Activity Observation of Water Treatment Facility

Location UVA Dialysis Clinic with Carlton Anderson

Date & Time 9/9/2019 3:30-4:45PM

Observers L. Chen, J. Bonaffini

**Activity Detailed Description**

The Lead Biomedical Specialist of the UVA Dialysis Program, Carlton Anderson, gave us a walk-through of some of the operational aspects of Dialysis. First we were shown the dialysis unit, hookups for the dialysis machines coming out of the walls, and jugs filled with various ingredients. Afterwards, Carlton led us back to the water treatment room where city water is pumped in, sterilized via carbon filters, fed through a reverse osmosis machine, tested for compliance with standards, and stored. Bicarb tubs and citrasate concentrates are also stores in this room. Finally Carlton brought us back to the dialysis maintenance room where problems are troubleshooted and machines fixed on a periodic basis.

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| People  (main groups of people) | Objects  (used by people and populate the environment) | Environment  (surroundings & features) | Messages  (messages or conversation) | Services  (services offered or available) |
| Carlton Anderson, CBNT Lead Biomedical Specialist  Zion + other trainees/ dialysis machine technicians  Rose Warren - charge nurse who was testing the water periodically for chlorine | Pipes: intake of city water as well as transfer of subsequent filtrations to proceeding steps. Pipes also bring the final purified water, bicarbonate, and citrasate to clinic.  Bags: of solid bicarbonate, sodium chloride for water softening need to be physically made. Bicarb is not sterile - it attracts bacteria  Filters: constant replacement of depth filters when used to capacity  Dialysis machines: sterilized and extensively checked for bacteria growth least twice a year. | Water treatment has its own room near the dialysis clinic.  Tubs of bicarb, citrasate lined around the room  Pipes of dialysate lead to dialysis clinic within the wall.  Various machines - carbon filter, reverse osmosis, testing devices (conductivity, chlorine, endotoxin, resistivity.  Water constantly flowing or moving to prevent bacterial growth  Small room for troubleshooting and maintaining dialysis machines | “UV light not actually needed to kill bacteria, it gets hot anyway and can shatter from the water”  “Water temperature is what we can get”  “Silica tears through our membranes and machines”  Bicarbonate must be made fresh everyday  Nothing registers chlorine immediately, there’s an alarm but no lock out  “Need to reduce clotting, increased blood flow, need dialysate pack” in reference to IRAD | Waterboss has lots of hype, very very expensive  Dialysis machine maintenance (Zion)  Carlton also services other dialysis clinic locations. |

**Comments about User Experience**

Constant checking and cycling throughout the day.

The fact that these systems are unique to the water that feeds them makes them difficult to standardize.

Dialysis clinics are at the mercy of the municipalities that purify water to various degrees.

**General Thoughts and Comments**

The water filtration system is very dependent on what the city water properties.

Maybe a little outside our field with the optimization.

Most every dialysis patient uses the same recipe for dialysate called 45x -- 1 part acid concentrate, 1.72 parts bicarb, 42.28 parts purified water.

Each dialysis clinic is unique by necessity due to uniqueness of the water systems that service each location.

Activity Training and Education on Dialysis machine with Pam Reynolds

Location UVA Dialysis Clinic

Date & Time 9/11/2019 3:30-4:45PM

Observers L. Chen, J. Bonaffini

**Activity Detailed Description**

Met up with Pam who is the educator of RNs who come to start at the outpatient clinic. She walked us through step by step as she would a new nurse on how to use the dialysis machine and allowed us to ask any questions that we could ever have about dialysis.

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| People  (main groups of people) | Pam Reynolds, educator of RNs in outpatient dialysis clinic. Used to be floor nurse.  Kevin | | | |
| Objects  (used by people and populate the environment) | Dialysis machine: both home (smaller more compact around chest height) vs. hemodialysis (around person height).  Peritoneal Dialysis (glorified glucose, ~15mins to get it into a patient gravity fed) vs. Hemodialysis    Training dialysis machine and supplies in office space  Filters: F180NR → 160, 250  Arterial (red) and Venous (blue) lines, “couplings” for dialysate  Different needles of different gauges (they are quite large)!  Do not have lines with water, bicarbonate, and citrate that the actual dialysis clinic has in the wall. | | | |
| Environment  (surroundings & features) | Well lit warm room with training materials everywhere.  Learning environment. | | | |
| Messages  (messages or conversation) | “I wish we could come up with a universal access for everyone”.  “Flip over dialyzer tap out the bubbles, remember to clamp 6 times”.  “As the dialyzer expands the filter can loosen up and the tubes can pop out”.  Tricks of the trade with a catheter: Coughing, laying on one side, flushing both pores to keep it clear.  Patients can get hypotensive at the end of treatment → can be mitigated with flow profile.  Too high of a positive pressure bringing the blood back can caught stenosis or hemolysis.  Clotting tends to happen with new patients, low blood pressure. | | | |
| Services  (services offered or available) | Educational materials on dialysis as well as vascular access (that people will still forget despite being tested on it). | | | |

**Comments about User Experience**

Many different components for the hemodialysis machine: mixers, saline for priming, appropriate filter fibers, arterial and venous lines, “pod” including heparin line, syringe.

**General Thoughts and Comments/What we learned**

Though no patient interaction we learned a lot about the process of getting a patient ready for dialysis, especially when it comes to vascular access.

Activity Training on Dialysis machine and information about access with Pam Reynolds

Location UVA Dialysis Clinic

Date & Time 9/13/2019 3:30-5:00PM

Observers L. Chen, J. Bonaffini

**Activity Detailed Description**

Met with Pam Reynolds again to review the different types of vascular access options available to patients - fistula, graft, and catheter. Dialysis starts around when Glomerular filtration rate (GFR) is 15% of the normal GFR and requires some type of access to vessels that can supply high blood flow. She explained the positives and negatives of each, noting that fistula is the most common and lease infection prone. Catheters are also popular despite the high risk of infection because they don’t lead to large fistula-caused bumps that are somewhat prevalent. She explained the signs of healthy vascular access, the education necessary for patients to make a decision, and other complications with vascular access.

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| People  (main groups of people) | Pam Reynolds, educator of RNs in outpatient dialysis clinic. Used to be floor nurse.  Kevin - nurse being trained by Pam | | | |
| Objects  (used by people and populate the environment) | Examples of the graft material used  Cuffed catheter with arterial and venous access ports  Various needles - sharp needles for clinic care, blunt (button hole) needles to permit home dialysis patients for using the same access site (prohibitory usually) | | | |
| Environment  (surroundings & features) | Training room adjacent to the dialysis clinic, filled with various training materials, machines, and Pam’s office | | | |
| Messages  (messages or conversation) | Training was communicated via powerpoint and discussion with Pam.  Arteriovenous Fistula (AVF)  Info - in non-dominant arm, 4-8 weeks to mature  Pros- biocompatible, can last a long time  Cons- can result in bulge, requires arm to be looked after  Arteriovenous Graft (AVG)  Info- plastic used to join artery in vein, can only cannulate in straight sections, requires 2-3 weeks to heal  Pros- good alternative to AVF  Cons- more likely to become infected, usually last <2 years  Catheter  Info- usually short term (acute kidney injury), last option, tunneled and cuffed underneath skin  Pros- can be used immediately  Cons- most likely to get infected, stenosis of central vein is very bad, cannot get wet  All forms can cause stenosis of major vessels, must be treated as early as possible in order to recover the access.  Bruit - swoosh sound from vascular access  Thrill - vibration from vascular access  Kevin had to do much of his training on a computer using online modules. | | | |
| Services  (services offered or available) | Training for dialysis machines, able to look into the different tools that are employed by the nurses around the clinic | | | |

**Comments about User Experience**

Vascular access alters the way people live their life -- vascular access must be pampered and looked after. Fistula is the safest but can affect cosmetics. All have some chance of infection, but catheters are most likely to become infected; people still choose this because it doesn’t look as bad. All forms can cause stenosis of major veins. In general, Pam said that vascular access, especially in the form of a fistula or graft, does not usually cause major issues if it is cared for properly (cleaned, pampered).

**General Thoughts and Comments**

High blood flow access generally must be set up for dialysis because there aren’t very many places in the body that allows for it. Fistulas were ground-breaking when discovered but access hasn’t been modernized that much since then.

Activity ICU Rounds in Main UVA Hospital with Drs. Bowman and Vincent-Johnson

Location UVA ICU

Date & Time 9/17/2019 8:45-11:00AM

Observers L. Chen, J. Bonaffini

**Activity Detailed Description**

ICU rounds of patients who were on dialysis among a host of other complications. Dr. Vincent-Johnson is doing a fellowship to specialize in nephrology. She would brief Dr. Bowman and us with a short description of the ailment of each patient and then go into specific numbers for Dr. Bowman to advise on/confirm treatment plans. We all would don the necessary protecting garments, get a squirt of hand sanitizer, and go into the room to check on the patient. If the patient was lucid, Dr. Bowman explained the status and checked on the machines for correct function. A nurse was in the room at all times to provide additional monitoring status. We went around to approximately 10 patients; we even saw a patient on an EKMO machine. Some patients had contracted an infection from the hospital and required a full body gown and gloves.

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| People  (main groups of people) | Dr. Bowman,  Dr. Vincent-Johnson,  ICU nurses and technicians  Sick patients  Operational staff | | | |
| Objects  (used by people and populate the environment) | Life Sustaining machines  IV poles: “God awful Christmas tree that is the IV pole”  Continuous Renal Replacement Therapy (CRRT) machines - most patients that have Acute Kidney Injury (AKI) are on this due to their fragile state  Lots of tubes going everywhere  EKMO machine  CROT: For slow dialysis, modified home hemodialysis  Note taking - most notes were written down by Dr. Vincent-Johnson on a piece of paper (for numbers) or notecards. | | | |
| Environment  (surroundings & features) | Spaces can be cluttered, we were often in the way although we tried our best to be courteous  Machines had lots of tubes, even tubes on the ground for effluent fluid coming from dialysis machine  Patients that required kidney care were dispersed -- kidney disease is not a disease or event that is usually treated in the ICU since it is a chronic condition | | | |
| Messages  (messages or conversation) | Discussion about the condition and background of the patient outside each room. Dr. Vincent-Johnson relayed to Dr. Bowman all the specific numbers such as fluid in/out, electrolytes given, etc.  Dr. Bowman would update the patient if he/she was lucid in easy to understand terms | | | |
| Services  (services offered or available) | Every type of hospital staff could be seen  operational staff for maintenance and cleanup  Nurses that did the majority of the patient care  Doctors to draw up patient care plans  Administrators for smooth running of all the above | | | |

**Comments about User Experience**

Most patients were not lucid -- only 1 of them was fully awake and able to talk.

There was at least one patient that was in the ICU that was a regular dialysis patient -- she had broken many bones due to a car crash. Broken bones are more likely for those suffering from CKD due to mineral bone disease that makes bones more brittle.

**General Thoughts and Comments**

This was an amazing and compelling experience. I was fascinated by the coolness with which Drs. Bowman and Vincent-Johnson conducted themselves. Most decisions they made were formulaic, but also taking into account the fragile status of the patients.

Kidney care was rarely the #1 concern of these patients, thus CRRT was employed frequently for maximum ease on the body. Some patients were barely able to drive the necessary blood through the machine (even on a low setting) due to their fragility.

Activity Shadowing Charge Nurse in Outpatient Dialysis Clinic with Patients

Location UVA Outpatient Dialysis Clinic

Date & Time 9/18/2019 3:30pm - 4:50pm

Observers L. Chen, J. Bonaffini

**Activity Detailed Description**

We shortly talked with Pam Reynolds in the training room. She felt most “annoyed” or frustrated with the fact that some nurses are unable to recall their training despite her extensive courses such as basics like necessary arterial and venous pressures for blood coming in and going out of the machine. We then went to the dialysis clinic area to discuss with Rose Warren, the charge nurse. She sat at the central desk taking records, assisting nurses when needed, and performing triage duties (patient entering or leaving). We mostly talked together in the central desk area, but went to the “pods” (sectioned off groups of dialysis machines of 6) to perform a triage once. On our way out, Rose when to help with taking a patient off the machine due to a crossover of two patients leaving with only 1 nurse to perform the task.

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| People  (main groups of people) | Pam Reynolds - educator of RNs in outpatient dialysis clinic  Rose Warren, Charge Nurse of the UVA outpatient Dialysis Unit  Deborah ???? - RN/manager? Said she thinks non-touch control of dialysis machines would be useful, reset alarms etc.  4 RNs that perform the tasks with putting patients on, taking patients off, tending to alarms, and monitoring statuses of all those in their assigned pods. | | | |
| Objects  (used by people and populate the environment) | PAPER SCHEDULES AND JOURNALS for information gathering and communication. Nurses are assigned patients and groups of pods about a week in advance.  Must use computer (that needs a password with every change you document) in input patient information and changes in health as well as to check on doctors orders on patient plan.  Packages are prepped for each patients: clamp, saline bag, dialyzer. | | | |
| Environment  (surroundings & features) | Off white color, there is some natural light but most windows are blinded. Patients can watch a movie, beds are down low.  Not as stressful as ICU, but still upbeat with just enough nurses to cover each patient that comes in and finishes.  Central desk where the computers and phones are with beds dotted surrounding the desk.  Very busy from 10AM-2:30PM | | | |
| Messages  (messages or conversation) | A major major problem is patient compliance: not staying for the whole treatment, as many as 50%  ~10% skip treatments - forget/had to go to hospital  Many will eat a large meal or drink a big gulp - become hypertensive or otherwise interrupt their appointment due to vomiting, need to use restrooms  Others don’t take their other medication, resulting in conditions where treatment cannot be given, ex: very high BP  Software is out of date and slow, ask password at every EMR prompt  Infection is not that common and can usually be treated in the unit instead of going to the ER, but sometimes escalation is necessary. Perhaps 1/month catheter infection (serious). | | | |
| Services  (services offered or available) | * They do administer drugs there if they inspect the patient and see if something is wrong. * Putting patients on or taking patients off machines * Remedying alarms if they are not important * Triage on patients entering or leaving the clinic * Heparin to keep the blood from clotting (a short half life though) | | | |

**Comments about User Experience**

The computerization of a lot of the information has been great in terms of data collection but Rose believes it inherently slows down the care

Many patients don’t want to do Home Hemo because they are scared and don’t want to deal with the hassle -- rather have someone else do it.

**General Thoughts and Comments**

We had no idea patient compliance was such an issue -- this could be contributing greatly to bad outcomes if patients are not receiving the prescription that doctors plan on. Patients must also comply with the medication they’ve been put on outside of the clinic.

Other issues make it difficult for the patients and nurses - sometimes it is just not possible to get patients to a healthy maintaining state. Often patients are left with too much fluid, not enough BUN decrease

91 Patients at the current time with 3-4 RNs for each pod. Many patients do not stay for their entire treatment. Nurses need to work with doctors on how much fluid to pull; the nurses must follow the prescribed amount.

Activity Kidney Center Clinic with Drs. Rahman and Portz

Location UVA Kidney Center Clinic

Date & Time 9/25/2019 1:00pm - 4:00pm

Observers L. Chen, J. Bonaffini

**Activity Detailed Description**

Dr. Rahman, the director for the UVA Kidney Center Clinic graciously allowed us to shadow him during a normal (but light on appointments scheduled) day. He first explained some of the basics of the kidney, effects of CKD, stages of CKD, and preventing progression of CKD. Dr. Ports, a senior fellow at the clinic handled most of the appointments. He first examined the patients, and then discussed plans with Dr. Rahman. Both doctors then went into the exam rooms to talk with the patient, ask them how they were feeling, and adjust medication if necessary. I believe this was a little uncommon, as Dr. Rahman did not have any appointments himself due to him returning from travel earlier than anticipated. We shadowed for 4 patients. Dr. Rahman also explicitly stated the importance of some new technology/processes -- there has not been much innovation in renal care for many years, just optimizations to current technology. He also stated his thoughts about the importance of ensuring personalized therapy based on previously acquired data.

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| People  (main groups of people) | Dr. Rahman - attending doctor who we mostly followed around  Dr. Portz - Senior fellow, did most of the planning and legwork for patients before we entered patient rooms with Dr. Rahman  Patients - various CKD patients, all of them with stage 4 or less CKD (not needing dialysis yet), range of ages  Nurses - mostly sitting at desks | | | |
| Objects  (used by people and populate the environment) | Notes written by hand and into the Epic EMR.  Normal exam room items | | | |
| Environment  (surroundings & features) | Office for discussion of patient background and forward plan   * Desks, chairs, and lockers for employees * White board for planning   Appointment rooms for meeting with patients for check-ups   * Small rooms with an examination bed, computer, a few chairs, cabinets - your usual examination room | | | |
| Messages  (messages or conversation) | Talks with Dr. Rahman about the Kidney, research, and care for those with kidney disease   * Do No Harm * CKD treatment is all about preserving the function remaining in the kidney while making up for lacking function via medication * Kidneys perform a plethora of functions including creation of hormones, acid/base balance, electrolyte balance * CKD clinic does not get money if patients are outside normal ranges in their labs, ex: hemoglobin is often low in patients due to renal anemia and must be corrected via prescribed erythropoietin * Comorbidities are VERY common - high BP, diabetes * ESRD (< 15% function) is usually treated via HD, but morbidity is not good among elderly   Discussion with Dr. Rahman and Dr. Portz, relaying the background of the patient and making an initial plan for medication, treatment plan, review of lab results, etc.   * Assessing renal function early is a problem - no good biomarkers, urea and creatinine clearance used as a proxy * The earlier you can spot renal function decreasing, the earlier you can account for it via medication, diet, BP, diabetes management * Place the least amount of stress on the kidney as possible to avoid nephron hypertrophy (overwork)   + Preserve nephrons that are still alive * Assess kidney function as a trend, not a single data point - slow vs fast transition into ESRD makes a difference   Discussion with patients, Dr. Rahman, and Dr. Portz during an appointment. | | | |
| Services  (services offered or available) | * Patient appointments   + Management of CKD * Patients get prescribed Dialysis (1-2 people/month) * Educational classes for dialysis, what it is, what does it affect * Social Workers for dealing with stress, other difficulties * Talks with current patients about their experience regarding dialysis | | | |

**Comments about User Experience**

Dr. Rahman placed special consideration upon patient care and wishes that there was more ability to personalize and predict medication or therapy response based on past data.

Regular Check-in appointments are necessary to monitor the stability of kidney function - it must be watched with a close eye to determine long term trends and prepare patients for ESRD and Dialysis therapy if necessary.

Initial appointments are scheduled if creatinine/urea clearance is low -- less than 90% or stage 2 or worse.

**General Thoughts and Comments**

As Dr. Rahman is a research cognizant physician, he is very open to new/upcoming therapies and a great proponent of this program.

Compliance with standards (ex. Maintaining ranges of lab results such as hemoglobin) as every patient is different and is affected by medications a little differently. There was as much as 50% non-compliance due to wildly changes lab results on a nationwide scale. A better way to ensure compliance is needed -- predict correct dose or other therapies.

Mortality among elderly patients on dialysis is terrible and needs to be improved - as much as 50% for those above 65 years old.

Activity UVA Home Dialysis Clinic with Lynne Hill, RN and Home HD Training

Location UVA Home Dialysis Clinic

Date & Time 9/26/2019 9:00am - 12:30pm

Observers L. Chen, J. Bonaffini

**Activity Detailed Description**

Lynne Hill spent the majority of the first hour and a half showing Patient X and Patient X’s wife how to assemble the HHD machine. Using a NxStage cartridge with all necessary tube, needle, and dialyzer components, Lynne walked Patient X’s wife through the steps. All of this required practice of aseptic technique. Since this was only the third time using this machine, Lynne had to inform Patient X’s wife of the steps. It usually takes 4-6 weeks to establish comfort with using the machine. By 10:30, Patient X was hooked up to the machine from the AVF in his arm and we watched a few educational videos about the machine components and aseptic technique. I also had time to ask Patient X and Patient X’s wife about their thoughts regarding dialysis, UVA, and their experiences.

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| People  (main groups of people) | Lynne Hill, RN - Nurse who was training patient and patient’s care taker (wife)  Patient “Patient X” - Elderly man who was recently put on dialysis and decided to go with home hemodialysis due to distance from UVA, later also found out that this form of HD is associated with better outcomes, which bolstered their decision  Wife of Patient - Lynne was mostly training Patient X’s wife to operate the home hemodialysis machine  Dr. Rahman - Patient X’s doctor, came to check on his status | | | |
| Objects  (used by people and populate the environment) | Home Hemodialysis (HHD) machine manufactured by NxStage  HHD water treatment machine  Reclining chair for Patient X  Chairs for Patient X’s wife and Lynne  TV for view educational videos  Examination table  Posters of CKD and Dialysis related topics  Supplies to run HHD machine including tube+dialyzer+needle pack and Saline bag (sodium chlorate)  Ipad to connect to HHD machine for vital statistics, data is fed back to Lynne | | | |
| Environment  (surroundings & features) | Small clinic separate from the dialysis unit with a number of small examination/education rooms for privacy  Lisa and I observed the action in the only populated room, where Lynne, Patient X, and Patient X’s wife were. It was packed, the room couldn’t have been more than 10’x12’ | | | |
| Messages  (messages or conversation) | Discussion how to set up HHD machine   * “Build” the machine   + Attach tube pack to machine   + Pierce saline bag with one needle to get air out of system -- prime the machine, \*\* it is difficult to pierce this bag without holding onto port, which you cannot do because that is not sterile -- had to start over because of this   + 20 mins for machine to test operation, clear air, test pressures   + Chlorine test on water * Connect Ipad to machine   + Vital statistics including dialysate flow, arterial/venous pressures   + BP must be taken every 30 minutes to ensure patient doesn’t go hypotensive (fluid being drawn during treatment)   + Paperwork/record keeping - lot numbers of supplies * Clean arm with soap & water, alcohol swab   + Remove scabs from button holes (use same pierces every time with dull needle for ease on care-taker) * Ensure Machine is ready to go, pumps are off * Hook up arterial and venous lines   + Patient X’s wife was most hesitant about using the needle, would be nice to have more practice \*\* what do med students and nurses use to practice this??   + Give heparin * Turn on pump, enter information into Ipad * Turn on machine   + Slowly bring up blood flow -- can’t do this too fast because machine has pressure driven pumps, not hydraulic pumps   Sterility VERY important   * Clean vs sterile vs dirty are important distinctions * “Aseptic technique” | | | |
| Services  (services offered or available) | * HHD and Peritoneal Dialysis training   + HHD training is about 4 weeks * View Educational videos * Dialysis run in center during the training * Lynne checks relevant data after each home session to ensure no one is having problems | | | |

**Comments about User Experience**

Lynne was very low pressure about learning the machine -- Patient X and Patient X’s wife like this attitude of solutions focused and optimism without being overbearing.

Piercing is the most daunting if you’ve never done it before.

**General Thoughts and Comments**

HHD program does not have many people enrolled - Patient X was one of about 10 -- why is this despite the outcomes? Some may be due to feeling of community you get from being with other patients. Patient X and his wife mentioned that while in the Dialysis clinic, there was some camaraderie with those in his “pod.”

Activity Meet with Jacob Wright

Location Kardinal Hall

Date & Time 10/1/2019 6:00PM-8:00PM

Observers L. Chen, J. Bonaffini

**Activity Detailed Description**

Lisa and I got a beer with Jacob at Kardinal Hall. Jacob, who graduated from UVA in 2016 as an engineer, had previously had end stage renal disease, likely due to a bacterial infection that affected his kidneys. CKD landed him in the hospital; he was found to have very high blood creatinine. Other signs of CKD were not as prevalent for him, but those that were included fluid build up, the smell of ammonia, and having to take many pills such as phosphorus binders.

Jacob had a fistula in his upper arm. Complaints about vascular access include the chance that a needle goes through the wall, causing a “blow out” or other problems with needle placement. Sometimes Jacob could feel when a needle was placed improperly, such as too close to a vessel wall as to disallow sufficient flow.

Jacob went on dialysis while at school, taking the night shift schedule, sometimes leaving as late as 9PM from the clinic. He formed bonds with others in his pod; generally these are individuals with jobs that don’t have any other time. Jacob decided against home dialysis because he was living with others and didn’t know if he was able to keep the sterile environment required. Before and after every dialysis session, he was asked how he was feeling so that nurses can judge whether a person is likely to suffer from other complications such as cardiac arrest (common in dialysis patients due to increased left ventricular volume LVM). Side effects from dialysis included cramps if too much fluid was drawn off and feelings of exhaustion the day after. Sometimes Jacob was able to sleep during dialysis, but otherwise he would work on homework or relax, watching tv or Netflix.

After being on dialysis for 5.5 years, Jacob received a kidney transplant. The transplant was based on a number of parameters including compliance, age, age of donor, and donor match. For every transplant there would be a list of 3 people that were notified, and patients could choose if it was the right kidney for them. If it wasn’t, the next person could be ready to make that decision. This kind of decision was necessary because some kidneys were small (coming from a child or infant) or from older patients. As Jacob got closer to the front of the waitlist, he began to receive more “backup” calls until finally being able to accept a kidney, which was placed in his lower right abdomen. Usually, doctors try to find a “good” first kidney, as they tend to last longer than subsequent kidney transplants. Old kidneys remain in the body unless they are causing problems such as infections.

Jacob now has been living with his transplanted kidney for a couple years and must take immunosuppressant drugs and maintain a good diet. He regularly checks in with his transplant doctor and does blood work often. He said that another good person to talk to may be a dietician. He decided to keep his fistula just in case it was needed.

The POEMS observation model does not fit this experience as this was simply a chat with someone our age.

Activity Peritoneal Dialysis Checkup with Drs. Khan and Mulhim

Location UVA Dialysis Clinic

Date & Time 10/2/2019 10:00-11:00AM

Observers L. Chen, J. Bonaffini

**Activity Detailed Description**

Every Wednesday, ESRD patients that have elected for home peritoneal dialysis (PD) come in to the UVA dialysis clinic for a brief checkup. This checkup is required once a month; since there are about 50 PD patients, about 12 come every week. Nurses bring patients to the checkup rooms (same rooms as the home hemodialysis education rooms) and they are later checked on by doctors. In this case, attending Dr. Khan manages this PD program. Dr. Mulhim, a senior fellow assists her.

We were able to sit in on one of the checkups, in which a patient who had recently switched from clinic hemodialysis to PD. Bloodwork is checked over, as well as the patient concerns such as pain, discomfort, and other worries (ex: infection at PD cath site, fluid build-up in the legs). Some patients use PD throughout the day, manually cycling in new fluid for “dwells” based on the amount of time prescribed by the doctor. For example, if the prescription (kt/V) necessitates 8 hours worth of “dwell” time, and the patient feels best in increments of 2 hour “dwells” then this process of filling and draining must be done 4 times. This is tweaked as necessary, often based upon saved effluent fluid from PD.

Otherwise a cycler is used overnight that automatically cycles the dwell fluid.

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| People  (main groups of people) | Dr. Khan - attending doctor  Dr. Mulhim - senior fellow, Lisa and I shadowed him on this checkup  Patient and family - the patient only spoke spanish, so family members translated for her. She uses PD effectively while working her job. Patient switched from a catheter hemodialysis (which got infected but is now healed and closed up).  Nurses - would take basic vitals and bring the patient into the room. In some cases (Beth, a RN) consulted patients about their prescription and concerns | | | |
| Objects  (used by people and populate the environment) |  | | | |
| Environment  (surroundings & features) | Small examination room with posters on the walls, counter and sink, and a few chairs for the patient and family members. There was also an examination bench. | | | |
| Messages  (messages or conversation) | Checkup for PD cath site - infections can occur at the surface exit site, at the tunneled site, or of the peritoneum (peritonitis - ab pain and extra white blood cells in the effluent fluid, most common).  Discussion about how the patient was feeling - ex: patient didn’t feel well with a certain saline concentration 1.5K vs 2K (causing bad cramping), so it was changed to something else.  Updates to medication as necessary from patient concerns and bloodwork. | | | |
| Services  (services offered or available) | Consultation with doctors  Very close to the hemodialysis and kidney clinic areas if additional expertise is needed  Checkup for health or infection  Home dialysis - about 50 people on PD, 10 people on HHD  Home must be checked to make sure it is suitable for PD in terms of cleanliness and sterility | | | |

**Comments about User Experience**

Dr. Mulhim was very thorough in his examination and questioning of the patient. He wanted to make sure that everything was OK and that there were no additional concerns/everything that was of concern was addressed properly. For example, the patient had recently had her tunnelled HD catheter removed due to an infection and wanted to make sure there was no residual infection -- he double checked to ensure everything was ok and assured them to keep in touch in case anything were to happen.

**General Thoughts and Comments**

It was quite busy for this session -- we didn’t want to bother the doctors too much if they were too busy to interact with Lisa and me. While the doctor interaction is necessary for compliance and general checkup, I think something like this checkup could be done on a remote basis if patients are far away. Bloodwork is the only concern.

Activity Shadow Dr. Angle

Location UVA Hospital: Interventional Radiology

Date & Time 10/2/2019 12:30 PM-3:30PM

Observers L. Chen, J. Bonaffini

**Activity Detailed Description**

We met up with Dr. Bowman in the UVA Hospital Main Lobby before walking over to the Radiology department on the first floor. Interventional Radiology was in a section of this department. Since there is wide use of Fluoroscopy machines, we donned bunny suits and lead aprons, vests, and thyroid protection. We talked with Dr. Angle in the room where IR doctors reviewed cases, talked with each other, and looked at images. All the IR suites were on a hallway - each suite included an operating room and adjacent viewing room with monitors. We walked this hallway and met with Dr. Park to view a ballooning procedure in which the venous side of the fistula vascular access had undergone stenosis. The Fluoroscopy machine (a Siemens Artis model) was used to view the placement of the wire that held the balloons for widening the vein. Contrast agent was used to ensure flow had been restored.

We then walked over with Dr. Park, where he was inserting a central line through the femoral vein of a one month old patient. Dr. Park explained to us that IR doctors are most involved with the “plumbing” of the body, as this is the necessary access for other parts of the body that is used. Procedures mostly involved a hollow needle stick, then guide wire, then tube (\*\*\*\* Lisa, if you remember, please check my accuracy on this, I don’t remember exactly what he said!).

Following this, we viewed a tube replacement of a gall-bladder drain. Main advantages of IR include minimal invasivity and the patient can be awake during the procedure. Total radiation dose must be considered so that alternate side effects are not felt. Before, after, and at critical points in the procedure, the Fluoroscopy machine is used.

After this, we removed our PPI. We discussed Kidney related procedures in the doctors’ room until he was called in to fill in on an urgent procedure. During this time, Dr. Angle explained that most IR procedures involving CKD involved when a transplant had already occurred but not working properly or for vascular access fixing. There was a new device by Bard that will assist in the creation of fistulas in IR as opposed to normal surgery. We had to leave to attend class.

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| --- | --- | --- | --- | --- |
| People  (main groups of people) | Interventional Radiology Doctors - Dr. Angle, Dr. Park, other doctors  Doctors would often converse with other doctors in the viewing room for advice while operating  Nurses -  assist in the operating rooms with doctor, administering anesthetic, or monitor status in the viewing room, all wear protective equipment.  Also seen moving patients into and out of operating rooms.  Patients | | | |
| Objects  (used by people and populate the environment) | PPI - bunny suits, lead gear  Monitors in viewing room, generally pretty old equipment, but run Siemens software fine  Artis Siemens Fluoroscopy machine, centered over patients while doctors are working  Lights above patients in room for extra focus on the site  Operating table  Adjoining equipment sitting on rolling carts  Viewing rooms crowded with chairs  Doctors’ “relaxation room” was dark and full of monitors for reviewing cases, checking email, and reviewing the schedule | | | |
| Environment  (surroundings & features) | Cramped viewing rooms  Operating rooms had a lot more room but also a lot more equipment, much more well lit than viewing rooms  Carts along the side of the hallways  Doctors’ room filled with chairs, monitors, and computers, very dark | | | |
| Messages  (messages or conversation) | Discussions between doctors about the next step (especially during the gall bladder procedure)  Not much discussion going on (but we didn’t go inside the operating room), mostly just the doctor focusing | | | |
| Services  (services offered or available) | IR procedures - Dr. Angle said they have the capability of performing 450 different procedures  Operation on many patients, minimally invasive  Imaging in each operating room  High throughput - some procedures are less than 20 min | | | |

**Comments about User Experience**

I may be biased, but if I had a problem that was solvable through IR means, I would take it because it is minimally invasive and you can go home the same or next day. Doctors are confident and have vast knowledge due to the variety of procedures. For example, the patient that Dr. Angle had to operate on at a moment’s notice required just a few minutes of looking at images and reviewing history for him to be prepared. Additional relevant knowledge could be gained at the beginning of the procedure when the Fluoroscopy machine was being used to image the starting point.

**General Thoughts and Comments**

This was an amazing experience. IR is a quickly emerging primary field due to its applicability. Doctors stand a greater chance of making a large impact with a small, quick procedure.

Activity Dialysis Clinic Observation of Pod C

Location UVA Dialysis Clinic

Date & Time 10/9/2019 12:30PM - 1:45PM

Observers L. Chen, J. Bonaffini

**Activity Detailed Description**

James and I tried to go in when Pam, RN said to be the busiest time for the clinic; around 11am-2pm. Though the pod was not as busy as we had hoped to observe we did learn a little bit more about the process by talking to some nurses. One nurse is particular had worked for DeVita, the for-profit dialysis company, before coming to UVA. She described UVA as being more driven to accommodate new research and are better with patient to patient variance when it comes to best care. A nurse mentioned one of the biggest problems with clinic dialysis is the logistics of transporting patients on time to the hospital causing patients to have to cut their treatment short.

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| --- | --- | --- | --- | --- |
| People  (main groups of people) | Patient with walking or wheeled in and out of the pod.  2-3 nurses cycling patients   * One nurse Danielle, RN used to work at DeVita * Rose Warren, RN | | | |
| Objects  (used by people and populate the environment) | Sterile wipes to clean machine  Machine interface, cuff, and seats  Dialysis supplies  Gloves, tape, blankets | | | |
| Environment  (surroundings & features) | Same surrounding as other observations in UVA Dialysis Clinic   * Frequent movement with large shelves and racks, some of which are stable and others that are rolled back and forth | | | |
| Messages  (messages or conversation) | “Machines have too many crevices” in reference to cleaning  “I want a flat machine so it’s easier to clean”  Patient transportation can be very unreliable; a nurse cited that logistics of travel is a large daily issue and can cause patient’s treatment to be cut short → some patients claim their appointment is earlier to make sure they will actually arrive on time.  Asking where a catheter was placed (either surgery or IR). | | | |
| Services  (services offered or available) | Hemodialysis  Brief check of vital signs  Vascular access health | | | |

**Comments about User Experience**

Patients who were able to walk on their own could come in sit down, get their treatment, and then walk away fine. Someones a patient would walk in and be informed their chair wasn’t quite ready yet.

If a patient's vascular access had a problem the nurses would ask the patient to make an appointment to have it looked at; it is an extra step to go to IR or surgery to have it looked at.

**General Thoughts and Comments**

There is a lot of cleaning (rightfully so) of the machine between patients. Any blood needs to be wiped away and sanitized to prevent infection and communicable diseases from spreading throughout the clinic.

Activity UVA Home Dialysis Clinic with Lynne Hill, RN and Home HD Training

Location UVA Home Dialysis Clinic

Date & Time 10/10/2019 9:15am - 12:00pm

Observers L. Chen, J. Bonaffini

**Activity Detailed Description**

This is the 2nd time we saw patient X and their training on home hemodialysis. They are advancing pretty well, and the wife was already a lot more independent. Lynne would leave them alone for long periods of time to encourage this independence. Lynne mentioned that patients appreciate being kept in the loop of changes in schedule and health status. She tries to overlap patients transitioning to home hemo as much as possible (for example, patient X is at the end of their training and about to go home and in the same week a new patient will be coming for training).

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| --- | --- | --- | --- | --- |
| People  (main groups of people) | Patient X and wife  Lynne Hill, RN | | | |
| Objects  (used by people and populate the environment) | Home hemodialysis machine, cartridge, packs of tubing, saline  Chlorine check kit  Some syringes are prefilled and presterilized in packaging. | | | |
| Environment  (surroundings & features) | Same as home hemodialysis observations in the past (nothing different). | | | |
| Messages  (messages or conversation) | “Phosphate binders can be quite expensive”  “Home hemo training for them is going so well that they will transition within the 3 weeks”  “I can tell when the needle is in properly and can feel them the whole time” - Patient X | | | |
| Services  (services offered or available) | Dialysis as well as training on home hemodialysis  Check on medication → Phosphate binders for example  Call in supplies once a month  Call plumber to hook water up to machine in their home.  Machine will be delivered & a nurse will come home with them the first time the patient is dialyzing at home. | | | |

**Comments about User Experience**

The wife mentioned that her learning process came from making mistakes (dropping a line and having to build the machine all over again).

**General Thoughts and Comments**

A huge limitation on patients transitioning to home hemodialysis is the need for dexterity! It also seems like right now Lynne is the only nurse that is handling home hemodialysis training!

Activity Whiteboarding with Dr. Bowman

Location Nephrology Division Conference Room

Date & Time 10/11/2019 11:00AM-12:15PM

Observers L. Chen, J. Bonaffini

**Activity Detailed Description**

Dr. Bowman spent time with us in a conference room to review the observations, give feedback regarding problems we have seen so far, and to come up with some very rough potential solutions. Most of the problems and ideas are outlined in aptly named sections after this one. In a general sense we discussed the following topics:

Home Hemodialysis

People will take the path of least resistance and opt for in-center dialysis instead. There are still some barriers, mental and otherwise, that people make their decisions based upon.

Vascular Access

Question/Problem - when does stenosis become flow limiting, requiring angioplasty?

* If angioplasties are too frequent, it can cause intimal hyperplasia (thickening of the vessel wall) and cause more stenoses down the line
* Fistulagrams are expensive
* Nurses will send patients to imaging if they detect decrease in venous flow
* There should be a better way to measure flow on either side of prospective stenoses
* Need to be able to test flow at load after angioplasty to avoid too much damage

Preventative Care

* Many patients are not diagnosed with kidney disease until stage 3 or 4 (according to Dr. Rahman)
* Often detection can be from high protein content in dilute urine
  + Solutes must be “normalized”
  + Is there a way to test this rapidly?
* GFR estimation is poor, mostly done using a protein called inulin

Conventional Dialysis

* Compliance is poor - people often don’t show up on time or at all, or they leave early
  + Is “hoteling” an option for dialysis clinics?
* Often the issue is staffing - nurses need a schedule

AKI and real-time risk assessment

* Patients at risk of AKI transitioning to stage 3+ kidney disease
* AKI often occurs in trauma - if there is a way to detect damage being done to the kidney early, then the kidney could be protected in advance to avoid rapid degradation of kidney function in the long term (and future dialysis)
* This requires real-time analysis

POEMS Observation Structure doesn’t match this experience -- a detailed description is more application.

**Comments about User Experience N/A**

**General Thoughts and Comments**

This discussion with Dr. Bowman is very helpful because he has in depth clinical knowledge that can guide our problem/solution finding. We plan to meet every other week to review observations with him.

Activity UVA Home Dialysis Clinic with Lynne Hill, RN and Home HD Training

Location UVA Home Dialysis Clinic

Date & Time 10/22/2019 9:45am - 12:30pm

Observers L. Chen, J. Bonaffini

**Activity Detailed Description**

The first part of the observation involved attending appointments with Dr. Rahman in the Home Dialysis Clinic. Patients with appointments were undergoing home hemodialysis and were usually accompanied by their care-giver, such as a daughter or husband. Dr. Rahman ran through their labs, reviewed the patients’ status, asked if they were feeling well/poorly, and any other small discrepancies in health. We were also accompanied by a dietician and nurse (Lynne Hill). There was a balance between kidney care and other health care that had to be struck. For example, one patient had a skin problem and Dr. Rahman advised them to get a referral for a dermatologist.

The second part of the observation involved the 3rd time seeing the learning home hemodialysis patient that we had seen in the past. It was the last day at UVA before the patient and care-giver were to take the machine home for good. Thus, Lynne Hill only briefly checked on them to make sure they were doing ok periodically during the session. We were able to ask questions about how they felt -- the care-giver felt a lot more confident cannulating than in the beginning and the whole process went relatively smoothly except for a small problem with the water treatment device in its flow of effluent fluid.

We were also able to get a short preview of the new telehealth program at UVA using the TYTO device. A telehealth technician was troubleshooting a connection issue with the examination device not being able to connect to the UVA ipad, and thus not able to relay data to the prepared telehealth room at UVA.

Finally, we had a short discussion with the dietician mentioned earlier. She stated that diets are made specific to the patient, but there are a lot of general guidelines to follow.

* Conventional dialysis patients often have more build-up of phosphorus and other harmful solutes and thus require binders.
* Home Dialysis patients often have more than necessary clearance of phosphorus and other solutes due to additional time on the machine and may even require supplements to keep these values in the recommended range.
* Diet has a lot to do with control of solutes in your body - in the example of phosphorus, added phosphorus in soda and some meats is taken up 100% by the body and thus not recommended for many dialysis patients. Naturally phosphorus-rich foods such as beans are only taken up by the body ~50%, so it is not as harmful.
* Diet is more to control the comorbidities of diabetes and hypertension, as these conditions unduly stress the kidneys. Because of this, diets are constructed for stage 2/3+ patients (not undergoing dialysis).

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| People  (main groups of people) | Dr. Rahman  Lynne Hill, RN  Dietician  Patients + care-givers  Learning Patient + care-giver | | | |
| Objects  (used by people and populate the environment) | HHD machine + dialyzer kit - Nxstage  Chairs for patient and care-givers | | | |
| Environment  (surroundings & features) | Small examination rooms with chair for the patient - these were the same rooms as previously described in observations of home dialysis  Mobile carts with necessary HHD items such as saline syringes, gloves, needles | | | |
| Messages  (messages or conversation) | Checkups + labs discussion  Kidney Health discussion, diet and medication discussion  Correct HHD procedures | | | |
| Services  (services offered or available) | HHD checkups  HHD training  Telehealth set up in the examination rooms (soon) | | | |

**Comments about User Experience**

There were lots of clinicians for every patient and caregiver - we believe that patients were given adequate attention. Discussion was thorough, making sure that the patients had no problems, or if they did, the problems were addressed

The HHD learning patient and care-giver seemed prepared to bring home the machine for good. This is exciting because it returns part of their life to normalcy. Also HHD seemed to be associated with better quality of life due to the sufficient clearance of toxins from the blood.

**General Thoughts and Comments**

It was interesting to see the progression of the learning patient; Lynne Hill is an excellent educator and made sure the patient and care-giver were comfortable at all steps in the process (and continue to be comfortable once monthly checkups are started).

Activity Telehealth Session Shadowing

Location UVA Home Dialysis Clinic

Date & Time 10/23/2019 10:00-11:00AM

Observers L. Chen, J. Bonaffini

**Activity Detailed Description**

We accompanied Dr. Rosner in the Home Dialysis for a checkup on a patient that is currently undergoing PD. He asked about the patient’s wellbeing, discussed labs, and examined the patient using the TYTO monitoring device. Interactions were similar to those in person, in the clinic, without the ability to physically touch (which may be important for pedaledema examination). The patient was very talkative and I didn’t feel like there was a lowering in the quality of the visit, not to mention that there was no travel required. The only hiccup was that the bandwidth of the patient’s internet may not have been enough to support the TYTO camera. Resulting in some freezing.

After this, Jessica, a nurse administrator, showed us the mechanics of PD. The process of removing the sterile cap of the catheter is likely the source of the peritonitis. \*IDEA\* Some kind of device to ensure the catheter tip stays sterile while transferring between tips and bags of dialysate. We also saw Dr. Khan demonstrate the use of a PD cycler.

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| --- | --- | --- | --- | --- |
| People  (main groups of people) | Dr. Rosner  Dr. Khan  Nurse Administrator Jessica  Medical student | | | |
| Objects  (used by people and populate the environment) | TV  Camera  Mobile cart is used as a desk for the keyboard and mouse  PD bag rack  PD cycler  Binder with patient information and handwritten notes by healthcare professionals | | | |
| Environment  (surroundings & features) | Same examination rooms as before.  All of the focus was on the tv and camera on the wall to interact with the patient. | | | |
| Messages  (messages or conversation) | Discussion about patient health, labs, and any general worries  Mechanics of PD - transfer of sterile tip from cap, to dialysate bag adaptor, and to new sterile tip when done  If there is an infection (peritonitis), then it requires a visit from a UVA clinician to ensure conditions are clean/suitable for PD | | | |
| Services  (services offered or available) | Telehealth services - Clinicians stand in the examination rooms to consult with patients  PD clinic checkups and education - PD patients must attend 4 sessions to learn about the PD process before being allowed to perform the procedure | | | |

**Comments about User Experience**

Telehealth is very convenient for both patients and doctors if both sides are equipped. The rollout of this program is perfect for PD patients because most patients are pretty responsible to begin with. Check-ups can result in a referral to another doctor, but are rarely urgent (requiring immediate medical attention), and well suited for this format of appointment.

**General Thoughts and Comments**

I was impressed with the clinicians’ and doctors’ willingness to take up the remote health option. Even with a few hiccups, it seems to be getting the job done. It does rely on some of the tech-savviness of the patient, so I can see why many elderly patients might prefer to have an in-person appointment instead.

I think there are some options to improve upon the mechanics of PD, really making it foolproof to prevent infection.

Activity First At Home Hemodialysis Shadowing with Lynne Hill, RN

Location Patient X’s home in Scottsville

Date & Time 10/24/2019 11:00AM - 3:30PM

Observers L. Chen, J. Bonaffini

**Activity Detailed Description**

James: This was the first time that dialysis had been performed at home by this patient and his wife. Unfortunately, there were still some problems to be solved with the plumbing; therefore, instead of using the pureflow system, pre-mixed dialysate liquid was used. The problem was to be resolved soon. Additionally, there were some issues with the NxStage cycler connecting to the router, as the router was located on the other side of the house. This was also to be resolved within a few days. A signal amplifier was necessary to allow the cycler to pick up the WiFi connection. The WiFi adaptor on the cycler was not beefy enough to pick up the signal, while the NxStage IPad was able to pick it up. The dialysis procedure, was still able to proceed since Lynne could record the measurements for later transcription and submittal to CMS.

The “usual” warnings popped up on the cycler periodically due to the system testing itself to make sure it was working properly.

In terms of dialysis supplies, the NxStage had delivered months worth of dialyzer setups, sterilization supplies, and other essentials.

Lisa: (Middle and end) The treatment was terminated early because of a large kink the in the dialysate bags that restricted flow into the machine. With multiple errors overridden by Patient X’s wife, the machine stop the treatment and reset. The patient ended up not losing any fluid weight mostly due to the shortened treatment. Lynne was okay with not finishing out the treatment because the next day was truly on their own for dialysis. Lynne for the most part stayed out in the living room to avoid any dependence on her; although she knew the alarms and sounds of the machine quite well and could step in (to lower the rate of draw when an alarms went off for example) to help. Blood pressure had to be taken throughout the treatment and it lowered as time went on.

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| --- | --- | --- | --- | --- |
| People  (main groups of people) | Lynne Hill, RN  Patient X  Patient X’s wife | | | |
| Objects  (used by people and populate the environment) | Lazy Boy by window with sunlight  Large bed possibly to be moved  Months worth of supplies in the garage  NxStage home hemodialysis machine  10 5L Dialysate bags: with twist off connectors | | | |
| Environment  (surroundings & features) | Old pictures of patient X as a young man, pictures of family members.  Infinitely more comfortable and warm than at the UVA Clinic  Directly sunlight coming through window | | | |
| Messages  (messages or conversation) | Error messages (E+a number). It is usually “normal” warnings in which the system tests itself periodically.  “I was going to say just wait until we get home but we are already home!”  Before pushing the saline to flush patients blood back in, an error message appeared and distracted from flushing. By the time it was sorted out Lynne suggested against flushing the blood back in to avoid any clotting that had already started. | | | |
| Services  (services offered or available) | CMS → Meticulous about the record of treatment as they handle the billing for Medicare.  Lynne had to count all the boxes of supplies for record. | | | |

**Comments about User Experience**

Because the machine is set up in the corner the dialysate bags are sometimes hard to reach towards the back.

After disconnecting, the closing of the stick site takes quite a while to close up (and blood will spurt out if not ready).

Kink in the bag was noticed a little too late → patient X’s wife said that she learned actively from these kinds of mistakes and will be more vigilant as they become independent.

Lynne stated that she feels like she never has enough time with patients and accomplish the necessary charting. She often has to stay late to make sure everything is up-to-date, but she often feels like she is drowning in paperwork

**General Thoughts and Comments**

The built in alarms are great (although it just comes up as an error + #) but one alarm could be because of a whole host of issues (a drop in blood pressure or a shift of the physical arm). The iPad will tell you what the error is (like arterial pressure) but doesn’t make suggestions on how to fix it. For example the machine detected a loss of flow from the dialysate bags but could not tell the users it was because of a kink (or the check for one).

Home hemodialysis seems a lot more pleasant; the patient was saying how a TV in the bedroom and everything will be great. Patient X’s wife mentioned reading in the room with him. Just seemed a lot more relaxed.

Activity Whiteboarding with Dr. Bowman

Location Dr. Bowman’s Office

Date & Time 10/25/2019 12:30PM - 1:50PM

Observers L. Chen, J. Bonaffini

**Activity Detailed Description**

Dr. Bowman spent time with us in his office to review the observations, and to come up with some very rough potential solutions. He also reviewed some of the more damaging or shortfalls of dialysis as well as some of the commercial solutions that are currently coming into the Renal space. We discussed the following topics:

Bard Wavelinq - solution for IR surgeons to create AV fistulas

* A lot less invasive than a vascular surgical method
  + No general anesthesia needed
* Taking away business from vascular surgeons — a political caveat where technology advancement can be hamstrung
* Waiting for the “perfect patient”
  + Dependent upon vascular structure
  + Don’t want to use this product on a low viability patient since the outcome can affect whether UVA picks it up as the main way to create anastomoses

Idea - Shower protector for cuffed catheters

* Huge quality of life issue for patients - unable to properly take showers because getting a catheter site wet is a huge risk for infection
* Must be peelable, waterproof, and easy to place

Issue - Patients that undergo in-clinic HD must endure the “long break” between treatments over the weekend

* 50% of deaths occur on Sunday and Monday
  + Either solute levels become out of balance or the dialysis treatment on monday “shocks” the system and often results in sudden cardiac death
* Heart death is not from vfib or some arrhythmia that is recoverable, but rather from pulseless electrical activity or some type of brachycardia
* Often a potassium disorder
  + Too high - example, eat a tomato and spike levels on saturday - unable to account for the change and death occurs sunday
    - Or the shock from going from a very high K, to a relatively low K after treatment monday is enough to cause cardiac death
  + Too low - go in for dialysis with an already low K level, resulting in more K being removed, resulting in a higher chance for cardiac death

Idea - Input sensor on dialysis machines for ions such as Na and K

* More personalized prescription given to patient so as not to shock them from a large change in ion concentration or continue to leave the patient outside normal solute ranges
* Labs are only done once a month and prescriptions often go years without changing (including K concentrations)
* Measure ion concentrations before treatment and adjust as necessary
* Keep the osmolarity of the dialysate constant by adjusting Na, so as to keep in line with the ultrafiltration goals
* Avoid fatal arrhythmias!

Dr. Bowman also mentioned the use of the pooled data from “Thrive”

* ICU data can be repurposed to check trends
* Rivanna is the name of the UVA supercomputer
  + “Ivy” is the secure part of Rivanna
* More screening as to why dialysis patients get hospitalized - is there a better marker for this or trend that may show why patients end up in the hospital
  + Idea - catch patients when they are showing bad signs as to avoid advancing to a stage where they need emergency treatment

Activity Shadowing in Interventional Radiology

Location Interventional Radiology Clinic- Floor 1 of UVA Hospital

Date & Time 11/6/2019 12:45PM - 4:45PM

Observers L. Chen, J. Bonaffini

**Activity Detailed Description**

We shadowed in Interventional Radiology for an afternoon. As we had before, we donned bunny suits and hair nets so as to keep the environment as clean as possible and prevent all possible infections. We observed from the control rooms, adjacent to each OR.

The first procedure we viewed was the end of a complicated Fistulagram. In this case, a placed stent in the cephalic vein had seen significant tissue build up in its interior. This necessitated a 4 hour procedure to scrape tissue from the stent interior to restore flow. One thing to note was that the stent was intended for an arterial system in which vessel walls tend to be more resilient. The fact that the stent wasn’t intended for venous-side procedures may have had something to do with the tissue buildup. An IR doctor informed us that there is a movement towards venous procedures and that companies are innovating for this purpose. When asked about the new Bard Wavelinq system, the doctor was interested in using it, but found that there were some “political issues” that were holding it back.

The second procedure we observed was of the treatment of an AV malformation that had resulted in significant fluid buildup. The procedure involved aspirating the fluid, filling the space with an antibacterial solution, letting it dwell for 40 minutes, and then aspirating that solution as well. Since this was a child, there was a special consideration into using the Fluoroscopy machine as little as possible, instead using ultrasound. Radiation was mostly used to take before and after pictures, or to guide the catheter into the more difficult-to-navigate sections of the AV malformation.

The final procedure we observed was the replacement of a cuffed femoral catheter. We were only able to see the beginning part of the procedure. Often femoral catheters are opted for in the case of Potassium being to high — being too close to the heart using a normal tunneled catheter near the heart could result in arrhythmias. Femoral catheters are also often temporary, however, in this case it was the primary, long-term vascular access for this dialysis patient. We observed the patient and sterile field get prepped before we had to leave for class.

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| People  (main groups of people) | Patient 1: Fistulagram: vessel had grown into a stent and caused a long procedure in IR.  Patient 2: Child  Patient 3: Dialysis catheter in leg | | | |
| Objects  (used by people and populate the environment) | * General sanitation is followed precisely and doctors must be helped getting dressed after sterilization   + Scrubs, apron, bunny suit, sanitize, gloves right on * OR must be darkened to see ultrasound images   + One monitor displays image that everyone must crowd around to see.   + Pretty mobile, can be pushed around and turned many different angles. * Needle and vials * Lots of sterile sheets and big plastic sheet to isolate the operating site. | | | |
| Environment  (surroundings & features) | * Can get quite cramped in the room with the number of people * James and I counted up to 5 different monitors displaying things at once | | | |
| Messages  (messages or conversation) | * BARD system on shelf —> “political” pushback * For an operation on a femoral catheter the doctors had to ask the patient to not touch his leg after being sterilized. Our hands naturally fall right where his catheter was. The table the patient was sitting on was also very thin not leaving much space to stretch or move or place hands elsewhere. | | | |
| Services  (services offered or available) | IVC Filter removal: Usually with a kit but sometimes you need to troubleshoot → in the past, troubleshooting caused a renal vein nick. | | | |

**Comments about User Experience**

IR permits rapid and varietal surgical experience. Patients can be in and out, with nothing other than local anesthesia in less than an hour, depending on the case. Thus IR is an expanding field that many patients (and referring doctors) are taking advantage of. Additionally, IR doctors are especially eager to try new devices, which may make for an engineering opportunity.

Class action lawsuit around IVC removal: where the filter never gets taken out and it becomes a problem.

I saw needle stick injury dangers in the form of a sterilized HCP would hold a vial with bare hands and the doctor with sterile gloves would aim and stick the needle into the vial. It’s 2 separate people and not very much stability.

**General Thoughts and Comments**

The display system for patients is really nice. It is listed by IR room # on the x axis and time on y axis. Graph is then filled out with patient boxes and what procedure is to be done/condition. The boxes then change colors according to status (arrival, triage, operating, recovery, etc.) It’s very easy to tell where people are and what stage they are at.

Activity Shadowing in Interventional Radiology

Location Interventional Radiology Clinic- Floor 1 of UVA Hospital

Date & Time 11/12/2019 8:00AM - 1:00PM

Observers L. Chen, J. Bonaffini

**Activity Detailed Description**

After arriving at the IR clinic, we were able to talk to some IR doctors a bit before observing some cases. Dr. El-Abd informed me of a missing quantitative measure of flow when assessing fistulas before and after intervention. He stated that most cases are referred due to patients experiencing prolonged bleeding (higher blood pressure from stenosed vein leading to difficulty in clotting) or increased venous flow.

We then stepped into the first case - a liver tumor embolism. An IR doctor demonstrated the methods used to guide the catheter to the target location. Dr. Angle took the lead in discerning the pathway of the artery using the fluoroscopy machine and a 3-D image fluoroscopy method. In this case, it was difficult to find the tumor “flush” and the catheter needed to continue to be advanced into the distal regions. Guiding the wire was challenging due to the specific curvature and 3-D topography of the vessels. Periodically as the guidewire is advanced, the catheter is advanced along with it. Once the catheter was positioned correctly, an oil and Contour embolism particles (Boston Scientific) was released into this distal section of the tumor to occlude the tumor vessels, causing the tumor cells to lose access to oxygen and nutrients and eventually die. The catheter was then retracted. This was all performed while the patient was awake.

The second case that was observed was a fistulagram. In this case, the patient came in for this procedure due to nurses having to “pull clots from the venous needle.” The patient had also previously been checked out for steal syndrome but this was ruled out. A sterile field was set up before the patient arrived, then the patient was brought in and moved to the IR bed. The patient had her arm with the fistula (brachial-cephalic fistula) prepared and a preliminary ultrasound done by a technician. The IR doctor then arrived, checked the ultrasound again, and inserted a catheter. Sets of images with contrast were taken to observe the arterial and venous flow. There was found to be no stenosis - at most a mild arch stenosis near the brachial arch. Another IR doctor came in to give a secondary opinion and came to the same conclusion.

The third case was liver ablation in the CT room with Dr. Angle. The room had a pale yellow mute lighting with a very narrow operating table. CT ended up not being needed (it gives better tissue resolution), visualization was done mostly using ultrasound to see the tumor. There was a glitch in the needle for ablation: you usually reset the needle in air but it didn;t register and they had to pull out the needle and reset it again.

The fourth case was a placement of a central line catheter (for stem cell treatment). General procedure is a placement of a guidewire into the central line and then sliding over every so widening catheter to enlarge the opening. A paper measuring was used to measure how far out the catheter line was from the patient. Wires come pre-measured in set lengths so they try to get the tunnels similar in length. They made sure the each port in the catheter was able to draw blood clearly with a syringe. A final stitch is used to keep the catheter in place. The sticky tape to isolate the operating site was very strong and definitely hurt the patient when it was taken off. Patient was in pain and conscious for the majority of the procedure. Even though the catheter for this patient was for stem cell treatment the doctor informed me that the procedure would be the exact same with a dialysis catheter but with a larger diameter tube and only 2 ports instead of three.

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| --- | --- | --- | --- | --- |
| People  (main groups of people) | Dr. El-Abd  Dr. Angle  IR technicians and nurses  Patients  Dr. Caleb  Other doctors that would stop in, view, and help with procedures when necessary | | | |
| Objects  (used by people and populate the environment) | Fluoroscopy machines  IR bed  Ultrasound  Sterile table  Scrub-in area  Monitors hung throughout the room  Control room with monitors and chairs | | | |
| Environment  (surroundings & features) | All of the case rooms (ORs) were equipped with fluoroscopy machines and other supplies necessary for a surgery. The control rooms were behind a lead wall/glass and darker than the case rooms. There were plenty of sterile supplies and lead aprons all around in case you needed to go into the OR at a moment’s notice.  There are 5 rooms total (7 after renovation in a different area of the hospital, equipped with an additional CT scanner per room), with a main hallway that is wide enough to roll in patients on hospital beds.  In general, IR was a very relaxed atmosphere - there wasn’t a ton of trauma or blood occurring since most work was performed via manipulation of catheters.  There were lines running on the floor and there is a trolley with a large surface for a large selection of tools, wires, and gaugze. | | | |
| Messages  (messages or conversation) | Discussion about how to proceed with the liver embolism case - many images had to be taken and compared so that the 2D fluoroscopy images could be correlated to 3D fluoroscopy images, PET image stacks, and MRI image stacks. The tumor was relatively small, so finding and navigating to the correct distal path was challenging. At one point, there must have been 8+ clinicians trying to figure out the plan. Dr. Angle was able to explain to us the strategy they used to find their way to the tumor via progressive contrast-enhanced imaging.  The fistulagram was much more relaxed - at most involving 4 clinicians. | | | |
| Services  (services offered or available) | Again, we were amazed at how many different procedures the doctors in IR were ready to perform. | | | |

**Comments about User Experience**

IR services are often treated with the same amount of value for the time since procedures are generally quick. In the case of the fistulagram patient that didn’t require any intervention, there were a lot of time and resources wasted. The procedure was scheduled for a 2 hour window and there were at least 3 clinicians that were directly involved in the case, with one doctor providing a second opinion regarding the necessity of intervention.

Patients for IR usually are very very conscious and awake. Pain is pretty common throughout these procedures with catheters and guide wires. There is some debate between using a nerve block vs general anesthesia. There was a patient that needed knee drainage that had to stop because it hurt too bad. There is generally very little anesthesiologist knowledge in IR.

**General Thoughts and Comments**

Paralleling with the neonatal cardiac team, the placement of catheters/ guiding wires through the vessels is not trivial and is often a source of complication.

IDEA for device: quantitative measurement device for fistula flow under similar loads as during dialysis

Activity ICU Rounds in Main UVA Hospital with Drs. Bowman and Okulo

Location UVA ICU

Date & Time 11/14/2019 9:00-11:00AM

Observers L. Chen, J. Bonaffini

**Activity Detailed Description**

During this set of rounds in the ICU, we saw different patients with kidney issues with Drs. Bowman and Okulo and a visiting medical school student on rotation. Each patient had different issues regarding their kidneys. Several of the patients had issues with keeping enough fluid in their circulation -- they would easily become hypotensive, resulting in insufficient treatment. This is especially bad for ICU patients because they are in more fragile conditions and hypotensive episodes can more easily shock the kidneys, causing further AKI.

In one case, a patient was on the same floor as the thoracic ICU and there was some clinical emergency taking place -- many clinicians were huddled in an adjacent room to the patient we were consulting. Some clinicians were wearing much more sterile gear than others and there was a crowd of extra equipment that had also been wheeled to the room.

Otherwise, most patients were not lucid enough to speak, even though Dr. Bowman attempted to do so, just in case they might be awake. In general, most of the time was spent outside the room going over the patients’ most recent specifics and developing a forward plan. One of the plans was difficult and showcases the complexity of the kidney -- a patient had low electrolytes and being put on dialysis might result in further lowering of osmolarity of the blood. This could cause nerve cell lysis, an irreversible process that can cause major damage. However, this patient had extremely elevated BUN, which could offset some of the extra loss in osmolarity from dialysis to prevent the cell lysis event. Still, it was a difficult decision to make, as there was a build-up in other toxins that are normally cleared by dialysis.There was another patient that had a hematoma which was causing a large reabsorption of K+ which was straining his kidney function.

Many patients were high fall risk/aspiration risk in addition to renal replacement therapy.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| People  (main groups of people) | Dr. Bowman  Dr. Okulo  Medical School Student  Patients, each in their own ICU rooms  Families of several patients  Other rounding doctors and students | | | |
| Objects  (used by people and populate the environment) | New type of dialysis machine we have not seen - Fresenius 2008T  Crit-line - measures hematocrit, but was apparently not all that helpful for predicting hypotensive episodes (which is why it was brought in the first place)  Lots of IV drips | | | |
| Environment  (surroundings & features) | Loud and crowded; many patient rooms were dark.  Patient status/ risks were often posted on the outside of the wall (sometimes written on the windows in erasable marker) | | | |
| Messages  (messages or conversation) | The doctors were mostly monitoring patients labs and ability to produce urine -- telling patients or their families the status  Mostly “wait and see” approach to AKI with CRRT while kidney function was offline  Ensure electrolytes were in the correct ranges  Check BUN - if there is too much “trash” in the blood, it would need to be taken out by dialysis (this was in conjunction with testing for return of kidney function after AKI)  Dr. Bowman often times told patients they were hopeful that they (us as the kidney team) would fade into the woodwork meaning hopeful recovery from AKI’s. | | | |
| Services  (services offered or available) | Rounds of clinicians, making plans for patients or consulting on next steps.  Administration/ recounting of medicines taken. | | | |

**Comments about User Experience**

Surgical Trauma ICU is very loud with a lot of commotion and people running about.

**General Thoughts and Comments**

There is a balance between how much fluid you can pull off of a patient and how fast the lymphatic system puts fluid back into the extracellular system.

Systemptoms again bleed over from one condition to another often times making it difficult to make clinical decisions.

Urine output is a large indication for doctors to assess kidney health and recovery.

PROBLEM: Patients can become hypotensive very easily when on dialysis and when too much fluid is getting filtered out

Activity Whiteboarding with Dr. Bowman

Location Dr. Bowman’s Office

Date & Time 11/15/2019 1:00PM - 2:00PM

Observers L. Chen, J. Bonaffini

**Activity Detailed Description**

During this discussion, Dr. Bowman detailed some of the issues related to the transition from conventional hemodialysis in a clinic to home dialysis. The challenge lies in making dialysis in general less miserable. Dr. Bowman brought up the idea of allowing patients to run their own dialysis and be a part of the care. This way, less nurses were needed to staff the clinics and patients could perform the procedure on their own time. There was emphasis placed on making patients more comfortable transition to hemodialysis.

Water purification in any kind of designing of dialysis is always a challenge → Dean Caimen.

We further discussed the dialysis vascular access idea in quantitatively measuring whether a stenosis was flow-limiting - often times a stenosis doesn’t become flow-limiting until a vessel is 80% stenosed.

Dr. Bowman also let us know about the massive amount of data that was available including blood pressures every 60 minutes during treatment as well as before and after, blood flow, dialysate flow rate, and medication given. This data could be used in a multitude of ways, such as the prediction of hypotensive episodes. Hypotensive episodes result in patients ending their treatment early, which is never a good thing for long term outcomes. There was talk of making more devices point of care like POCUS (ultrasound) but with electrolyte imbalance and estimating how much fluid to take off.

Dr. Bowman also told us about Kidney Week - a conference for kidney clinicians detailing the latest technology, best kidney-health practices, and other issues that are disney related. One of the neatest events Dr. Bowman saw was a talk by Dean Kamen about a new high-throughput tissue engineering startup.

IDEA: Patients have hypotensive episodes when too much fluid is being taken off using ultrafiltration

Activity Whiteboarding with Dr. Bowman

Location Dr. Bowman’s Office

Date & Time 11/22/2019 11:30PM - 12:15PM

Observers L. Chen, J. Bonaffini

**Activity Detailed Description**

This session was mostly spent reviewing the clinical challenges that we had compiled over the course of the semester. These include 25+ challenges related to diagnosing and prevention of CKD, End Stage Renal Disease care, vascular access considerations, and the transition to home dialysis. He supported all of our top options, saying they were right on-target in terms of improving kidney care and the current/changing policy environment. He expressed some concern with early detection of CKD just because it would be a large upheaval to get it integrated in the current healthcare system.

Dr. Bowman also spent some time discussing the policy consequences of the Executive Order on Advancing American Kidney Health. As a clinician that runs a number of UVA dialysis clinics, Dr. Bowman will be directly affected in the change to the payment models as well as the shift from conventional hemodialysis in the clinic to home dialysis. He explained the difficulty in persuading people to go on home dialysis compared to the clinic due to worries in not performing the procedure correctly or simply wanting someone to do the procedure for them. Dr. Bowman is optimistic that lives will be improved in this shift, but the pains associated with upending the current entrenched system may be considerable

**PROBLEMS**

* Patient Compliance
  + transportation/logistics
  + Eating/drinking before/during dialysis
  + Insufficient prescription
* Dialysis Technologies
  + Insufficient kidney replacement
    - Larger molecules left in the body
    - More intense treatment (only filtering 12 hours/week)
    - No hormones (patients often become anemic or develop mineral bone disease)
    - pH (Acid/Base)
    - Limited in fluid balance (kidney adjusts according to intake)
  + Home Dialysis
    - Many people don’t trust themselves (overwhelming at first)
    - Needle sticks are a barrier
    - Must have dexterity (or someone who has dexterity) and vision to do home dialysis (both PD and hemo)
    - Tube filling + dialyzer - make sure there are no bubbles
    - Caretakers become burnt out
    - Sometimes the more frequent home hemo will take out too many solutes such as phosphorus (the system isn’t “smart” enough to balance all the solutes in their respective clinically optimal ranges).
* Dialysis Access
  + Stenosis/Aneurysms
    - Need for Interventional Radiology
  + Infection
  + Aesthetic considerations
  + Caring for access correctly
* Annoyances
  + Taking off and putting on gloves to use dialysis machines
  + Cleaning machines\*\*
  + Compliance
  + Software system
* Early CKD/diagnosis
  + Unable to measure GFR correctly
  + Unable to diagnose CKD until late stage
  + Progression from ICU stays/ prevention?
  + Can not reverse kidney failure, only can preserve what’s there → but people come in stage 3 or worse.

**IDEAS**

* Fistula/graft/catheter surgery now that we’ve learned about it
* Another charge nurse round
* Diagnosis/ planned patient care
* Transplant and organ harvesting

Clinic

* Getting rid of nooks and crannies and cracks on machines → much easier to clean and helps prevent infections
* Where does the waste go? Can that be a useful source of information?
  + Measure Conductivity, flow rate, chemical makeup?
  + Measure total prescription progress

Home Hemodialysis

* Pre-filling tubing and dialyzer with saline and sterilizing it → less need for user force
  + Pre-filled syringes are already a thing → see if it’s translatable

Brainstorming with Dr. Bowman

* “Hoteling” patients - the patient runs their own dialysis in the clinic
  + Consider staffing, flexibility, etc.
* Vascular access health monitoring
  + Need to calculate flow inside vascular access to prevent unnecessary trips to imaging, IR, or surgery
  + Answer question - When does stenosis become flow limiting?
* Real-time risk assessment of Acute Kidney Injury while in the hospital
  + Protect kidney function / prevent rapid decay of function
* Early detection of Kidney disease
  + GFR estimation
  + Proteinuria - detection in the urinal via rapid urine testing
    - High protein in dilute urine is a sign of CKD (normalization of protein to other solutes) for example albumin normalized to creatinine.
    - Treat as public health problem → install screening puck in urinals
  + Prediction curve for each patient to hit their target level of tacro or epogen for example.

Brainstorming with Dr. Rahman

* Early detection of Kidney disease
  + Assessing renal function with creatine right now but need more specific and sensitive biomarkers.

**QUESTIONS**

* Why is kidney disease diagnosis so late for many patients? See <https://www.kidneyx.org/> where it says 48% of people with CKD don’t know that they have it
  + How valuable Is it to know in advance to prevent further degradation?

**THINGS WE STILL NEED TO SEE**

* Transplant
* Nutritionist/ Dietician
* Vascular Access Placement

**TEMPLATE**

Activity

Location

Date & Time

Observers L. Chen, J. Bonaffini

**Activity Detailed Description**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| People  (main groups of people) |  | | | |
| Objects  (used by people and populate the environment) |  | | | |
| Environment  (surroundings & features) |  | | | |
| Messages  (messages or conversation) |  | | | |
| Services  (services offered or available) |  | | | |

**Comments about User Experience**

**General Thoughts and Comments**