Renal Team Clinical Challenges

List of 25 possible Clinical Challenges identified through Observations

Early Detection/ Diagnosis (3)

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|  | Clinical Challenge | Description |
| 1 | Kidney function assessment is lacking | Creatinine and BUN are only proxy biomarkers for kidney function and do not fully assess possible issues with the kidney. |
| 2 | GFR estimation is poor | GFR is a functional cornerstone of kidney function that remains difficult to measure. It often takes a special test wherein a patient must carefully follow a procedure to use inulin to measure the function |
| 3 | Many patients do not seek advanced kidney care until late stage Chronic kidney disease | Most kidney care is performed after a patient has reached stage 3 or 4CKD, resulting in a lot of already-lost kidney function that could have been prevented. |

Preservation of Kidney Function (2)

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|  | Clinical Challenge | Description |
| 4 | Acute kidney injury is not always prevented in the ICU even when it is a possibility | Patients, prior to having a procedure performed, could have a kidney ligation procedure to prevent "shocking" of kidney that may cause AKI and progress into ESRD |
| 5 | Patients with CKD/are on dialysis often have comorbidities that can conflict with kidney care recommendations | Many CKD patients are hypertensive, diabetic and have cardiovascular issues, where the treatments for those illnesses can be detrimental to remaining kidney function |

Vascular Access (5)

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|  | Clinical Challenge | Description |
| 6 | Vascular access function measurement is imprecise | Clinicians send patients to have their access (fistula) assessed by IR very frequently, not knowing if a stenosis is actually flow limiting. IR surgeons perform fistulagrams and feel compelled to perform angioplasties. Flow is measured qualitatively instead of quantitatively |
| 7 | Technique used in IR to get medication sterile in syringe is a hazard | The outside vial of medication is unsterile and is held by a HCP with bare sanitized hands as the doctor in gloves aims the syringe needle to puncture the vial: huge needle stick hazard. |
| 8 | Catheters are difficult to keep dry | Catheters that get wet lead to infection.  Due to this constraint there is a rather large restriction on quality of life: no swimming and limited ways to shower. Keeping the area clean and dry in these risky scenarios is of utmost importance. |
| 9 | Visualizing and tracking a catheter through vessel networks is difficult | Visualization techniques in IR does not map 3D CT scan images to 2D fluoroscopy images leading to confusion to difficulty in placing the catheter in the correct vessel region |
| 10 | Patients can be in extreme pain during a catheter placement in IR | No or very little sedative is used during catheter placement in IR. A lot of physical force is needed to thread the catheter tubing through the subclavian vein. The operating site was secured through a strong adhesive sheet |

Renal Replacement Therapy (RRT) (In clinic) (11)

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| 11 | Dialysis is an insufficient therapy for those with ESRD  Please Note:  We do not think we have enough time to re-engineer dialysis or a different Renal Replacement Therapy (RRT).  This simply points out the deficiencies of dialysis | * Dialysis only filters out smaller molecules; larger waste molecules are often left in the body * Kidneys function continuously 24/7; dialysis is condensing all the filtration work into 12 hours * Kidneys produce important hormones such as erythropoietin, calcitriol, and renin that dialysis does not and often contribute to additional illness states such as anemia and mineral & bone disorder. * Insufficient pH control (electrolytes) * Limited fluid balance control (non-dynamic prescription) |

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|  | Clinical Challenge | Description |
| 12 | Diets are difficult to manage as a CKD patient | Patients with different deficiencies must consume/avoid certain foods - coming up with a plan that can provide the patient some flexibility/quality of life while also avoiding patient complications is challenging |
| 13 | Brady-arrhythmias are difficult to detect or predict in dialysis patients | Dialysis patient mortality often results from brady-arrhythmias |
| 14 | Access to dialysis is limited by the strict schedule requirements (often restricted by nurse staffing) | Since clinics can only host patients at specific times of the day depending upon open slots, patients are having to dialyze at times that conflict with their schedule.  This results in worse compliance. If there was more flexibility, patients might be more compliant. |
| 15 | It is difficult to keep hemodialysis machines clean. | The machines have lots of nooks and crannies on them and blood pressure cuffs are used for all the patients that sit in that chair that day. Lots of sanitation is needed and the nooks increase risk of transferring illnesses through blood. |
| 16 | Patients often do not complete their dialysis treatment | Patients can eat or drink large amounts of food or liquid before treatment that often makes them feel sick. They then request that they end the treatment early. |
| 17 | Hypotensive episodes during dialysis lead to the patient ending treatment early | Hypotensive episodes are difficult to predict in dialysis patients during dialysis.  If ultrafiltration is too aggressive, it can cause a hypotensive episode. |
| 18 | Dialysis patient electrolytes can swing drastically or be shifted into dangerous regions due to dialysis treatment after “The long break” | Electrolyte concentrations drastically swinging or being left outside the normal range lead to bad outcomes. Labs are usually only taken once a month and do not sense electrolyte variability day to day. |
| 19 | Dosing is difficult for drugs which take days or weeks to take effect | Epogen and tacro are frequently guess work when it comes to giving a prescription. It is not uncommon to see levels overshoot because it is difficult to predict how a patient will react. |
| 20 | Patient electrolyte concentration is uncontrolled during the long break | Variability in a patient's day to day diet can lead to electrolytes being outside the normal range. |
| 21 | Patients do not complete their treatment because they arrive late to the dialysis clinic | Patients often come late to appointments due to logistical challenges. This often leads to patients not getting their full treatments. |
| 22 | Clotting can interrupt treatments | Heparin is currently given either through several doses or continuously; however, each patient has different guidelines on when to administer the drug. |

Transition to home dialysis (6)

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|  | Clinical Challenge | Description |
| 23 | Home dialysis is under-utilized.  Explore: Sticking someone with a needle mental barrier to home hemodialysis | HHD is a relatively low utilized (less than 5%).  There must be better persuasion or ease of transfer to home dialysis in order to hit the executive order target of 80% of new dialysis patients by 2025 |
| 24 | Home dialysis patient caretakers get burned out | Caretakers can get burned out by how frequently dialysis is needed for the patient; it is ultimately constant can a lifelong commitment. |
| 25 | Home hemodialysis machine tubing easily becomes kinked | Kinks in tubing will set off and restart the dialysis machine |
| 26 | Home dialysis is under-utilized.  Explore: Good vision and dexterity are barriers to home dialysis | A caretaker or a patient who possesses good vision and dexterity is needed for home dialysis to manipulate the tubes and, in the case of home hemodialysis, “build” (setup) the dialysis machine |
| 27 | Infection is common with home peritoneal dialysis | There are 2 sterile connections patients themselves have to make with the Fresenius stay safe organizer.  This exchange of connections has a high chance of infection if improperly performed. |
| 28 | It is difficult to remove the air bubbles from home hemodialysis tubing | Caretakers need to be aggressive with tubing to fill with saline and rid it of air bubbles. |

Transplant

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|  | Clinical Challenge | Description |
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List of "favorite" Challenges and rationale for their selection.

(3) Many patients do not seek advanced kidney care until late stage Chronic kidney disease

This is a relatively unexplored part of kidney care. The techniques for evaluating kidney function are few and far between.  We want to tackle this issue as a “public health issue” - kidney disease is not an illness that has much recognition. There are advantages to preventing further degradation of kidney health in order to avoid renal replacement therapy. There is a lot of room for creativity and out of the box engineering thinking here.

(6) Vascular access function measurement is imprecise

All measurements of vascular access (fistula) function are qualitative.  Once patients are sent to Interventional Radiology to be examined, surgeons feel compelled to perform angioplasty because there is no way of confirming if a stenosis are flow-limiting.  Having a baseline “before” measurement and comparing to an “after” measurement would be valuable in assessing the usefulness of procedures and nail down if a stenosis is the true reason for low flow in a fistula.

(18) Dialysis patient electrolytes can swing drastically or be shifted into dangerous regions due to dialysis treatment after “The long break”

Currently patient electrolyte levels are checked once a month through labs; these screens are expensive and time consuming, which is why they don’t happen every time the patient is dialyzed. Major changes in electrolyte concentrations or leaving electrolyte concentrations outside normal ranges, especially potassium, are presumed (but not scientifically confirmed) to lead to worse outcomes.  If doctors had a way to measure concentrations on a per-treatment basis, they would change dialysate prescriptions accordingly.

(27) Infection is common with home peritoneal dialysis

There can be two parts to this problem and both are interesting. One issue is the two mechanical transfers of sterile connections that PD UVA patients must make with the existing peritoneal dialysis organizers. Patient error may cause this frequent infection. The other is early detection of infection by analyzing effluent fluid or some other detection mechanism.

Preliminary Pugh Chart

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|  | Patient Prevalence | Feasibility to complete in class | Likelihood or ease of Clinical use | Ease of integration into non-clinical settings | Financial Impact | Total |
| Many patients do not seek advanced kidney care until late stage Chronic kidney disease | 5 | 3 | 5 | 5 | 3 | 21 |
| Vascular access function measurement is imprecise | 2 | 2 | 4 | 2 | 5 | 15 |
| Dialysis patient electrolytes can swing drastically or be shifted into dangerous regions due to dialysis treatment after “The long break” | 4 | 2 | 4 | 3 | 3 | 16 |
| Infection is common with home peritoneal dialysis | 3 | 5 | 3 | 5 | 3 | 19 |