HIMSS

Davies Award of Excellence Case Study
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Use of AI-enhanced data analysis to identify persons at risk of chronic kidney disease, assist in delivery of kidney-protective therapeutics and reduce hospitalizations

Intermountain Health

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Executive Summary

Intermountain Health Kidney Services (IKS) was realized through a collaboration of Intermountain Health and MDClone to change how we care for individuals with chronic kidney disease _23_23(CKD) and improve their lives. Central to this new approach Is the implementation and maintenance of an effective, data-driven, AI-enhanced analysis that focuses on identification and risk stratification of each individual. Coupled with a dedicated multispecialty group of healthcare workers, patients are empowered through

education and understanding and treated with the latest kidney-protective modalities. Unique to our approach, early outreach and care coordination is leveraged to facilitate an as-soon-as-possible approach to providing kidney protective therapeutics.

To achieve this goal, MDClone worked with clinical and operational leaders in Kidney Services to deploy algorithms that accurately identify CKD patients by stage and stratified them by gaps in care and time from last encounter. This set the foundation for a data-driven referral program where MDClone and Actium Health produced a patient engagement tool to prioritize and coordinate outreach. Intermountain Kidney Services is then positioned to leverage MDClone to track and manage these patients by action, outcome, and cost.

Working with MDClone to identify persons with CKD, the Intermountain multispecialty Nephrology care team sought to determine the appropriate CKD-staged diagnosis and implement a patient centered CKD stage specific action plan inclusive of stage appropriate patient education, stage specific care, and kidney protective SOC therapeutics including ACE inhibitors, ARBs and SGLT2 inhibitors. Also, due to demands of the pandemic, both CKD clinic and education encounters were offered in-person and as video visits. CKD education was also adapted to COVID restrictions by creating internet-based education opportunities including 1:1 remote education and online on-demand video education. Processes were developed to promote a consistent standard of work within the clinic regardless of location or provider. Also, as opportunities of quality improvement became evident, multidisciplinary committees were established to evaluate and make recommendations for process improvement including meeting weekly to review care and established processes.

Over the course of our first 3 years, we have exceeded our goal of proper risk stratification, delivery of education and CKD heath literacy, and implementation of kidney protective treatments. Although early in our follow up, we have realized a consistent stabilization in kidney function and reduction in admission rates within our clinic.

Like many clinics since 2019, we experienced challenges and learned lessons not just related to our project but also through working within a global pandemic. Many individuals in the U.S. are unaware of their risk of CKD and often find themselves in end-stage renal disease without ever being aware of a problem. Early in the course of our clinic we learned this is a difficult message for persons to hear from a clinic they have never gone to in the past. By partnering with their trusted primary care providers, we optimized outreach. Forging these relationships through education also engendered stronger ties between patients, the kidney clinic, and PCPs. Similarly, through early recognition of the impact COVID restrictions were placing on traditional provider-patient interactions, we effectively pivoted to online resources for education as well as remote, often at home, video-based clinic visits. Because we prioritized the patient even over the interaction, we were able to continue to provide care to our established and newly identified patients. Through the COVID pandemic our clinic consistently grew the number of patients under the care of each of our providers.

Some of the notable results achieved over the course of the partnership to-date include:

1. 80.3% of patients seen in the IKS CKD clinic received a KDOQI DQI (Kidney Disease Outcomes Quality Initiative) staged diagnosis, whereas only 33.3% did prior to establishing our clinic.
2. 78.3% of CKD stage 3-5 patients cared for in the IKS CKD clinic received ACE/ARB therapy, up from 31.6% at the time of referral. This successful implementation of ACE/ARB standard of care (SOC) therapy was also realized across CKD stages and exceeded 80% in stages 3a and 3b.
3. Identification and early engagement of CKD patients enabled early intervention and an approximate 50% reduction in admissions to 19%, surpassing our target of 50%.
4. Among the patients who presented with stage G3A or G3B, none progressed to dialysis.

Define the Clinical Problem and Pre-Implementation Performance

Intermountain Health and MDClone worked collaboratively to enable AI-enhanced informatics to properly identify individuals with chronic kidney disease (CKD) as a means to improve risk stratification and implementation of renoprotective therapies to improve morbidity and mortality within this population.

Patients with CKD are known to have an increased morbidity and mortality rate despite high resource utilization. The CDC has estimated that up to 15% of the US adult population has CKD and up to 90% are unaware of the diagnosis (1) resulting in a lower-than-expected penetrance of known beneficial therapeutics. In 2019 D Murphy and colleagues reported only 40.1 % of NHANES survey participants with known CKD received SOC ACE/ARB therapy between 2011-2014 (2) underscoring a significant opportunity for improved care within the CKD population.

Within the Medicare population, persons with CKD have substantial annual cost proportional to the stage of CKD. Honeycutt et al reported a $12,700 annual individual cost attributable to stage 4 CKD in 2013 (3) expanding to $81 billion nationally in 2018, or 22.3% of Medicare's annual spending (4) much coming from inpatient care. Unlike the equivocal improvements seen in value based primary care nationally (5), significant decreases in both readmission rates and Medicare payments were realized in the Comprehensive End Stage Renal Disease Care program's five years of reporting (6, 7). We feel a similar opportunity exists within the CKD population.

In Utah, the prevalence of CKD amongst adults was 2.6% in 2020, close to the national 2.9%, and was highest at 6.6% in ages 65+, lower at 2.8% in ages 45-65 and 1.1% in ages 18-44. A strong inverse relationship between income level and CKD prevalence was also reported: in persons with income of <$25,000 CKD prevalence was 4.8%; at $25-$49,999, 3.7%; at $50-$74,999, 2.8%; and at 75,000+, 1.9%, similar to national trends (8). Complicating this social determinant is the high percentage of rural and pioneer communities in Utah limiting access to care.

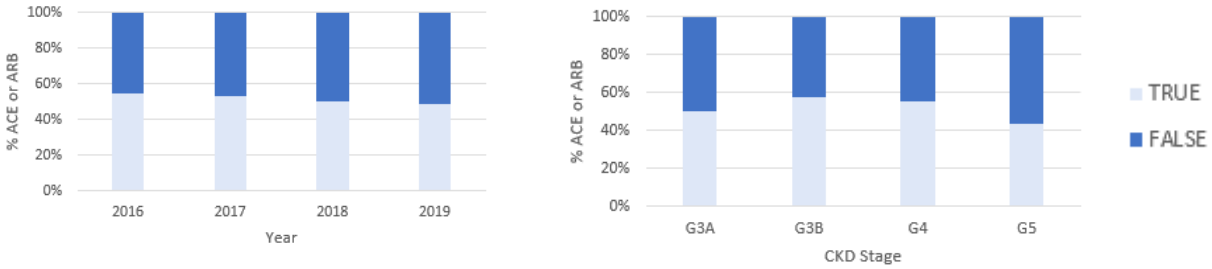
In early 2018, MDClone and Intermountain Kidney Services (IKS) kicked off a project to certify & identify CKD patients by stage in order to analyze the current SOC across the health system. Through the project, the team collaborated to design and deploy a set of proprietary algorithms within iCentra (the Cerner

EHR platform), and SelectHealth claims data to retrospectively, and eventually prospectively, analyze system adherence to the CKD care process models via MDClone's ADAMS Platform. Clinical criteria based on practicing knowledge, published guidelines including the 2021 CKD-EPI creatinine equation, and a pragmatic approach to electronic data workflow and collection led to the ability to establish a validated CKD diagnosis. Patients were also staged on earliest date-time inclusion and on subsequently reflected temporal clinical staging over time (see Design & Implementation).

2021 CKD-EPI Equation for Glomerular Filtration Rate (GFR)

Sex	Serum Creatinine (mg/dL)	Equation
Female	≤0.7	$GFR = 142 \times (Scr/0.7)^{-0.241} \times 0.9938^{Age} \times 1.012$
Female	>0.7	$GFR = 142 \times (Scr/0.7)^{-1.200} \times 0.9938^{Age} \times 1.012$
Male	≤0.9	$GFR = 142 \times (Scr/0.9)^{-0.302} \times 0.9938^{Age}$
Male	>0.9	$GFR = 142 \times (Scr/0.9)^{-1.200} \times 0.9938^{Age}$

Through this algorithm, the team was able to retrospectively identify 12,797 adults with CKD stage 3-5 between 2016-2019 prior to establishing the Intermountain Health Kidney clinic. The KDOQI CKD stages are a widely accepted classification system of 5 stages spanning near normal to non-dialysis end stage kidney failure. Only 60% of these individuals carried any ICD10 diagnosis of CKD and only 53.7% were diagnosed according to KDOQI CKD stages. 51.7% overall were treated with kidney protective ACE/ARB therapy which improved only marginally when comparing those with specialized Nephrology care to those without; 54.5% vs 48.9%. The penetrance of ACE/ARB utilization varied little from year to year and across stages of CKD.



Recognizing that changes in mortality and morbidity would take time to be realized, we targeted improvements in the delivery of the SOC processes through procedural care quality measures, which were reported to be tied to improved CKD outcomes including diagnostic and therapeutic outcomes (9-15). Diagnostic procedural outcomes included establishment of KDOQI staging of CKD in the system-wide problem list and provision of Kidney Disease Education for improved CKD health literacy. Therapeutic procedural outcomes included delivery of kidney protective SOC including ACE/ARB and SGLT2 as well as goal directed hypertension therapy to meet SOC set in KDOQI and ESC guidelines. Since admission rates could be impacted within the initial 3 years of this program, we monitored that as well.

The clinical quality measure targets are 55% diagnosis by KDOQI CKD stage, 60% utilization of kidney protective SOC ACE/ARB therapy and 75% delivery of patient-centered CKD education. Recognizing the difficulty in defining reliable base-line blood pressure and meaningful changes, we sought to better understand how informatics can improve upon this data point.

Also, as will be discussed, over the course of this initiative, real-time changes to SOC (e.g., SGLT2 inhibitors) and delivery of care (i.e., COVID restrictions) forced us to alter both our care delivery protocols and the fundamental therapeutic encounter.

1. Centers for Disease Control and Prevention. Chronic Kidney Disease in the United States, 2021. Atlanta, GA: US Department of Health and Human Services, Centers for Disease Control and Prevention; 2021
2. D Murphy et al., JASN 2019; 30(7) 1314-21
3. Honeycutt etal., JASN 2013, sept 24(9); 1478-83
4. J Sundstrom et al, Lancet vol 20 June 29,2022
5. K Sullivan etal., Stat July 26,2022
6. D Ullman et al., Health Affairs; 41 (6); 2022; 893-900
7. CMS.gov; comprehensive ESRD care Model [innovation.cms.gov/innovation-models/comprehensive-esrd-care]
8. America's Health rankings website: https://www.americashealthrankings.org/explore/annual/measure/CKD/state/UT and CDC behavioral Risk Factor Surveillance System
9. Mendu, M etal., Jasn, 31, 602-14, 2020
10. Zhang, Y etal., Drugs; 2020; 80(8); 797-811
11. Wheeler, DC et al, Diabetes Therapy 2020; 11(12);2757-74.
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13. Qu X etal., Front. Pharmacol., 2021; vol 12; 1-12
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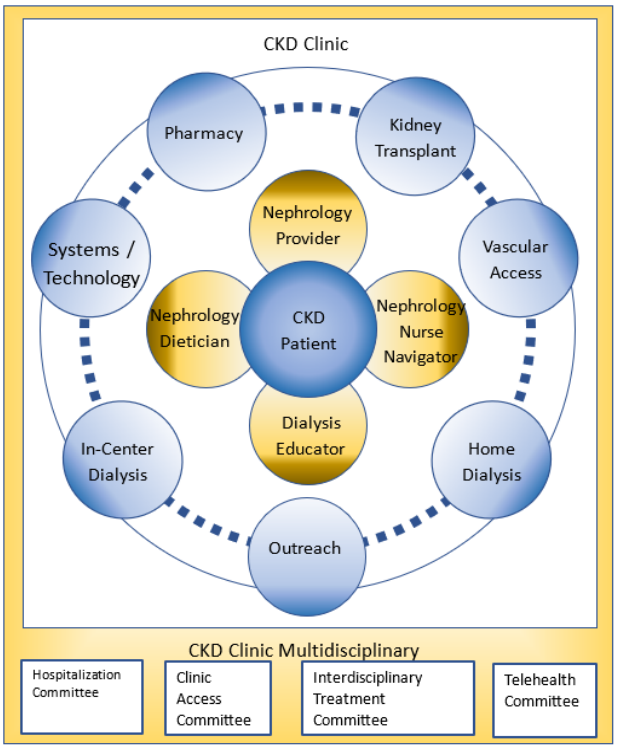
15. Lv, J etal., CMAJ; 2013; 185(11);949-957

Design and Implementation Model Practices and Governance

Within the IKS-MDClone collaboration a multidisciplinary team was needed to optimally identify patients with CKD, deliver quality evidence-based care, and measure outcomes as a result of proactive interventions. Keeping the CKD patient at the center of the process was critical to improving the outcomes.



Through the use of MDClone's proprietary algorithms, Intermountain Health EHR and SelectHealth data are analyzed retrospectively and prospectively to identify CKD events and at-risk individuals by performing the following workflow:

- Check if a patient record has at least one inclusion criteria and add the patient to the cohort of CKD at the earliest date-time that criteria is met.

Inclusion Criteria and Date-time of Inclusion	
Criterion	Date-time of inclusion
Criterion 1 At least 2 results of eGFR<60 ml/min/1.73m2, at least 90 days apart, where there is no eGFR>=60 between the first eGFR<60 and the second eGFR<60	Date-time of first eGFR

OR

Criterion 2 At least 2 diagnoses of CKD recorded at least 30 days apart.	Date-time of first diagnosis

The algorithm creates the following properties characterized by above inclusion criteria:

CKD Stage identification - Columns/Properties	
Column/Property	**Description**
CKD event date-time	Date-time of a CKD event.
CKD 'onset' date-time	Date-time of CKD 'onset' (based on data available to the algorithm).
CKD stage	G1, G2, G3a, G3b, G4 or G5.
CKD stage numeric	1, 2, 3.1, 3.2, 4 or 5.
CKD stage (calculated & 'certain')	G1, G2, G3a, G3b, G4 or G5. This field contains a value when eGFR changed by at least 25% (drop or rise) from previous/baseline.
CKD stage numeric (calculated & 'certain')	1, 2, 3.1, 3.2, 4 or 5. This is the numeric counterpart of "CKD stage (calculated & certain)".

CKD Stage identification - Columns/Properties	
eGFR (2021 CKD-EPI creatinine)	Calculated eGFR in ml/min/1.73m2 (from serum/plasma/blood creatinine).
Criterion for CKD onset identification	"eGFR" or "Diagnosis"
Age at event	Patient's age at 'CKD event date-time.'

- Add additional events for every inclusion criterion met with subsequent diagnostic values excluding AKI episodes defined by MDClone's AKI algorithm.

Inclusion Criteria for AKI Event Start Date-time and End Date-time	
Criterion for start date-time	Date-time of inclusion
Serum creatinine > 1.3mg/dl **AND** Derivative of serum creatinine ($\lvert \Delta Cr/\Delta t \rvert$) > 0.1 **AND** The difference between the maximum and minimum of serum creatinine during the AKI episode is >= 0.31	The collection date-time of the first serum creatinine result that satisfies inclusion criteria.
Criterion for end date-time	Date-time of inclusion
10 days after start date-time with no derivative of serum creatinine > 0.1 **OR** Serum creatinine < 1.1mg/dl **OR** Serum creatinine result is the last instance of a serum creatinine recorded for the patient **OR** Length of the AKI episode reached 90 days.	The collection date-time of the last serum creatinine result that satisfies inclusion criteria.

- CKD stage progression is assessed each time calculated eGFR changes by at least 25% from previous baseline unless occurring during an AKI episode during which potential calculated stage variation will not reflect the true trajectory of stage progression.

Implicit in the above algorithm, the underlying etiology of CKD (i.e. primary vs secondary causes) is not considered. This was intentional to minimize the confound specific etiology identification could have on algorithm accuracy. Successful computer-enhanced identification of individuals with CKD, regardless of etiology, would allow a greater referral throughput to the IKS CKD clinic. Then, after CKD was identified and risk stratified by the

MDClone algorithm, the underlying diagnosis could be evaluated, and etiology-specific therapies implemented on a case-by-case basis in the IKS CLD clinic.

The relationship between MDClone and Intermountain was important in oversight of data governance and data management. Developed and monitored via a close two-way relationship, continuous quality checks were performed by MDClone and validated clinically by Intermountain Health Nephrologists. And ongoing monthly collaborative meetings review algorithm consistency in candidate identification & risk stratification and clinical performance.

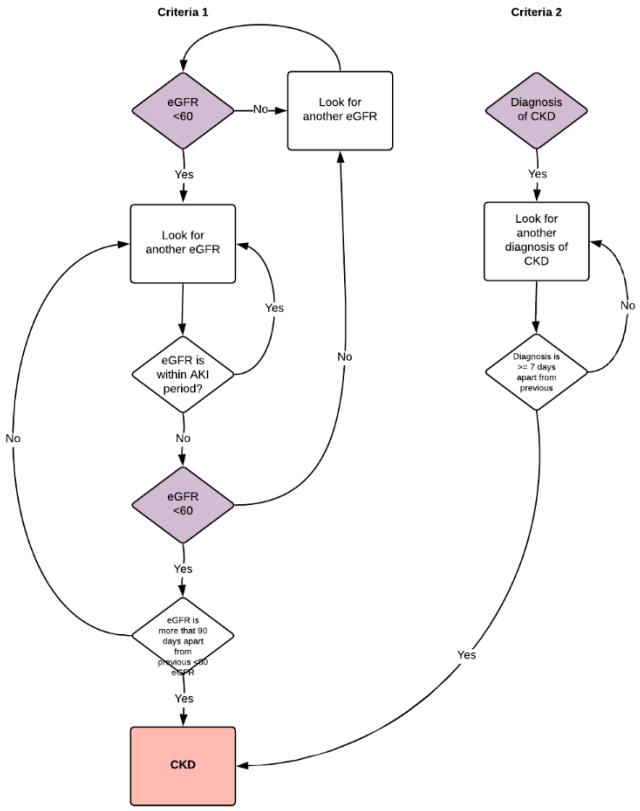
Once at-risk individuals are identified, IKS Nurse Navigators work with Nephrology and Primary Care Providers to notify patients. Some of these individuals are then referred, either through MDClone assisted or more traditional pathways, and are evaluated in the patient-centered multidisciplinary CKD clinic. Through rapid evaluation of kidney function and urine albuminuria screening, a CKD diagnosis is validated and staged by the KDOQI DQI followed by CKD education. CKD SOC therapies are considered, implemented, or dose adjusted as part of the initial and follow up visits. CKD care is provided by the Nephrology provider, Nurse Navigator, dietician, and dialysis educator to meet each patient's needs. At times supportive services become involved as well.

Care guidelines were implemented in the clinic to rapidly adopt SOC kidney protective therapeutics including ACE/ARB and goal directed hypertension therapies. This approach allowed us to rapidly adopt SGLT2 therapy in CKD when it was first recommended as SOC in late 2020. Also, due to demands of the pandemic, both CKD clinic and education encounters were offered in-person and as video visits. CKD education was also adapted to COVID restrictions by creating internet-based education opportunities including 1:1 remote education and online on-demand video education. Processes were developed to promote a consistent standard of work within the clinic regardless of location or provider. Also, as opportunities of quality improvement became evident, multidisciplinary committees were established to evaluate and make recommendations for process improvement including meeting weekly to review care and established processes.

The IKS CKD clinic providers included Nephrologists and Nephrology APRNs, and PA-Cs. Providers worked closely with Nephrology Nurse Navigators and Medical Assistants to maintain clear communication and limit errors of omission. Working collaboratively with MDClone allowed continual screening for individuals with CKD not seeing other nephrology providers as well as track impacts of process improvements on rates of kidney protective therapies. Weekly Interdisciplinary Team meetings were in place to discuss patients at risk of progression or with meaningful changes in health status. Staff also met weekly to discuss process improvements. Often joining these meetings were individuals with expertise in IT, Telehealth, Billing, Dietary, and Nursing to help keep the patient the center of the care process.

Clinical Transformation enabled through Information and Technology

A challenging obstacle in creating a successful CKD Clinic program is the poor diagnostic penetrance that exists in this population. Up to 15% of the US adult population has CKD with close to 90% unaware of the diagnosis (16). The MDClone AI enhanced CKD algorithm identified individuals with markers of a CKD diagnosis and without established Nephrology care. Next, Nephrology Nurse Navigators coordinated with PCPs to provide POC education and establish care with an IKS Nephrology provider. Additional CKD patients entered the CKD clinic by the traditional provider- or self-referral pathways.



Intermountain Kidney Services worked collaboratively with MDClone ahead of clinic launch (September 3rd, 2019) to deliver AI based patient identification and risk stratification. The algorithm facilitated outreach and access to patients, monitoring the adherence to the standard of care adherence, referral for pre-emptive transplant, home dialysis first policy, and referral to home training centers and satellite clinics.

Leveraging MDClone's algorithms for temporal nature of stage and other clinical factors, we were able to analyze the population over time from 2016 to present. MDClone ADAMS platform builds data and allows for self-service interrogation of data longitudinally with patient (rows) and clinical features (columns) in focus as they receive care over time.

Entered stage 4 or 5	Low eGFR (17) 5.7 M ago; ACR: 948.5 (64 M ago); F Age 23; Cerebrovascular Disease ; Chronic Pulmonary Disease ; Diab
Entered stage 4 or 5	Low eGFR (14) 6.8 M ago; ACR: 7376.2 (18 M ago); M Age 29; Diabetes Mellitus ; PCR = 6; UAlb = 545.1; UProtein = 406;
Entered stage 4 or 5	Low eGFR (15) 6.3 M ago; ACR: 6998.1 (14 M ago); M Age 34; Congestive Heart Failure ; Diabetes Mellitus ; Peripheral Vi
Entered stage 4 or 5	Low eGFR (14) 7.5 M ago; ACR: 1383 (6 M ago); F Age 35; Diabetes Mellitus ; PCR = 5.5; UAlb = 730.1; UProtein = 500; Re
Entered stage 4 or 5	Low eGFR (19) 3.2 M ago; ACR: 40.5 (3 M ago); F Age 41; Diabetes Mellitus ; Liver Disease ; Peptic Ulcer Disease ; UAlb =
Entered stage 4 or 5	Low eGFR (10) 17.3 M ago; No ACR; M Age 57; Diabetes Mellitus ; Peptic Ulcer Disease ; UProtein = 100; Rethinopathy ;
Entered stage 4 or 5	Low eGFR (12) 6 M ago; ACR: 6929.8 (7 M ago); M Age 51; Diabetes Mellitus ; PCR = 15.7; UAlb = 395; UProtein = 500; Re
Entered stage 4 or 5	Low eGFR (15) 3.6 M ago; ACR: 343.7 (4 M ago); M Age 52; Diabetes Mellitus ; UAlb = 26.6; UProtein = 100; Rethinopath
Entered stage 4 or 5	Low eGFR (14) 18.8 M ago; No ACR; M Age 69; Cerebrovascular Disease ; Liver Disease ; UProtein = 30;
Entered stage 4 or 5	Low eGFR (12) 3.5 M ago; ACR: 1583.2 (5 M ago); F Age 62; PCR = 1; UAlb = 73.3; UProtein = 100;
Entered stage 4 or 5	Low eGFR (20) 19.5 M ago; No ACR; F Age 64; Cerebrovascular Disease ; Chronic Pulmonary Disease ; Liver Disease ; Pep
Entered stage 4 or 5	Low eGFR (29) 26.1 M ago; No ACR; M Age 29; UProtein = NEG;
Entered stage 4 or 5	Low eGFR (18) 7.8 M ago; ACR: 8378 (4 M ago); M Age 48; Diabetes Mellitus ; Liver Disease ; Peripheral Vascular Disease
Entered stage 4 or 5	Low eGFR (18) 5 M ago; ACR: 3071.7 (2 M ago); M Age 70; Cerebrovascular Disease ; Congestive Heart Failure ; Malignar
Entered stage 4 or 5	Low eGFR (29) 10.5 M ago; No ACR; F Age 42; Cerebrovascular Disease ; Chronic Pulmonary Disease ; Diabetes Mellitus ;
Entered stage 4 or 5	Low eGFR (14) 4.9 M ago; ACR: 6937.7 (16 M ago); M Age 59; Diabetes Mellitus ; PCR = 9.3; UAlb = 657; UProtein = 500;
Entered stage 4 or 5	Low eGFR (30) 5.7 M ago; No ACR; M Age 35; Cerebrovascular Disease ; Chronic Pulmonary Disease ; Congestive Heart F
Entered stage 4 or 5	Low eGFR (19) 2.1 M ago; No ACR; M Age 68; UProtein = 6.3;
Entered stage 4 or 5	Low eGFR (21) 3.9 M ago; ACR: 24.5 (20 M ago); M Age 61; Liver Disease ; Peptic Ulcer Disease ; PCR = 0.5; UAlb = 2.6; U
Entered stage 4 or 5	Low eGFR (27) 18.4 M ago; ACR: 76.9 (19 M ago); F Age 49; Diabetes Mellitus ; Myocardial Infarction ; PCR = 0.6; UAlb =
Entered stage 4 or 5	Low eGFR (21) 4.6 M ago; ACR: 754.5 (5 M ago); M Age 59; Congestive Heart Failure ; Diabetes Mellitus ; Myocardial Infa

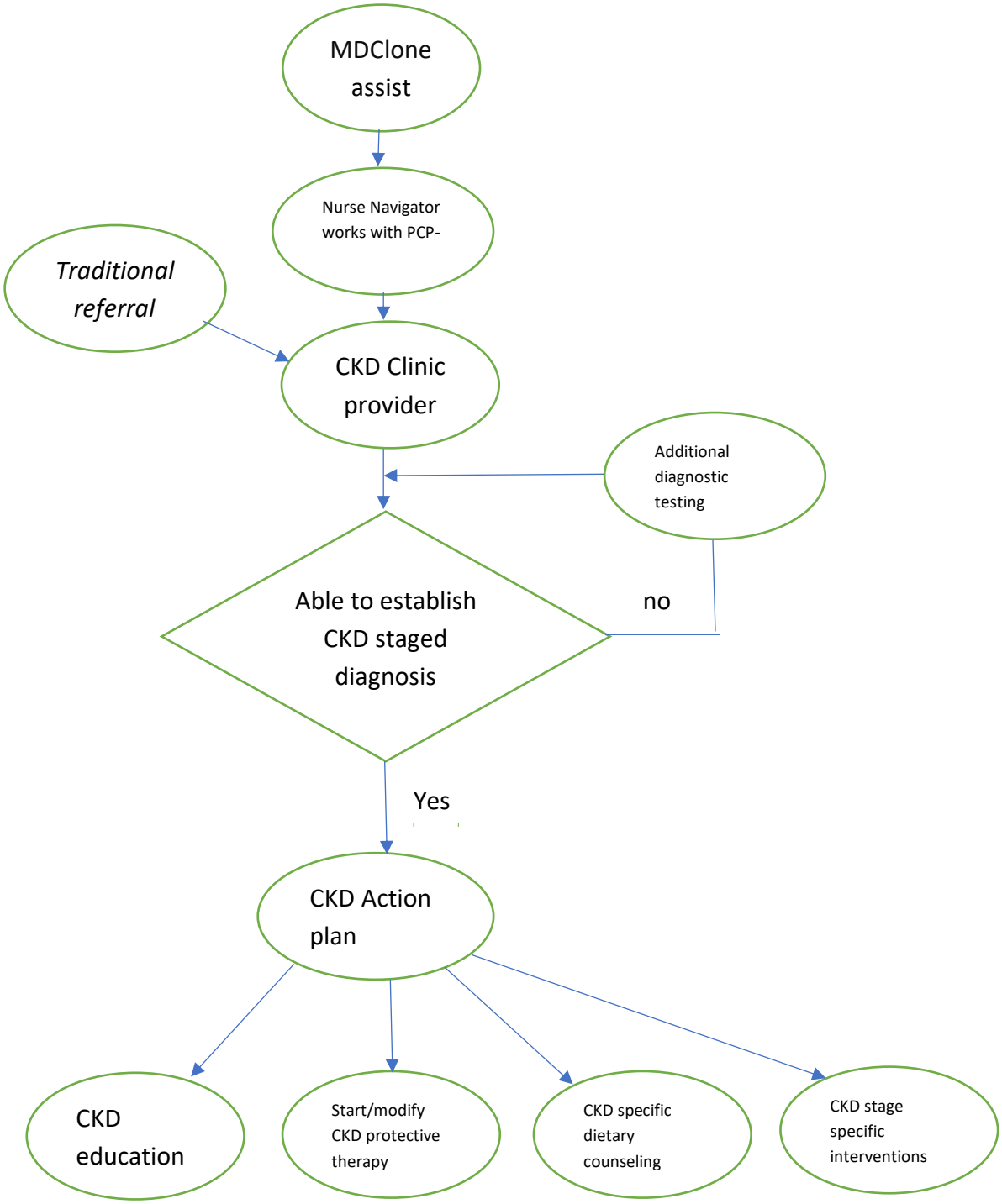
The initial risk stratifications were split by severity and KDOQI class addressed by priority: Stage 4 and later, Stage 3B, and patients in all stages lost to follow-up within last 18 months. For example, SelectHealth patients entering CKD Stage 4 with at least 2 claims in the last 18 months would be stratified by baseline characteristics and documented diagnostic information.

In the first year post-launch, Intermountain Kidney Services saw 1,322 adults identified with CKD stages 3-5 through AI enhanced review of medical records. 2% had no diagnosis of CKD and only 33.3% of patients had a correct KDOQI DQI stage diagnosis.

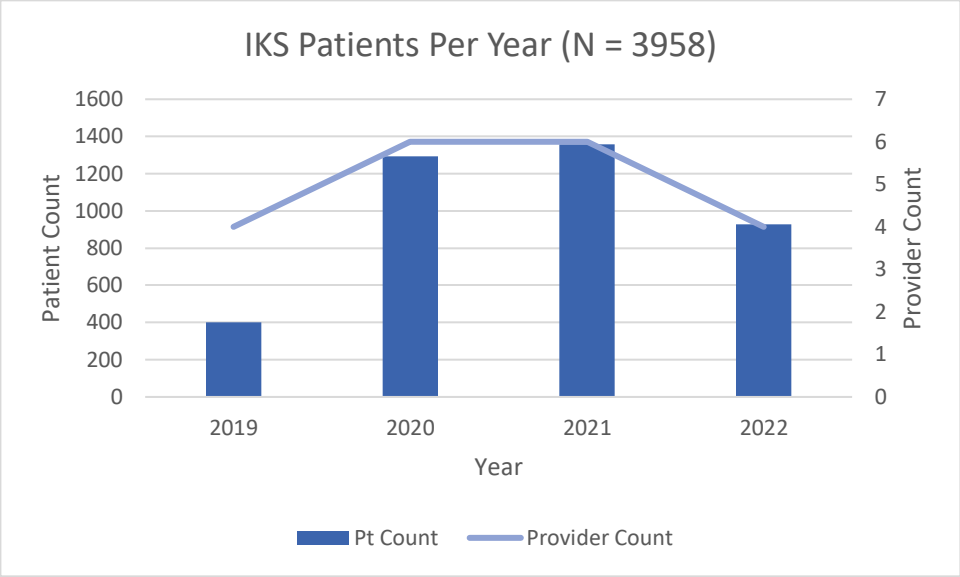
Once CKD severity is determined and holistic patient profile analysis is established, a patient-centered CKD action plan can be developed including appropriate implementation of kidney protective therapies. We found that only 52.9% of identified CKD patients were receiving ACE/ARB therapy prior to referral. Thus, after the MDClone proprietary CKD algorithm identified and properly diagnosed and risk stratified individuals, those evaluated in the CKD clinic would have a CKD action plan formulated including implementation of SOC kidney protective treatments like ACE/ARB therapy when applicable. The CKD action plan includes a multidisciplinary approach to CKD care including diagnostic testing, pharmaceuticals, hypertension management, CKD stage specific education, dietary counseling, cardiovascular risk assessment and reduction. The action plan may also include ancillary care including palliative care, vascular surgery, and kidney transplantation in those with advanced CKD.

Our goal of successful delivery of quality CKD care starts first with improved diagnostic specificity. 80.3% of patients seen in the IKS CKD clinic received a KDOQI DQI staged diagnosis, whereas only 33.3% did prior to establishing our clinic. The KDOQI CKD stages have been validated to predict both CKD progression as well as all-cause mortality and are a cost-effective means of risk stratification across a population.

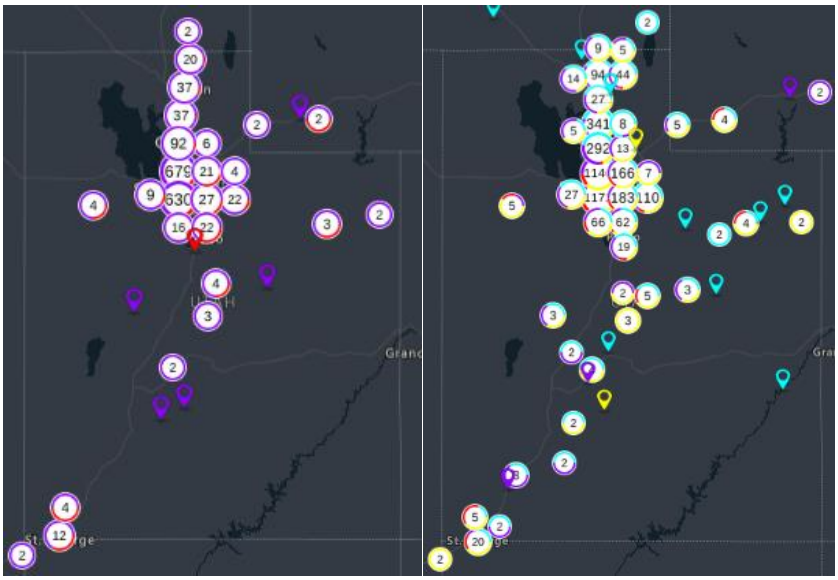
Opportunities of quality improvement within the CKD action plan were evaluated with MDClone. We found only 31.6% of CKD-diagnosed individuals were receiving ACE/ARB SOC therapy prior to referral. Factors contributing to this high rate of under treatment likely include access to care as well as poor health literacy and other causes. It is well established that poor health literacy both exists within the CKD population and is associated with worse outcomes (17, 18), Although we were unable to electronically define CKD health literacy prior to IKS CKD clinic referral, we did identify this as a quality improvement area. Part of the CKD action plan is CKD stage appropriate education. All individuals with CKD received education on CKD including the stages of CKD, interventions to improved kidney care as well as behaviors to avoid future kidney damage. Those that progress to the more advanced stages 4 and 5 received additional education on available dialysis modalities, kidney transplantation, as well as palliative care.


MDClone assist
Nurse Navigator works with PCP-
Traditional referral
CKD Clinic provider
Additional diagnostic testing
Able to establish CKD staged diagnosis
no
Yes
CKD Action plan
CKD education
Start/modify CKD protective therapy
CKD specific dietary counseling
CKD stage specific interventions

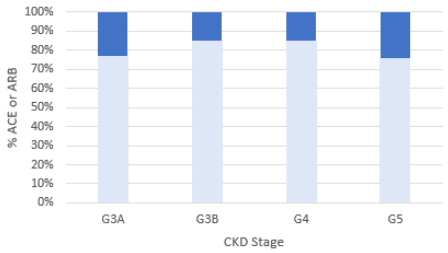
In large part due to the COVID-19 pandemic, we recognized that required in-person visits were a significant barrier to delivery of CKD care. Rapid adoption of telehealth within our clinic including home nursing and mobile lab draws allowed us to increase the number of patients we cared for throughout the pandemic including those in more remote areas or with mobility challenges.



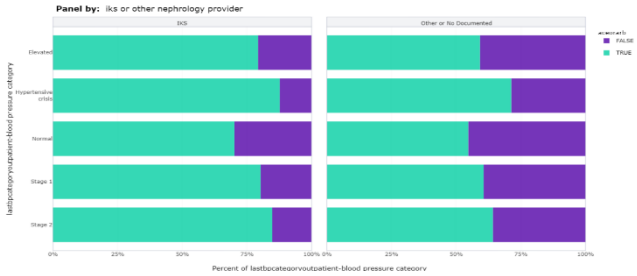
This growth was especially notable for those individuals living rurally more than 50 miles from the CKD clinic. In the following images, patient location is noted in 2019 (left) and from 2019-2022 (right) across Utah.



78.3% of CKD stage 3-5 patients cared for in the IKS CKD clinic received ACE/ARB therapy, up from 31.6% at the time of referral. This successful implementation of ACE/ARB SOC therapy was also realized across CKD stages and exceeded 80% in stages 3b and 4 (see next page).



Further, ACE/ARB therapy was implemented across stages of hypertension more often than patients with CKD not seen in our clinic (see below). The standardized practice of incorporating ACE/ARB therapy in the CKD action plan, involvement of patients in this decision through education and discussion, and by maintaining clinic access, contributed to the high rate of ACE/ARB utilization.



Hypertensive crisis when Systolic >= 180 or Diastolic >= 120, Stage 2 when Systolic between 140 and 179 or Diastolic between 90 and 119, Stage 1 when Systolic between 130 and 139 or Diastolic between 80 and 89, Elevated when Systolic between 120
and
129 and Diastolic < 80, and Normal when Systolic < 120 and Diastolic < 80.

Our proactive, patient centered action plan acts as a vehicle through which established SOC interventions and therapeutics can be provided to promote kidney protective interventions. The utilization of ACE/ARB therapy results include:

1. Within the first 3 years of the IKS CKD clinic, 80.1% of patients with CKD received a CKD staged diagnosis per KDOQI guidelines.
2. Within the first 3 years of the IKS CKD clinic, 79.2% of CKD patients were receiving ACE/ARB therapy compared to 31.6% in the three years preceding the clinic's opening and 54.8% in CKD patients not cared for in the clinic.
3. Within the first 3 years of the IKS clinic, more patients with hypertension and CKD were receiving ACE/ARB therapy than patients seeing a non-IKS nephrologist or under no nephrology care.

16. ***Centers for Disease Control* and Prevention. *Chronic Kidney Disease in the United States, 2021. Atlanta, GA: US Department of Health and Human Services, Centers for Disease Control and Prevention; 2021***

17. ***Taylor DM etal, NDT 2018 33(9) 1545-58***

18. ***Fraser SDS etal., NDT 2013;28(1):129-37***

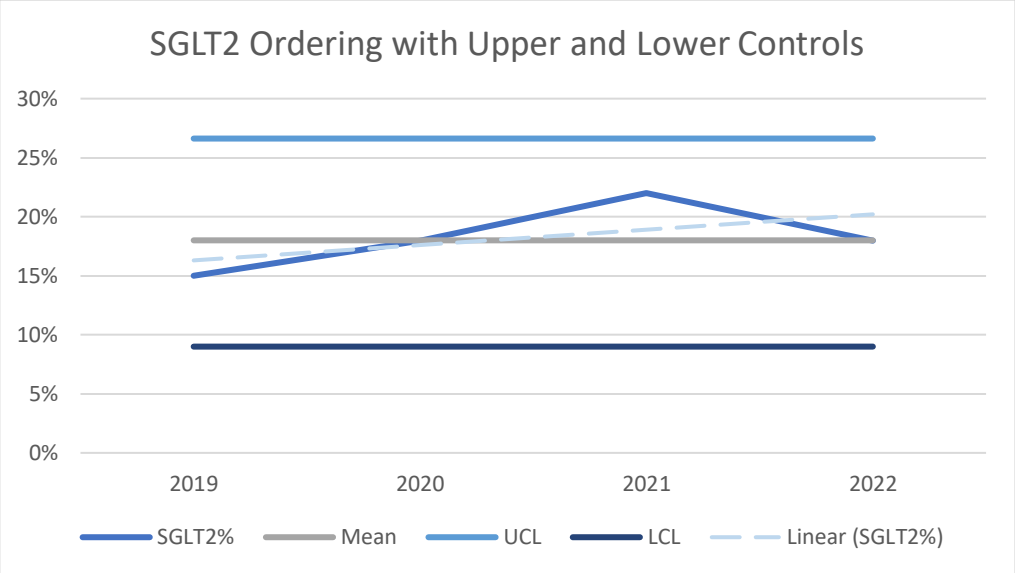
Improving Adherence to the Standard of Care

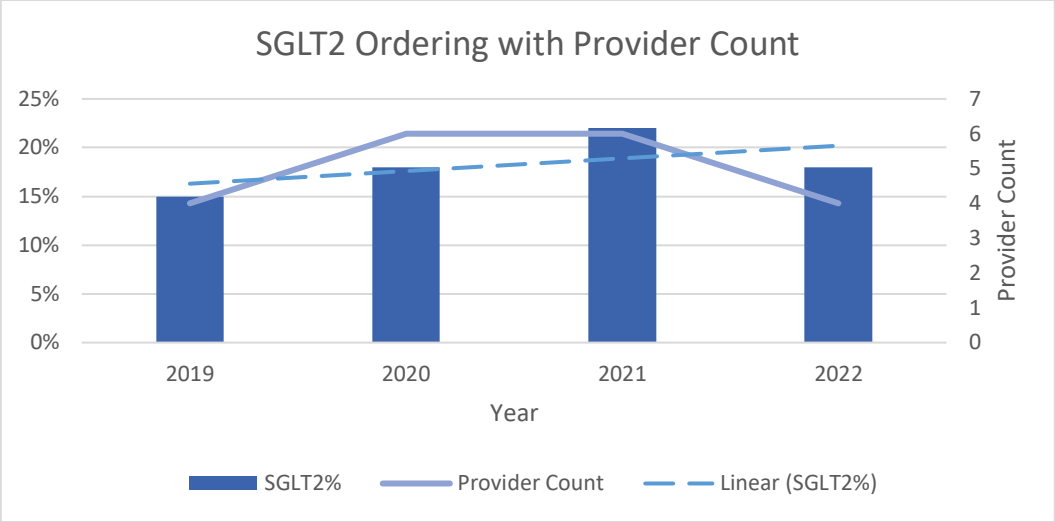
Intermountain Health and MDClone worked collaboratively to enable AI-enhanced informatics to properly identify individuals with chronic kidney disease as a means to improve risk stratification and implementation of kidney protective therapies to improve our patient's morbidity and mortality.

The core component of the Intermountain Kidney Services CKD Clinic program is the identification and diagnosis of persons with CKD relying on both proactive AI enhanced database searching and reactive traditional referral pathways. Based on this diagnosis, a CKD action plan is implemented including CKD stage specific care, CKD stage appropriate patient education, and kidney protective SOC therapeutics including SGLT2 inhibitors. On the heels of implementing our initial case study in CKD management, the DAPA-CKD trial was released in September 2020 heralding a new class of kidney-protective medications, the SGLT2 inhibitors (19.). Utilizing the multidisciplinary infrastructure developed to successfully increase the use of ACE/ARB therapy, providers within Intermountain's kidney clinic were able to be early adopters of SGLT2 therapy. In one example of adhering to the SOC for SGLT2, even though we experienced a slight decrease in providers, our trending data continues to support stability in the utilization of SGLT2 inhibitors as part of the SOC.

The numerator is the number of individuals seen in the IKS CKD clinic with SGLT2 therapy prescribed; the denominator is the number of patients cared for in the IKS CKD clinic with an AI assisted diagnosis of CKD.

The adherence to the standard of care within the CKD action plan as well as clinically driven evidence-based care processes are managed with clinically relevant analytics and weekly to monthly meetings to address multidisciplinary team compliance and obstacles in patient care.



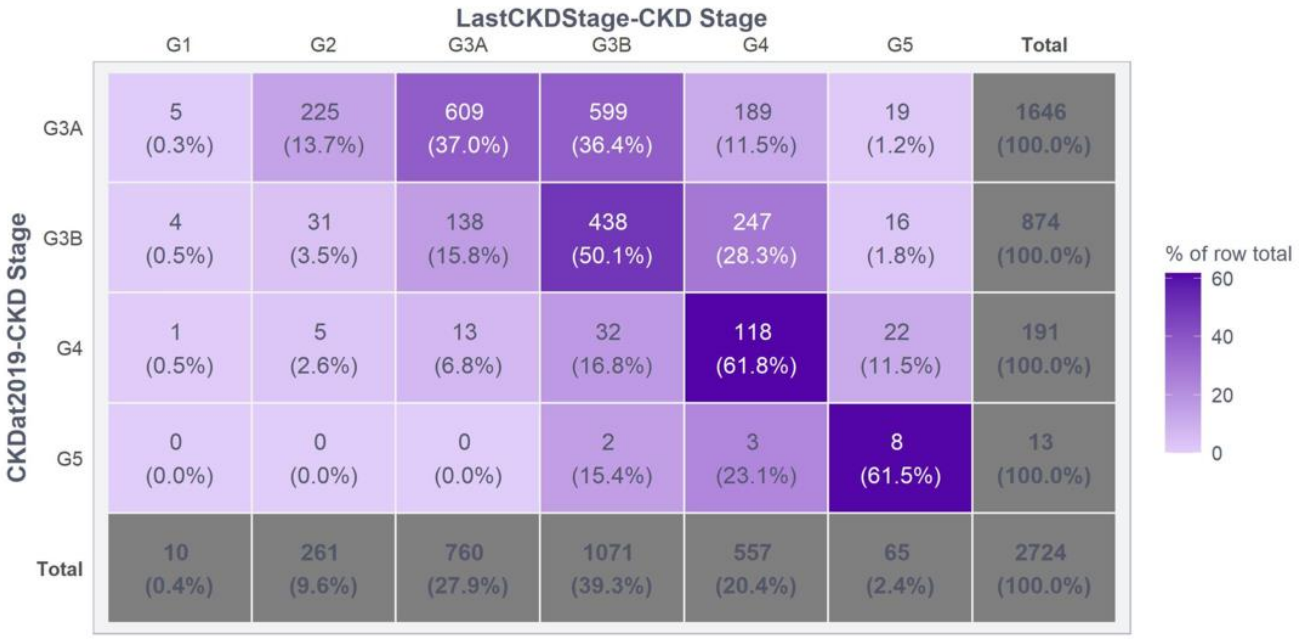


19. ***Centers for Disease Control* and Prevention. *Chronic Kidney Disease in the United States, 2021. Atlanta, GA: US Department of Health and Human Services, Centers for Disease Control and Prevention; 2021***

Improving Patient Outcomes

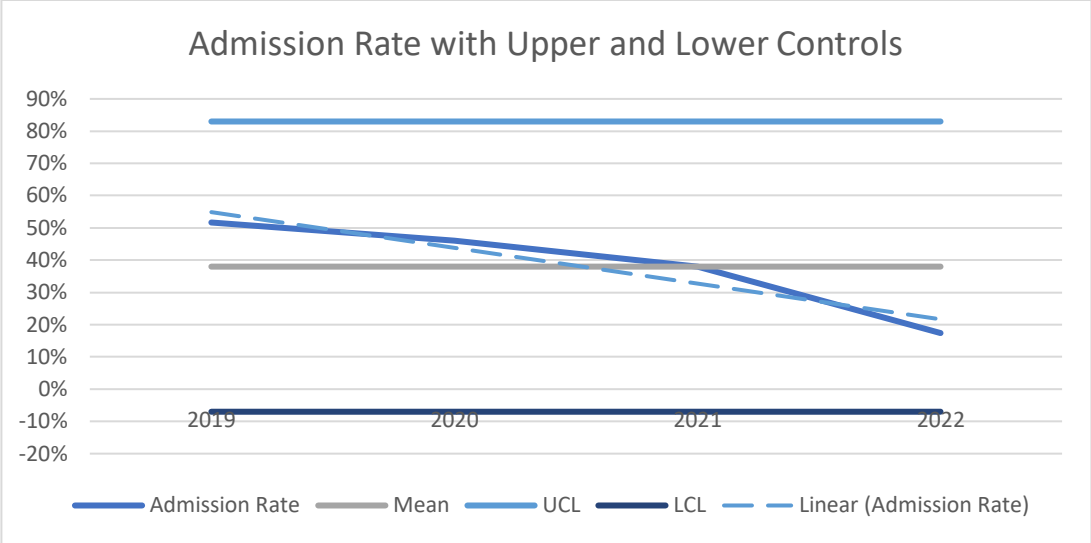
Recognizing that changes in mortality and morbidity would take time to be realized, we targeted improvements in delivery of SOC through procedural care quality measures reported to be tied to improved CKD outcomes including diagnostic and therapeutic outcomes (9-15). Diagnostic procedural outcomes included establishment of KDOQI staging of CKD in the system-wide problem list and provision of Kidney Disease Education for improved CKD health literacy. Therapeutic procedural outcomes included delivery of kidney protective SOC including ACE/ARB and SGLT2 as well as goal directed hypertension therapy to meet SOC set in KDOQI and ESC guidelines.

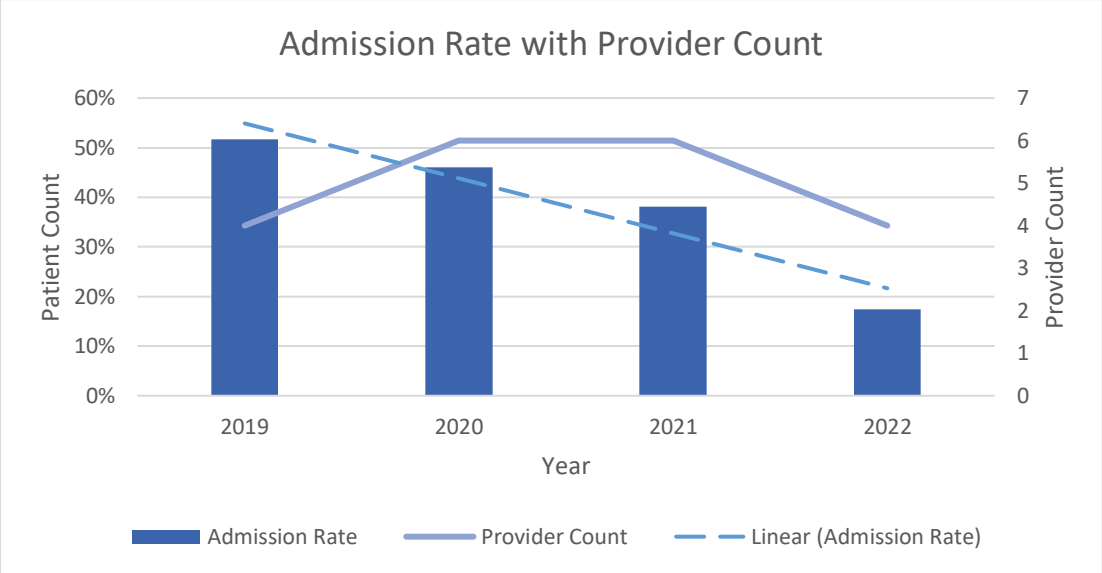
Preliminary analysis shows a positive outcome in delay of stage progression since 2019 as seen in the frequency table below. This figure presents patients stratified to their CKD stage upon referral on the left side and their final stage at most recent lab in purple. The majority of patients that did not progress to dialysis remained at or better than their CKD stage at the time of referral.



There is a statistically significant relationship between the two categories (Chi-Squared p-value < 0.001), though a moderate association is seen between the variables in effect size (Cramer's V = .309). It is important to note that smaller frequencies with less than 5 observations reduce accuracy. Further modeling around progression and IKS interventional impact is in progress.

In addition to impact on stage progression, there has been a significant reduction in yearly admission rates for patients cared for by the IH Kidney clinic:





Accountability and Driving Resilient Care Redesign

Weekly multidisciplinary team meetings were performed to identify lapses in care and obstacles in individual delivery of care. Within these meetings, individual patients are organized with regards to kidney relevant events including eGFR progression, admissions, dialysis modality education and decisions, and initiation of dialysis. (See representative image below). Participating in these meeting include CKD care providers, Nephrology nurse navigators, dieticians, and clinic office manager. Guest participants have included palliative care providers, mental health providers, dialysis providers, telehealth providers and cardiology providers.

A weekly care process meeting is attended by CKD providers, Nephrology nurse navigators, Nephrology administrators, CKD clinic manager, clinic staff and dialysis providers at times. Guests have included providers in other specialties, IT professionals, pharmacists, and others. Discussions within this venue often continue within subcommittees directed at specific elements of clinical activities including hospitalization, clinic access, and telehealth implementation.

From these discussions, we have established care triggers based on progression of CKD defined as a change from CKD stage 3b to 4 and from stage 4 to 5. Upon transitioning to stage 4, dialysis modality education and preparation as well as kidney transplantation consideration and education are initiated. Upon transition to stage 5 CKD, patients are further prepared to start on dialysis.

The adherence to the standard of care within the CKD action plan as well as clinically driven evidence-based care processes are managed with clinically relevant analytics and weekly to monthly meetings to address multidisciplinary team compliance and obstacles in patient care.

To scale the current care study and expand the benefits realized, Intermountain is currently increasing the number of Nephrology Clinicians and number of clinic sites. We are also continuing to evaluate additional opportunities to partner with MDClone to leverage computer enhanced data analysis in more timely detection of CKD while in stage 1 and 2 and partner with primary care sites to implement earlier kidney protective therapeutics, Our success in CKD stages 3-5 validates our approach to continue to streamline and reinvent the delivery of Nephrology care.

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