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| RESEARCH ARTICLE

Comprehensive Approach to Improve Quality of Life in Hemodialysis Patients by Early Creation of Arteriovenous Access

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| ABSTRACT

An arteriovenous fistula (AVF) is the closest to the ideal model of vascular access. Evidence suggests that people who approach end-stage kidney disease may have an arteriovenous fistula surgically created proactively, enabling the elimination of Permcath insertion for dialysis. Consequently, this proactive action will reduce the risk of bacteremia and admissions to inpatient services for this vulnerable population. The current mean waiting time for AVF creation in King Fahd Armed Forces Hospital, Jeddah (KFAFH), was 172 days**.** The aim of the project was to decrease the adult Chronic Kidney Disease patient mean waiting time for arteriovenous (AV) access creation from a mean of 172 days to less than 10 days within 12 months. The project was carried out in the Chronic Kidney Disease patient population of King Fahd Armed Forces Hospital, Jeddah. The Plan Do Study Act rapid cycles Quality improvement method was used to implement changes. The interventions include a multidisciplinary approach as the base for the new AVF strategy. Identification of CKD Stage IV patients with impending dialysis was booked for early AVF, thereby reducing the need for Permcath. An additional renal clinic was established to update the patients waiting time for AVF creation and to book patients as Day-surgery through fast track. Daily rounds in the dialysis unit were introduced to address issues of new patients on hemodialysis, and the waiting time for each patient was revised and booked to the new renal clinic for AVF creation. This reduced the referral time to the vascular clinic. Centralized approach by requesting early venogram & venous mappings. The addition of a dedicated inpatient bed for advanced access surgery like AV graft, superficialization, and bridging for patients on anti-coagulation was allotted. Addition of a dedicated operating room for at least daily AVF creation apart from the regular operating list. Addition of 1 more day to existing 1 day per week schedule for Day case procedures with 2 day surgery beds for vascular access. During the 1st PDCA cycle, the mean waiting time for AVF Access decreased to 127.75 days; during the 2nd PDCA cycle, the mean time decreased to 34.25 days, and during the 3rd PDCA cycle the project achieved proactive AVF access with the mean waiting time at -7.2 days. None of the patients with newly created AVF access developed steal syndrome during the project period. AV fistulae have a longer median survival, require less costly and invasive intervention to maintain patency and are less likely to become infected than AV graft or Permcath. A multidisciplinary team approach proved to be successful in reducing the mean AVF waiting time for hemodialysis patients. The interventions enable the team to perform proactive AVF creation in a timely manner eliminating the use of Permcaths for newly admitted Hemodialysis patients. Thus, reducing the CLABSI rate.

| KEYWORDS

Arteriovenous fistula, arteriovenous Graft, Permcath, Chronic Kidney Disease, Quality of life, hemodialysis.

| ARTICLE INFORMATION

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1. Introduction

1.1 Problem Description

A baseline retrospective data analysis was conducted for the period 1 January 2018 to 31 December 2019 to evaluate the contributing factors to catheter related infections. The following target areas were the focus of the study: Identification of risk factors, including vascular access, catheter days, history of bacteremia, immunosuppressive therapy and corpuscular hemoglobin.

Infections are common complications among patients on chronic hemodialysis. Hemodialysis patients with a catheter have a 2 to 3 fold increased risk of hospitalization for infection and death compared with patients with an arteriovenous fistula or graft.

Catheter-related bloodstream infections (CRBSIs), exit-site infections, and tunnel infections are common complications related to hemodialysis central venous catheter use.

Catheter-related bloodstream infections (BSIs) alone have a reported incidence of 1.1 to 5.5 episodes per 1000 catheter days and are associated with increased morbidity, hospitalization, and death.[1]

Barriers to increasing arteriovenous fistula (AVF) creation prompt the initiation of this project. Inadequate pre-ESRD care. A nephrologist often sees ESRD patients for the first time immediately before initiating long-term dialysis (29). In these cases, a PTFE graft often is constructed to avoid the 4- to 6-month maturation time required for an AV fistula. The central venous catheter is the first mode of access for 61% of ESRD patients compared with 15% for AV fistulas.

The ESRD program currently lacks senior management motivation to promote pre-ESRD medical management and preventive services among our dialysis population. Relatively few surgeons perform the AV fistula procedure due to a scarcity of surgeons in the KFAFH with proficiency in constructing AV fistulas, resulting in a shortage of capacity to establish this mode of access.

Diagnostic imaging is not used adequately to construct an AV fistula. Evidence base guidelines call for preoperative imaging to assess the appropriateness of AV fistula and facilitate construction. Preoperative imaging involves the use of Doppler ultrasound or low concentration contrast that allows for venous mapping.

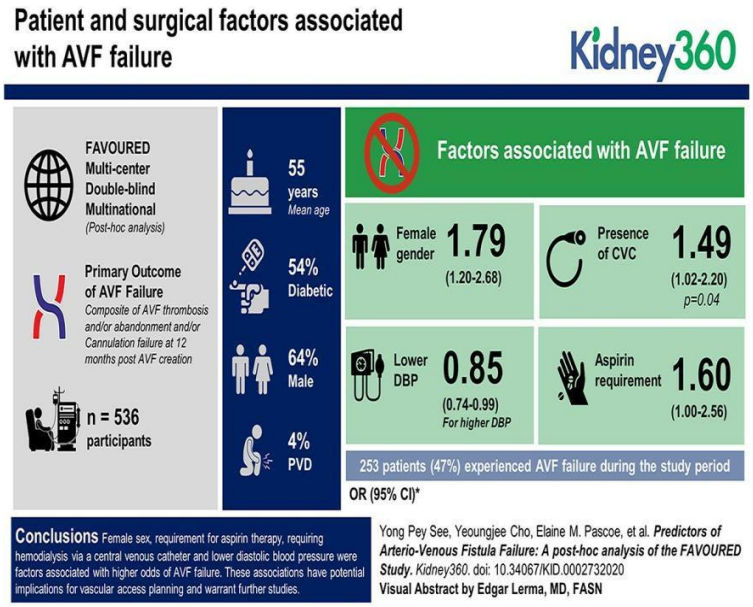
The use of preoperative imaging carries the potential to increase rates of AV fistula construction as surgeons are able to gain a better understanding of the patient's vasculature before surgery).
Surveillance of established AV fistula is spotty, leading to higher than necessary rates of failure; Surveillance is bundled as a component of the composite reimbursement for hemodialysis. Only one manufacturer (Fresenius) makes vascular access flow monitoring available as part of routine hemodialysis therapy. Flow surveillance is costly if the cost is absorbed by the provider.

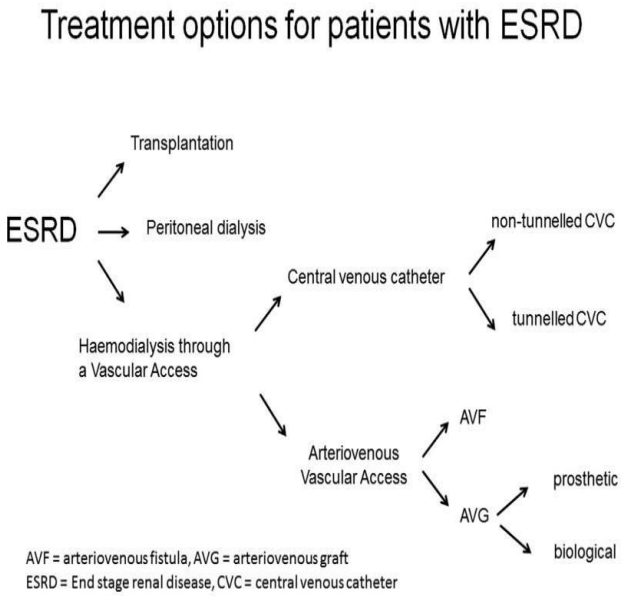
The unavailability of day surgery booking slots is a challenge since the Day Surgery Unit bed capacity
covers all surgeries, and AVF creation is not identified as essential surgery. Moreover, no dedicated day-surgery OR for AVF creation is allocated to serve this vulnerable population

1.2 Available Knowledge

An autologous arteriovenous fistula (AVF) is the vascular access of choice for most patients requiring hemodialysis due to improved longevity once successfully established, lower associated mortality and lower health costs compared with an arteriovenous graft or central venous catheter (CVC). However, these long-term benefits are hampered by exceedingly high rates of early AVF failure due to thrombosis and maturation failure, affecting up to 60% of patients. It is thus not surprising that vascular-access function is one of the most critically important outcomes for patients on hemodialysis and their caregivers.

Previous studies have identified delayed nephrology care, the smaller arterial and venous caliber on sonographic evaluation, and demographic factors, such as older age and female sex, to be associated with AVF failure, whereas greater surgical experience and use of regional anesthesia were associated with better AVF outcomes. Unfortunately, many of these studies have shown in-consistent and conflicting outcomes, likely driven by differences in study populations, sample size, and methodology, and substantial heterogeneity of outcome definitions. Scoring systems incorporating multiple factors have been used to improve predictive scoring for AVF failure; although showing promise, they have not been shown to consistently predict vascular access outcomes when applied to different study populations.





1.3 Rationale:

A pathway aimed to facilitate evidence-based practice was developed to ensure timely intervention for all dialysis patients who were at risk of developing CLABSI.

Considerations for achieving the right vascular access at the right time for the right patient. AV, arteriovenous.

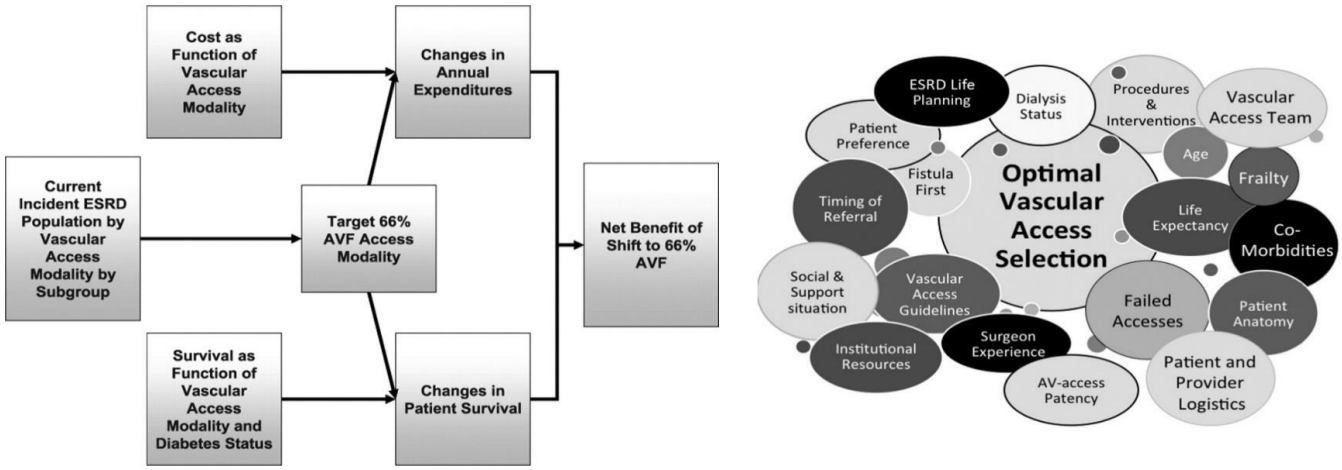


Figure 1: Prioritization Matrix

King Fahd Armed Forces Hospital, Jeddah Vascular Surgery Department 2020

Criteria / Issue	1 = Low or no 3 = Medium or moderate problems 9 = High or frequent problems	Problem Prone in Organization =10	1 = Low or no relationship 3 = Moderate 9 = High relationship	Relates to patient satisfaction=8	1 = Low volume 3 = Moderate 9 = High Volume	High volume event = 9	1 = Low or not related 3 = Moderately related 9= Directly related; element of performance	Related to a standard required for accreditation =7	1 = Low or easy to measure 3 = Moderately difficult to measure 9 =Difficult to measure	Easy to Measure=6	1 = Low or not related 3 = Moderately related 9 = Directly related	Related to National / International Patient Safety Goal or ESR	1 = None 3 = Few 9 = Several	Complaints from patients/staff	1 = None 3 = Mild 9 = Strong effect	Tracer/measurement shows deficiency	1 = None 3 = Somewhat, inconclusive 9 = Strong evidence	Identified as a problem in literature	1 = Slim to none 3 = worsenene potential 9 = Large potential	Potential future cost savings if implemented	Priority Score	Weighted Priority Score	Priority
Weight		10		8		9		7		6													
High patient visits number of diabetic patients with vascular complications (Jan to June 963/month)	3	30	3	24	3	27	1	7	1	6	1	3	3	9	9	36	119	4
Diabetic foot below knee Amputation:37.8%	3	30	9	72	1	9	1	7	1	6	1	3	3	3	9	34	143	3
Low AVD/AVF prevalence in HD patients: 39.1%	9	90	9	72	9	81	3	21	1	6	1	9	9	9	9	68	307	2
Long waiting time for AVF: 172 days	9	90	9	72	9	81	9	63	1	6	1	9	9	9	9	74	349	1
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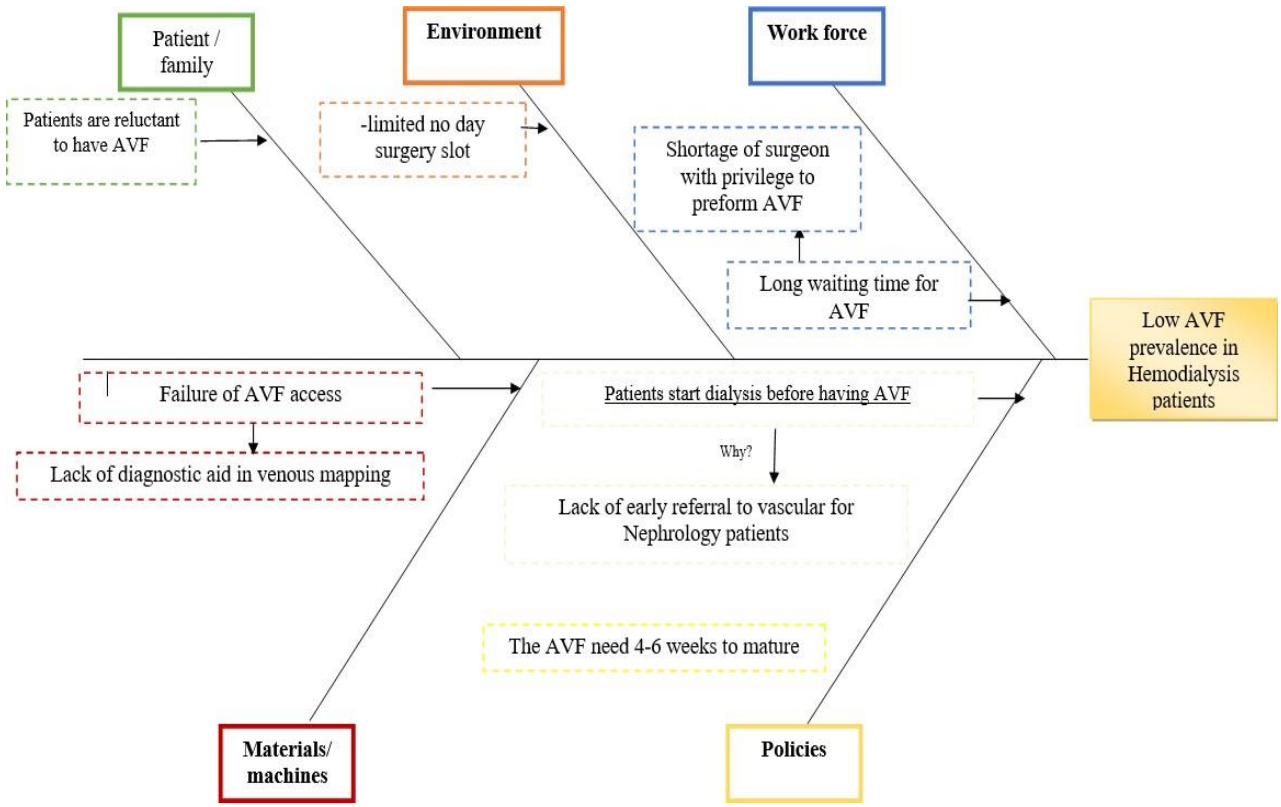
Authorized by: _____ Date: 23/12/2020
Quality facilitator

Approved by: DR. AHMED AFANDI DIV. HEAD VASC. SURG MS354 BLP 0493 Date: 23/12/2020
Director

A variety of quality tools, fishbone for root cause analysis, has been used to identify the root causes of low AVF prevalence in HD patients

Figure 2: Fishbone Tool



1.4 Specific Aims

A. Primary Aim:

To increase the AVF prevalence in Hemodialysis patients to 50% within 12 months

B. Secondary Aims:

To decrease the Average time (days) for HD Patients to have AVF creation from the hemodialysis start date >120 days to <10 days within 12 months.

To Reduce Catheter related sepsis in renal patients to less than 2 within 12 months. Increase AV access turnover
Increase Operating Room access day from 1 day to 2 days.

Reduce Catheter days. Reduce renal patients' hospital stay. Improve patient satisfaction/Patient experience and reduce cost

2. Literature Review

A baseline retrospective data analysis was conducted for the period 1 January 2018 to 31 December 2019 to evaluate the contributing factors to catheter related infections. The following target areas were the focus of the study: Identification of risk factors, including vascular access, catheter days, history of bacteremia, immunosuppressive therapy and corpuscular hemoglobin. Infections are common complications among patients on chronic hemodialysis. Hemodialysis patients with a catheter have a 2 to 3 fold increased risk of hospitalization for infection and death compared with patients with an arteriovenous fistula or graft. Catheter-related bloodstream infections (CRBSIs), exit-site infections, and tunnel infections are common complications related to hemodialysis central venous catheter use.

Catheter-related bloodstream infections (BSIs) alone have a reported incidence of 1.1 to 5.5 episodes per 1000 catheter days and are associated with increased morbidity, hospitalization, and death.1

Barriers to increasing arteriovenous fistula (AVF) creation prompt the initiation of this project; Inadequate pre-ESRD care. A nephrologist often sees ESRD patients for the first time immediately before initiating long-term dialysis (29). In these cases, a PTFE graft often is constructed to avoid the 4- to 6-month maturation time required for an AV fistula. The central venous catheter is the first mode of access for 61% of ESRD patients compared with 15% for AV fistulas.

3. Methodology

The project was carried out in the Chronic Kidney Disease patient population of King Fahd Armed Forces Hospital, Jeddah. The Plan Do Study Act rapid cycles Quality improvement method was used for this project.

The baseline assessment included a review of the patient's medical record before the intervention, and retrospective data collection was conducted for the required measures. The project was conducted from 01 May 2020 to 31 May 2021 with ongoing performance measures monitoring weekly, followed by interventions and action plans accordingly. The measures selected to monitor this Project were:

Process Measure: Mean AVF access waiting time: Target <10 days; Outcome measure: CLABSI rate per 1000 catheter days: Target <2/1000; and Balancing measure: Steal syndrome: Target 0

3.1 Intervention(s):

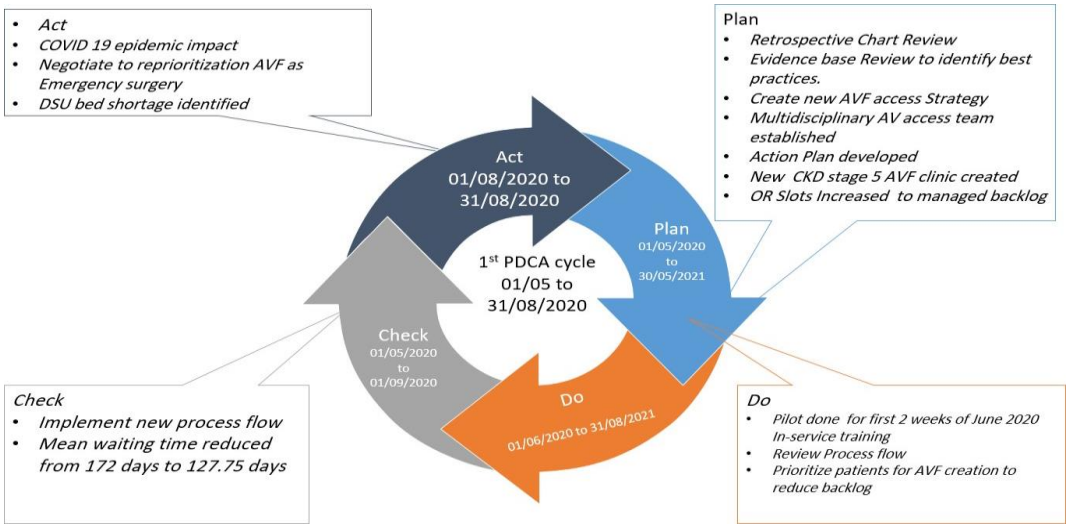
- In the first cycle, a retrospective chart review was done to identify the best evidence-based practices and to create a strategic approach for new AVF creation. A Multidisciplinary AV access team was established to facilitate the pre-operative preparation, assessments and anesthesia clearance, after which an action plan was developed. In-service training was provided to the staff to review the process flow and to familiarize them with the new strategic plan. A new CKD stage 5 AVF clinic was created, and OR Slot was increased to manage backlog, and patient waiting time was revised. A new process flow was implemented with a main focus on patients with the longest waiting time. The suspension of elective services due to the COVID-19 epidemic was a big challenge, and we had to negotiate to reprioritize AVF as Emergency surgery to avoid incidences of CLABSI during the pandemic. The mean waiting time was reduced from 172 days to 127.75. CLABSI rate was 1.76/1000 catheter days.

- In the second cycle, the urgency of the surgical process was rolled on, and an interdepartmental agreement was achieved to add an additional bed for AV Access surgery. New patients admitted to the hemodialysis schedule were identified and booked on priority. The mean waiting time was reduced from 172 days to 34.25 days. CLABSI rate was noted to reduce further
- 1.73/1000 Catheter days. The process flow was functioning smoothly, and the multidisciplinary team was stabilized. Patient resistance factors were identified.

- In the third cycle, the creation of AVF proactively for patients not yet started on hemodialysis was planned, and the process was rolled out to diagnose CKD stage V patients suitable for AVF. All patients admitted between 1 Jan 2021 to 31 May 2021 for HD had AVF created proactively.

- New audit tools were formalized to monitor the sustainability of AVFs with periodic assessments of AVF fistula to help identify failing fistula. The mean waiting time was reduced from 34.25 days to -7.2 days. CLABSI rate was noted to reduce to a further 0.72/1000 Catheter.

3.2 Project Timeline:

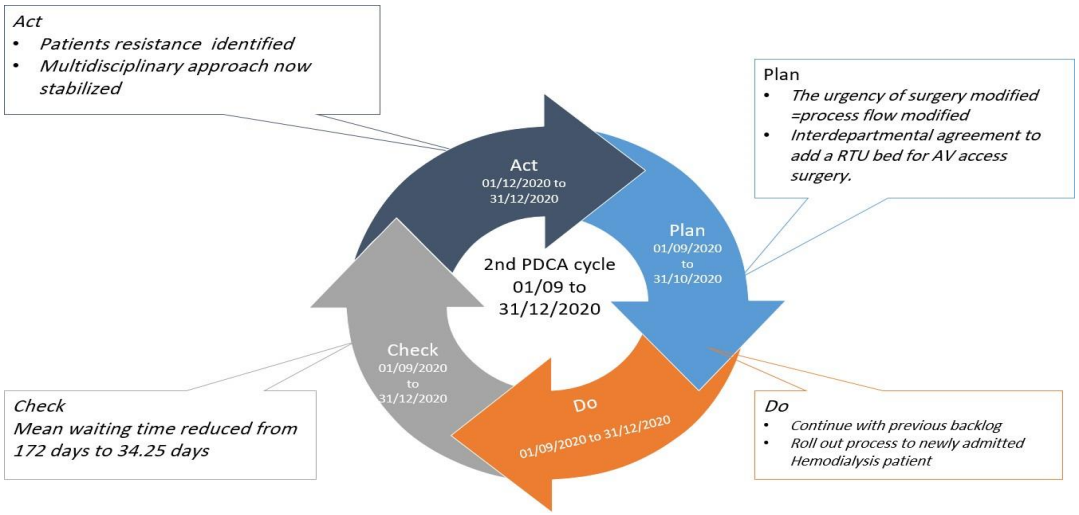


The Assessment of the intervention and their outcome was monitored as follows:

- Data collection and analysis on a weekly basis.
- Weekly meetings for the team to study the data.
- Weekly MDT review for the long-stay patients (>7 days, >30 days and patients refusing discharge).

The selected intervention was implemented step by step to monitor their impact individually. PDCA tool and Kotter's change model were used to create a guiding coalition, develop a vision and strategy and communicate the change required to implement the action to gain the desired target.

3.4 Measures:



Type of measure	Numerator	Denominator	Sample size
Process Measure: Mean AVF access time from the dialysis start date: Target <10 days	AVF access time from the dialysis start date till the AVF creation	# of patients booked for AVF creation	All cases
Outcome measure: CLABSI rate per 1000 catheter days: Target <2/1000 in Hemodialysis patients	HD patient with PermaCath and with a CLABSI	All haemodialysis patients with PermaCath access	All cases
Number of admissions	# of patients admitted with sepsis	All ESRD patients admitted (	All ESRD patient admissions excluded AVF complications)
AVF Prevalence	Number of HD patients with AVF	Number of pat on HD	All patients on HD
Balancing measure: Steal syndrome: Target 0	Number of patients with steal syndrome	Number of patients with newly created AVF	All cases

3.5 Analysis

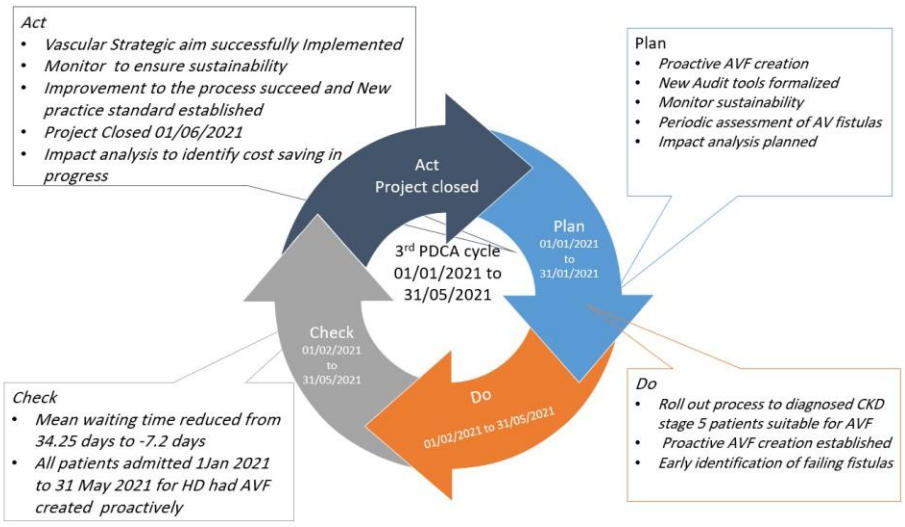
Descriptive statistics were carried out; categorical variables were summarized by number and percent, whereas continuous variables were summarized by the mean and standard deviation. Data displayed inline graphs to examine variation occurring at the aggregate level as well as linearity trend lines by using linear regression analysis to test a significant slope. All statistical analysis was performed by using software Microsoft Excel.

3.6 Ethical Considerations:

No conflict of interest or confidentiality issues pertains to patients.

4. Results and Discussion

During the 1st PDCA cycle, the mean waiting time for AVF Access decreased to 127.75 days; during the 2nd PDCA cycle, the mean time decreased to 34.25 days, and during the 3rd PDCA cycle the project achieved proactive AVF access with the mean waiting time at -7.2 days.



None of the patients with newly created AVF access developed steal syndrome during the project period.

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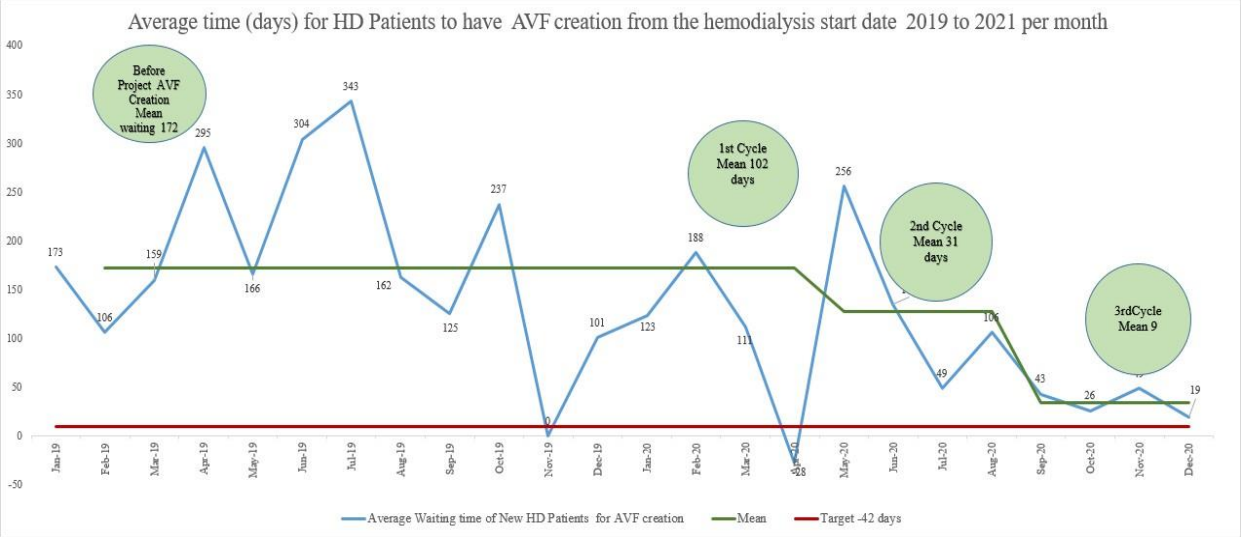
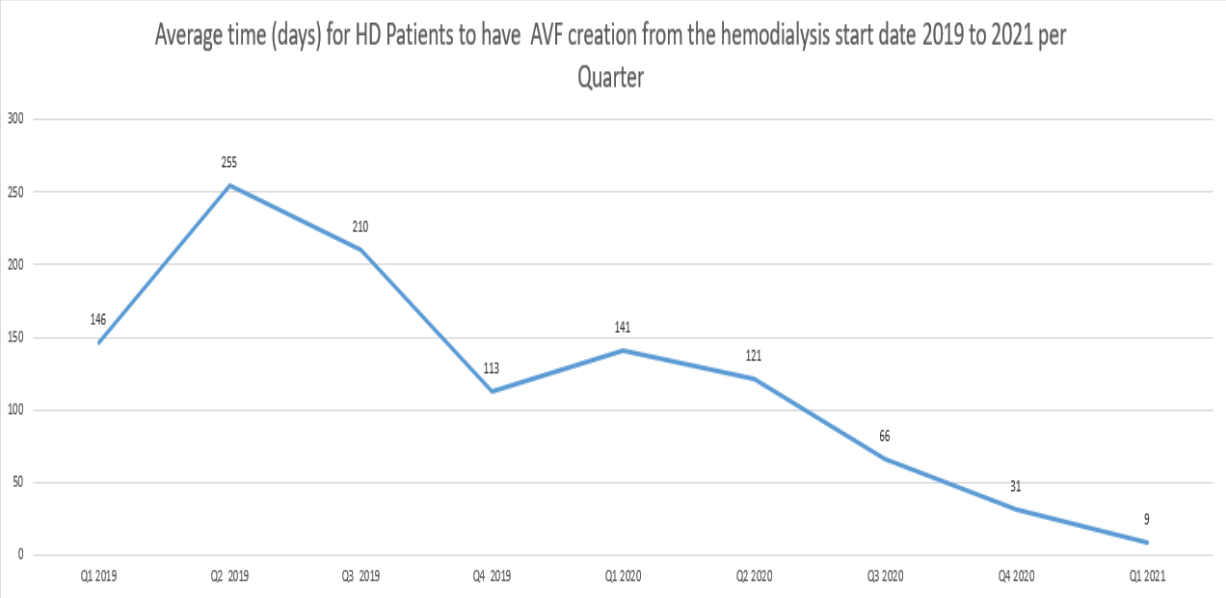
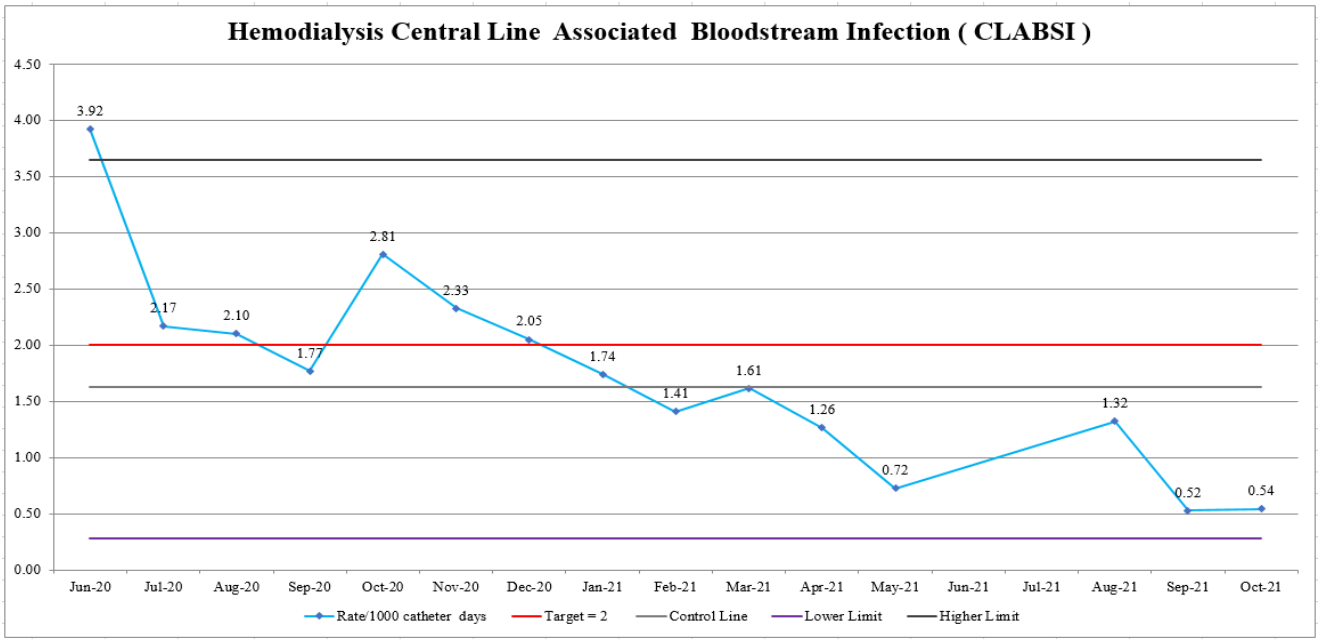
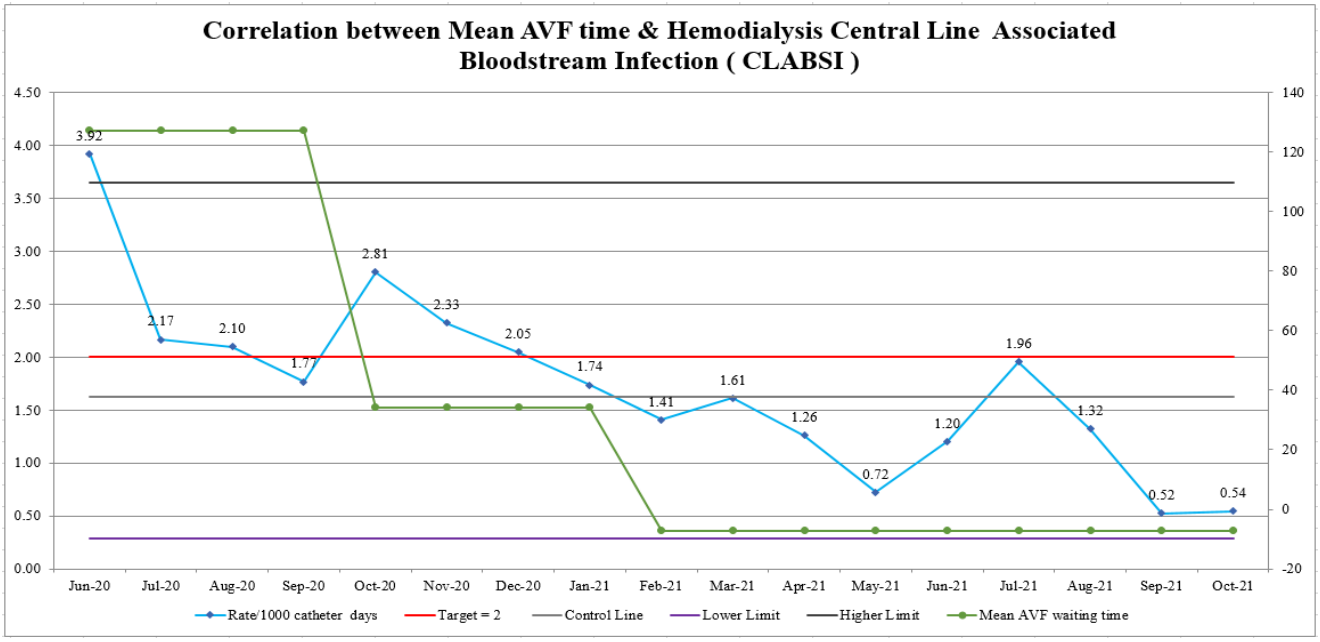
1. AVF Access Waiting Time





2. Hemodialysis CLABSI rate per 1000 Catheter days





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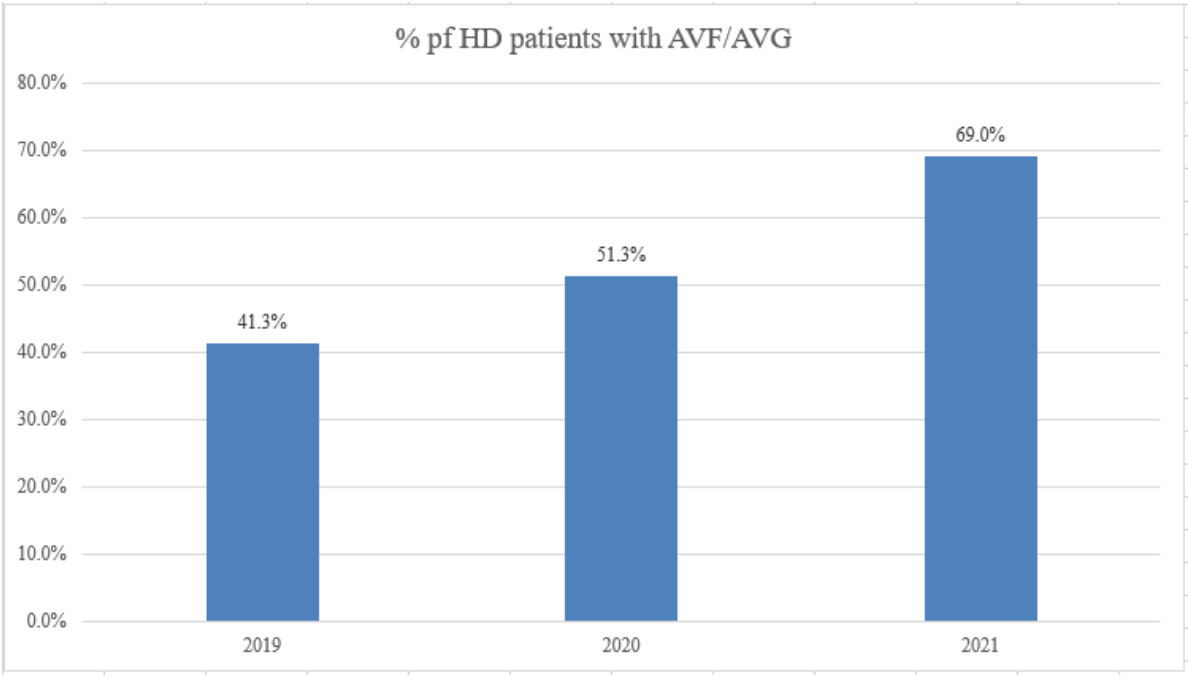
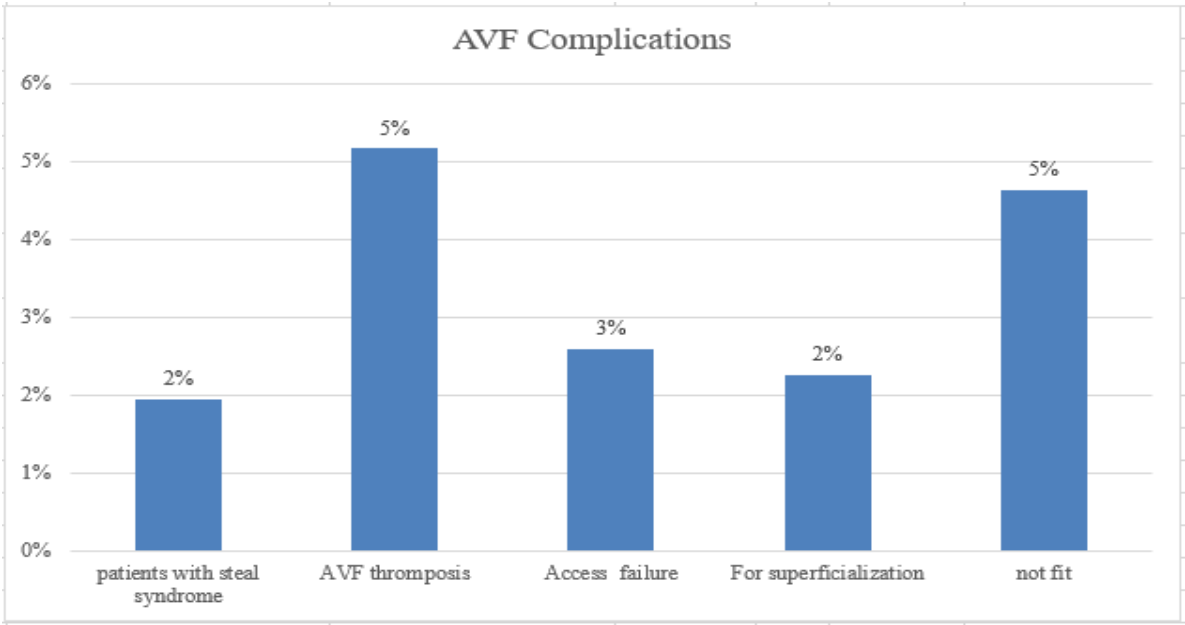
3. AVF Prevalence





4. Discussion

4.1 Summary

All members of the Multidisciplinary team were updated with the process flow and implementation protocol. We established a strategic pathway for CKD patients who were both near dialysis and on-dialysis. The Overall results following the interventions showed a significant decrease in the waiting time for AVF creation along with a significant reduction in morbidity, mortality, hospital stay and cost.

4.2 Interpretation

Worldwide, Central line-associated bloodstream infections (CLABSIs) result in thousands of deaths each year, yet these infections are preventable. The aggregate CLABSI rate decreased from 1.76 CLABSI per 1000 catheter days to 0.72 CLABSI per 1000 catheter days in less than 1 year and has remained in control.

4.3 Impact of the project:

During the first 2 weeks of the implementation phase, feedback from each team member was gathered to reprioritize patients with long waiting times. During the 1st PDCA cycle, the mean waiting time for AVF Access decreased to 127.75 days; during the 2nd PDCA cycle, the mean time decreased to 34.25 days, and during the 3rd PDCA cycle the project achieved proactive AVF access with the mean waiting time at -7.2 days. None of the patients with newly created AVF access developed steal syndrome during the project period. Despite the challenges, we were able to achieve our goal during the pandemic within a year.

Currently, a very low CLABSI rate is maintained with a successful reduction in waiting time for patients waiting for AVF creation

Estimated cost saving:

Avg. cost of per patient is SAR 60,000. (Avg. length of stay was 10 days)

For pre intervention data, No. of patients with CLABSI for the period of Nov 2019-Oct and 2020 is 82 patients

For post intervention data, No. of patients with CLABSI for the period of Nov 2020-Oct 2021 is 66 patients

82-66 = 16 less ClABSI per year 16 X 60,000 = 960,000 SAR saving

Impact Analysis Calculator

Project Title:	Comprehensive approach to improve quality of life in hemodialysis patients by early creation of arteriovenous (AV) access
Facility:	King Fahd Armed Forces Hospital , jeddah
Cost Per Defect ($):	$16,000.00
Cost Per Defect (SAR):	SAR 60,000.00

Before Improvement

Measurement Period day	No. of Defects	Defects Cost Per Period
365	82	$1,312,000.00

After Improvement

Measuremet Period day	No. of Defects	Defects Cost Per Period	Prevention Savings	Cost of Improvement	Net Savings
365	66	$1,056,000.00	$256,000.00		$256,000.00
					#VALUE!
					#VALUE!
					#VALUE!
					#VALUE!

Average Cost of Defects/ Per Measurement Period (Before Improvement):	$1,312,000.00	**Total Prevention Savings:**	$256,000.00	**Total Costs of Improvement:**	$0.00	**Total Net Savings:**	$256,000.00
	SAR 4,920,000.00		SAR 960,000.00		SAR 0.00		SAR 960,000.00

4.4 Limitations

The outcome/process measures and analysis used included only data obtained from the IT department. However, other measures could have been used for better assessment of the effectiveness of our current system, like accessibility waiting time and time used to complete the treatment per visit that was not possible to obtain from the IT department.

5. Conclusion

AV fistula creation among long-term renal dialysis patients will produce clinical benefits for patients and savings in vascular access costs for KFAFH. In the long term, ESRD expenditures may increase somewhat as a result of decreased mortality with AV fistula relative to PTFE graft or catheter access modalities. However, from a societal perspective, these gains in survival will be achieved at a cost that is well within the range that commonly is considered to represent good value for money.

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Conflicts of Interest: The authors declare no conflict of interest.

Publisher's Note: All claims expressed in this article are solely those of the authors and do not necessarily represent those of their affiliated organizations, or those of the publisher, the editors and the reviewers.

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