body. Blood that is pumped by the heart to perfuse all of the organs of the body provides the kidneys with the oxygen and pressure that is necessary for proper function. In the healthcare setting, patients often present with a debility in various systems and functions as the decline in one organ or organ system can lead to a cascade of complications. A case study is utilized to describe this cascade of complications rooting from the surgical intervention of an abdominal aortic aneurysm (AAA).

Pathophysiology

An aneurysm is a dilation or sac of an artery wall that forms due to a weakened section of the artery (Hinkle & Cheever, 2013). Aneurysms are classified by their shape; fusiform and saccular are the most common types. Fusiform aneurysms involve the complete circumference of an artery while a saccular aneurysm forms when the weakness of the artery wall is localized to one side of the artery. Aneurysms are most commonly caused by arterial atherosclerosis, however aneurysms can be caused by factors related to trauma, weakness, or disease as well as congenital disorders. Hypertension, tobacco use, and genetic components are all risk factors for the development of an aneurysm. Aneurysms can occur throughout the vasculature in the aorta as well as in peripheral vessels. The aorta passes through the thoracic and abdominal cavities which separates the aorta into the thoracic aorta and the abdominal aorta. When this weakening of the wall of the abdominal aorta occurs and an aneurysm forms, about forty percent of patients with this condition are asymptomatic. Clinical manifestations include the feeling of one’s heart beating in their abdomen or a throbbing mass. Thrombus formation can occur in an aneurysm
due to the blood stasis in the stretched artery. Emboli from the thrombus can break off and occlude other major vessels that supply organs and other portions of the body. These emboli can be cholesterol, platelets, or fibrin (Hinkle & Cheever).

A pulsating mass in the abdomen is the greatest indication of an abdominal aortic aneurysm (Hinkle & Cheever, 2013). Eighty percent of these can be manually palpated and produce a systolic bruit upon auscultation. Computed tomography angiography or ultrasonography are utilized to show the characteristics of the aneurysm including location and size. If the aneurysm is found to be smaller than six centimeters, or the size where the surgery to prevent a rupture outweighs the risk of complications during surgery, then ultrasounds are done every six months until this size is reached (Hinkle & Cheever).

Aneurysms can be managed through pharmacological or surgical means (Hinkle & Cheever, 2013). Increased blood pressure has been related to the rupture of an aneurysm, therefore the blood pressure of these patients is closely monitored. Antihypertensive agents such as diuretics, beta blockers, angiotensin-converting enzyme inhibitors, angiotensin II receptor blockers, and calcium channel blockers can be prescribed as management for hypertension. If the aneurysm grows to the size of five and a half centimeters in diameter, surgery is the predominant treatment. Resection of the artery along with sewing a bypass graft in place of the resection through open surgery is the leading surgical method of repair. Another option is through endovascular grafting with the placement of a transluminal, sutureless aortic graft prosthesis to bypass the aneurysm. This is performed under local or regional anesthesia as long as the abdominal aorta and iliac arteries are not small, calcified, or filled with thrombi. Bleeding, hematoma formation, wound infection, perforation of the aorta, graft thrombosis or infection, ischemia or embolization of distal arteries and organs, graft leak or migration, and rupture are
complication that can arise from either approach to repair the aneurysm. Monitoring of cardiovascular, pulmonary, renal, and neurological function is necessary postoperatively to ensure that no further damage occurs (Hinkle & Cheever, 2013).

The renal arteries which supply blood to the kidneys are connected to the abdominal aorta which further down separate into the iliac arteries which supply blood containing oxygen to the lower extremities (Hinkle & Cheever, 2013). When an aneurysm forms, all organs distal to the out pocketing can be affected. Most abdominal aortic aneurysms develop below the renal arteries, therefore the kidneys are unaffected by the condition (Hinkle & Cheever). In this case the circulation, sensation, and range of motion of the lower extremities should be assessed as cyanosis, mottling, and loss of function can occur (Sommer, 2013). If the aneurysm is located proximal to the renal arteries, then the addition of kidney function should be added to assessments.

The renal artery enters the kidney through the hilum, or the concave portion of the kidney and then divides into smaller vessels (Hinkle & Cheever, 2013). The vessels form the afferent arterioles which branch to form a cluster of capillaries known as the glomerulus, a part of the nephron, which filters the blood in the body and begins urine formation. One million nephrons are positioned within each kidney, and if less than twenty percent of these nephrons are no longer functional, replacement therapy is initiated. The glomerulus is suspended between the afferent and efferent blood vessels and enclosed in the Bowman’s capsule, an epithelial structure. The glomerular membrane is composed of three layers that aid in filtering. Certain molecules and fluids are filtered through the glomerular membrane to form urine while other molecules remain in the blood. Changes in permeability and blood pressure alter the passage of molecules and fluid that fill Bowman’s capsule (Hinkle & Cheever, 2013).
The rapid deterioration in renal function as a result of damage to the kidneys is referred to as acute kidney injury (AKI) (Hinkle & Cheever, 2013). Reduced blood flow to the kidneys can decrease kidney function and eventually result in kidney damage. This can be a result of hypovolemia, hypotension, decreased cardiac output, obstruction of the kidney or lower urinary tract, or obstruction of the renal arteries or veins. Signs of decreased kidney function include increased serum blood urea nitrogen (BUN) and creatinine levels and oliguria, less than a half a milliliter per kilogram per hour of urine. AKI can occur consequently to a prerenal, intrarenal, or post renal complication. This condition can be treated and issues that arose have the potential to be reversed (Hinkle & Cheever).

**Case Study**

“You are working on a telemetry unit and have just received a transfer from the ICU. The 50-year-old male patient, T.A., is postoperative day 2 after a repair of an abdominal aortic aneurysm (AAA) measuring 8 cm in diameter. He is an attorney with an active practice. Before surgery, he routinely took medication for gastritis and has a 10-year history of type 2 diabetes mellitus requiring insulin for the past 6 months to control glucose levels. Despite this, T.A. considered himself healthy before diagnosis of the aneurysm. The ICU nurse tells you during the report that since surgery, T.A. has experienced some weakness of his lower extremities and decreasing urinary output” (Harding & Snyder, 2015, p. 481).

T.A. believes that he was fine prior to surgery and that he would have still been fine if he had not been operated on (Harding & Snyder, 2015). Many people with an aneurysm are asymptomatic, however this does not imply that there is no issue (Hinkle & Cheever, 2013). An enlarging abdominal aortic aneurysm can lead to an aortic dissection where a tear in the wall of the artery can lead to blood accumulation. Patients have reported back pain upon dissection or
sudden, tearing abdominal pain. This blood accumulation has the potential of progressing to hypovolemic shock. Signs and symptoms of hypovolemic shock include hypotension, tachycardia, nausea, vomiting, faintness, neurological deficits, and apprehension. Peripheral pulses could be decreased or absent due to blood not traveling to the lower extremities. The kidneys can be affected if the dissection occurs proximal to the renal arteries leading to oliguria. Another complication that could arise is rupture of the weakened arterial wall. This can be life threatening as rupture can lead to hemorrhage, shock, and death. Surgical intervention is determined based on the size of the aneurysm and cardiovascular implications. Since T.A.’s aneurysm was greater than six centimeters, the determined size where intervention is necessary, surgical repair posed a lesser risk of death than the potential of rupture (Hinkle & Cheever).

The weakness in T.A.’s legs is an area of concern due to the location of his aneurysm and the implication of this. The abdominal aorta supplies blood to the iliac arteries which oxygenate the lower extremities (Hinkle & Cheever, 2013). If a thrombus had formed within the AAA, an embolus could have dislodged prior to or during repair leading to a blockage of the distal arteries. During surgery, blood loss or incomplete repair could have also led to weakness of the legs (Hinkle & Cheever). When performing an initial assessment of T.A.’s legs, it is necessary to assess temperature, circulation, or color and peripheral pulses, range of motion, and sensation (Sommer, 2013). Deficits or abnormalities found through these assessments can indicate a potential issue and the need for further intervention to prevent long term complications.

Following surgical repair of the AAA, T.A. is at risk of the development of a deep vein thrombosis (DVT). Endothelial damage, venous stasis, and altered coagulation are three factors that have been found to cause the formation of a DVT (Hinkle & Cheever, 2013). Prophylactic measures are implemented in hospitalized patients to decrease the DVT rate. The administration
of unfractionated or low-molecular weight heparin, as ordered, is a pharmacological intervention that aids in minimizing risk (Hinkle & Cheever). When administering these medications, it is necessary to abide by the rights of medication administration. This includes ensuring that it is the right patient, dose, drug, route, reason, and time. Other nursing interventions include the application of compression stockings and/or intermittent pneumatic compression devices, early mobilization, and leg exercises. Close monitoring for signs and symptoms of a DVT allows for immediate intervention (Hinkle & Cheever, 2013). Utilizing shared decision making by collaborating with the patient to determine the intervention that is employed can promote patient centered care.

Four days after admission of T.A. to the floor, it is noted that he has a total output of seventy-five milliliters of dark amber urine (Harding & Snyder, 2015). Normal hourly urine output is thirty milliliters. T.A. only has eighteen and three quarters milliliters per hour. This could be a result of an embolus from the AAA blocking the renal arteries or decreased volume or pressure of the blood to the kidneys (Hinkle & Cheever, 2013). Urine is normally clear and light yellow in appearance. Concentrated urine appears as a dark amber color. Urine can be concentrated as a result of fever, bile, excess bilirubin, dehydration, or medications (Hinkle & Cheever). Further diagnostic tests of kidney function should be performed to identify the cause of his altered urine output. In maintaining T.A.’s autonomy, he should be informed of these assessment findings and given the options of how to proceed. Diagnostic testing cannot be completed without T.A.’s informed consent.

The urinary catheter and tubing should be examined for obstructions, and then further assessments should be gathered. Variation in serum electrolytes including an elevated potassium calcium, and phosphorus levels and changes in sodium levels. Increases in BUN and creatinine
ABDOMINAL AORTIC ANEURYSM

indicate decreased kidney function, as well (Sommer, 2013). A urinalysis will show an increase in urine specific gravity and the presence of sedimentation such as protein or red blood cells if the glomerulus is not filtering blood properly (Hinkle and Cheever, 2013). Analysis will reveal metabolic acidosis in the event of kidney dysfunction due to the kidneys not producing bicarbonate. An x-ray of the pelvis of the kidney or a KUB can detect calculi or hydronephrosis. Obstruction of the urinary tract can be identified using an ultrasound. If there are anatomical alterations, obstructions, or issues with renal perfusion, a CT or MRI will detect this. Contrast dye should not be used for the CT because dye is cleared by the kidneys (Sommer, 2013). If the kidneys already have a decrease in filtration and function, the dye can lead to further damage, or the dye could accumulate in the body.

A STAT electrolyte panel is ordered on T.A. and the results come back from the lab for interpretation (Harding & Snyder, 2015). His potassium is 5.8 mEq/L which is high as normal serum potassium is 3.5 to 5.0 mEq/L. This could be due to decreased kidney function where the kidney is filtering and excreting less potassium (Hinkle & Cheever, 2013). T.A.’s sodium level is 132 mEq/L while normal serum sodium is 135 to 145 mEq/L. This serum sodium could be low due to the kidney’s inability to regulate sodium excretion. Sodium excretion is dependent upon a hormone known as aldosterone which is released by the adrenal cortex in response to a decrease of pressure in the renal arterioles. Aldosterone functions to retain sodium and water in order to maintain enough pressure adequate for the glomerulus to filter the blood. The glucose lab result is 224 mEq/L which is high as the normal blood glucose level is 80 to 120 mEq/L. As T.A. has a history of type 2 diabetes mellitus, this could portray poor glycemic control or may require attention to his insulin dosages and diet to adjust based on his needs. Each patient is an individual and care needs to be altered and adjusted accordingly. No two patients will have the
exact same combination of illnesses and manifestations, therefore providing care with beneficence needs to be individualized. Stress can also increase glucose levels due to an increase in stress hormones. T.A.’s blood urea nitrogen (BUN) is found to be 66 mg/dL while normal is 7-18 mg/dL. BUN measures the nitrogen in the blood which is a byproduct of protein breakdown. BUN can be increased due to dehydration or exercise. The kidneys excrete BUN, therefore a build up of BUN in the body can reflect decreased renal perfusion, however an elevation can also be independent of kidney function. T.A.’s creatinine was found to be 3.4 mg/dL which is an increase from the normal serum level of 0.6 to 1.2 mg/dL. Creatinine is the end product of muscle energy metabolism and is also excreted by the kidneys. Creatinine is a better indicator of renal function. Since both his BUN and creatinine are elevated, renal impairment is evident (Hinkle & Cheever). The physician determined that T.A. is in the beginning phases of Acute Kidney Injury, and he is sent for placement of a dialysis catheter (Harding & Snyder, 2015).

The physician updated the medical orders with Lantus, Novolog, imipenem- cilastatin sodium, dopamine, furosemide, sevelamer hydrochloride, and sodium polystyrene sulfonate (Harding & Snyder, 2015). Lantus is a long-acting insulin that is given to maintain a steady blood sugar throughout the course of the day which is used in adjunct with NovoLog, a rapid-acting insulin, given before meals to prevent a rise in blood glucose with the ingestion of food (Hinkle & Cheever, 2013). Imipenem-cilastatin sodium is an antibiotic used prophylactically for infection because T.A. just had surgery to repair his AAA. Dopamine is utilized to maintain T.A.’s blood pressure to improve renal blood flow to maintain urine output. To increase filtration of the blood by the kidneys and excrete potassium, furosemide is administered. Sevelamer hydrochloride binds to dietary phosphorus to further decrease potassium levels
through. Due to T.A.’s increased serum potassium levels, sodium polystyrene sulfonate can be administered to replace sodium with potassium in the intestinal tract to promote the excretion of potassium in the stool (Hinkle & Cheever).

T.A.’s dialysis catheter was placed in his left subclavian vein which is a double-lumen, noncuffed catheter (Hinkle & Cheever, 2013). No medications can be administered through a dialysis catheter so he has another peripheral intravenous line where dopamine is infusing through. If a nurse is preparing to administer the IV antibiotic, it would be necessary to obtain another site of IV access. A double lumen peripherally inserted central catheter (PICC) can be considered for placement if this is a long term issue.

T.A. is placed on a fluid restriction and a renal diet (Harding & Snyder, 2015). The goal is to avoid the progression of edema and hypertension (Hinkle & Cheever, 2013). Fluid restriction is person dependent. Weight, urine output, and response to therapy are factors that contribute to the prescribed volume for which a person can take in. While T.A. is on a fluid restriction, interventions such as oral hygiene, the avoidance of foods that cause thirst, and controlling blood glucose levels can promote patient comfort. The renal diet is one that has potassium, phosphate, sodium, and magnesium restrictions due the kidneys impaired ability to excrete these electrolytes in the urine. This diet should be high in protein in the beginning stages of AKI due to the increased breakdown protein and high in carbohydrates to provide energy and minimize protein breakdown. Iron, calcium, and folic acid supplements should be encouraged. A dietary consult may be necessary as dieticians specialize in calculating protein, calorie, and fluid needs (Hinkle & Cheever).

Throughout the shift, various aspects of T.A.’s care can be delegated to the unlicensed assistive personnel (UAP). Measuring the vital signs every two hours, assisting him with oral
hygiene as needed, and obtaining and recording accurate daily weights are all actions within the UAP scope of practice. A UAP can obtain T.A.’s glucose level prior to dinner, however it is not within their scope of practice to assess the glucose level and decide on an intervention. It is outside of the UAP’s scope of practice to monitor T.A.’s lung sounds every four hours as well as evaluating his intake and output for the past forty-eight hours. These are assessments that the nurse must complete and cannot delegate to the UAP.

Managing blood glucose levels within the hospital setting can be difficult. T.A.’s blood glucose levels have ranged from sixty-two to three hundred eighty-seven over the past three days, and he is curious as to how he is receiving two times the insulin that he would give himself at home but it isn’t managing his blood glucose levels (Harding & Snyder, 2015). The stress that surgery and hospitalization can place on the body raise blood glucose levels (Hinkle & Cheever, 2013). This leads to a need for higher levels of insulin. This is due to an increased production of stress hormones including epinephrine, norepinephrine, glucagon, cortisol, and growth hormone. If this hyperglycemia is not controlled, it would increase the risk for infection as glucose in the wound breeds bacteria which decreases the rate of wound healing (Hinkle & Cheever). It is essential to control T.A.’s blood glucose levels in order to ensure that his incision from his AAA repair heals adequately without infection.

Following T.A.’s return from dialysis treatment, he complains of a headache and severe nausea. He is restless and slightly confused with an elevated blood pressure (Harding & Snyder, 2015). These findings could be due to dialysis disequilibrium where there was too rapid of a decrease in BUN and fluid volume (Sommer, 2013). Manifestations are the result of cerebral fluid shifts. Other manifestations include agitation, vomiting, restlessness, and seizures (Sommer, 2013). If a patient presents in this manner, it is necessary to page the physician and
implement seizure precautions. Oxygen and suction should be readily available, two to three side rails should be up with padding, the patient’s bed should be in the low position, and the patient should be dressed in loose clothing. Anticonvulsants and barbiturates should be administered once they are prescribed as seizure prophylaxis. A nurse should also prepare for the administration of hypertonic solution, albumin, or mannitol to pull fluid from within the brain (Hinkle & Cheever, 2013).

While waiting for the physician to arrive, T.A. begins to vomit severely. He complains that something “not feeling right” in his abdomen (Harding & Snyder, 2015). The immediate concern would be T.A.’s incision site. Vomiting increases intra abdominal pressure and can lead to dehiscence of an abdominal incision (Hinkle & Cheever, 2013). Due to the numerous organs in the abdomen, this dehiscence can progress quickly to an evisceration. Vomiting is an associated sign of an evisceration. Upon removing T.A.’s abdominal dressing, a few loops of intestine are visible. While another staff member pages the physician, a nurse must stay with the patient. The evisceration should be covered with a dressing soaked in sterile saline without attempt of reinserting the organs. The patient should be placed in the low fowlers position with hips and knees bent, and monitored for shock (Hinkle & Cheever, 2013). Emotional support should be provided as the patient may be overwhelmed and nervous when they see their inner organs outside of their abdomen.

“After the repair of the evisceration, T.A. returns to the ICU. During the remainder of his hospitalization, he experiences delayed wound healing and difficulties maintaining fluid and electrolyte balance between his dialysis treatments. His kidneys eventually regain function, and he spends two more weeks on the rehabilitation unit before being discharged with home health assistance for wound care” (Harding & Snyder, 2015, p. 485).
Nursing Interventions

Patients who have recently undergone surgery, just as T.A. did for his AAA repair, are at risk of the development of DVTs (Ryan & Johnson, 2009). The need for thromboprophylaxis in postoperative care is vital in obtaining positive patient outcomes. The American Operating Room Nurses and National Institute of Clinical Excellence guidelines strive to improve patient outcomes with decreasing the risk of DVT formation associated with surgery. Pharmacological or mechanical prevention options can be used individually or in combination. Anticoagulation medications can be administered as ordered with positive effect, however anticoagulants increase the risk of bleeding. Mechanical prophylaxis does not have to associated risk for bleeding and include leg exercises, compression stockings, intermittent pneumatic devices, and early mobilization. Each of these decreases venous stasis which is a factor correlated to DVT formation (Ryan & Johnson).

Additionally, there are implications for the care of incisions following surgery. Surgical wounds normally progress through a series of processes that lead to tissue healing (Mizell, 2017). If these physiologic processes fail to progress and complete properly, then the surgical wound can present with complications including wound dehiscence. As abdominal wall tension puts increasing pressure on the tissue and sutures, the approximated wound can open. A wound that has dehisced is at risk for evisceration where organs are visible outside of the abdominal cavity. Wound dehiscence in the beginning stages of postoperative care is a surgical emergency. Following a wound dehiscence or evisceration, a moist dressing should be placed on top of the wound at the bedside. In the case of a dehiscence, a binder is placed around the patient’s abdomen as a preventative measure for evisceration. An abdominal binder should not be applied if the wound has already eviscerated to prevent bowel injury that could incur from the binder.
itself. The patient will require wound debridement and the potential for internal and external sutures to reapproximate the wound edges. Following surgical repair, nurses need to be aware of preventative measures for the wound opening again. This includes avoiding heavy lifting of greater than thirteen pounds from floor level which increases intra abdominal pressure (Mizell).

Throughout the case study, T.A. progressed to the development of AKI which requires another set of nursing interventions for care. Patients with AKI or chronic kidney disease (CKD) who require hemodialysis also manage fluid and electrolyte imbalances through fluid and diet restrictions (Filipe, 2015). Cardiovascular mortality can occur if these fluid restrictions are not followed. Self-care measures can be employed by the patient or promoted by the healthcare professional to manage the discomforts of the fluid restriction. Through a descriptive-correlational study, the common methods used to reduce fluid intake were analyzed. Patients avoided foods that cause thirst including spicy foods and candy. There was emphasis placed on restricting salt intake to decreased the instances of thirst. Avoiding the addition of salt to food after preparation and while cooking as well as avoiding smoked foods were measures used to prevent thirst. Patients on fluid restriction also reported sucking on ice cubes which does assist in relieving thirst but can increase fluid intake if over utilized. Other measures used to promote comfort on this restricted diet included avoiding sun exposure, avoiding alcohol, eating thick soup or reducing soup intake, and controlling blood glucose levels (Filipe).

**Analysis**

Through analysis of the literature, it has been found that the evidence based standards are consistent with the current standards of care. The current practice for DVT prevention and wound care in postoperative patients is consistent with the literature. The same holds true for comfort measures utilized in patients with fluid restrictions. Medicine and interventions are
constantly changing and new discoveries are made. Certain standards of care are sometimes left unchanged even though the evidence has evolved. This does not appear to be the case for these standards of care. While the medical management of patients with cases similar to T.A.’s is clear, further research could be conducted in the area of nursing care and patient compliance to this medical management. Cardiovascular and renal complications have a system for management, but it is patient compliance that creates difficulties in providing optimal care. There is a need to place emphasis on patient centered care and maintain autonomy of the patient in collaborating on the decision for management. In a case where there are a wide variety of health issues occurring, different alterations in health can contribute to one single manifestation. This is why clustering symptoms and performing diagnostic testing is necessary in coming to a conclusion on the source of the change in health status and determining treatment options. Furthermore, support systems such as family members can be utilized in assisting with care and promoting patient compliance.

Conclusion

It is apparent through the analysis of the pathophysiology and case study that the cardiovascular and renal systems are closely intertwined. As a nurse, it is critical to keep this in mind when obtaining assessments. It is important to not be solely focused on the one system that seems to be the issue and examine the patient as a whole. While it is necessary to give attention to management of a disease, it is also vital to hone in on prevention of further complications and the promotion of patient comfort. Above all, patient centered care should be fostered in all aspects of healthcare including assessments, interventions, and promoting compliance.
References


