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# DRUG UTILIZATION AND EVALUATION OF ERYTHROPOIETIN STIMULATING AGENTS IN HAEMODIALYSIS PATIENTS IN A TERTIARY CARE HOSPITAL

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**Abstract:**

***Introduction:*** *Anemia is most commonly associated with chronic kidney disease. In CKD patients, anemia usually occurs due to a decrease in the production of erythropoietin hormone by the kidneys. FDA has approved erythropoietin stimulating agents for the treatment of anemia. The main aim is to study drug utilization and evaluation of erythropoietin stimulating agents in hemodialysis patients.*

***Objectives:*** *To study hemodialysis patients with various comorbidities for effective drug utilization.To evaluate possible drug interactions, adverse reactions, and therapeutic outcomes of erythropoietin stimulating agents in hemodialysis. To evaluate the therapeutic use of antihypertensive in various hemodialysis patients*

***Methodology:*** *It was a prospective, observational study in the department of nephrology carried out on 110 patients for 6 months. The study was conducted in the Aster Prime hospital, Hyderabad. The data were collected through patient interaction, inpatient case sheets, and lab reports of enrolled patients in the study. Statistical analysis was reported using descriptive statistics, paired t-tests, and ANOVA.*

***Results:*** *We evaluated the effectiveness of erythropoietin stimulating agents by measuring lab parameters like hemoglobin, hematocrit, iron and RBC over a period of 3 months and our results show a significant increase in hemoglobin levels from month 1 (Mean=8.75, Standard deviation=1.37) to month 2 (Mean=9.22, Standard deviation= 1.47) to month 3 (Mean=9.70, Standard deviation=1.50), a significant increase in hematocrit levels from month 1 (Mean=39.71, Standard deviation=2.06) to month 2 (Mean=39.74, Standard deviation=2.16) to month 3 (Mean=40.62, Standard deviation=2.19), a significant increase in iron levels from month 1 (Mean=130.74, Standard deviation=33.32) to month 2 (Mean=135.62, Standard deviation=33.06) to month 3 (Mean=138.49, Standard deviation=32.79), show a significant increase in RBC levels from month 1 (Mean=3.37, Standard deviation=0.44) to month 2 (Mean=3.54, Standard deviation=0.37) to month 3 (Mean=3.73, Standard deviation=0.44).*

***Conclusion:*** *In our study by using ANOVA, we found out that in the lab parameters such as hemoglobin, hematocrit, iron, and RBC levels there is a significant difference over some time and the values of these parameters were increased over time by the use of ESA.*

*Based on the above findings, we can conclude that erythropoietin stimulating agents help improve anemia in CKD patients undergoing hemodialysis.*

***Keywords:*** *Chronic kidney disease (CKD), hemodialysis, erythropoietin stimulating agents, anemia, blood pressure*

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## INTRODUCTION:

Chronic kidney disease (CKD) has been identified as a major public health issue around the world. Patients with end-stage kidney disease (ESKD) who require renal replacement treatment are projected to number between 4.902 and 7.083 million worldwide **(1).**

Anemia is a serious complication that is associated with chronic kidney disease and may contribute to several adverse clinical outcomes. The prevalence of anemia increased with stage of CKD, from 8.4% at stage 1 to 53.4% at stage 5**. (2)**The principal therapies for anemia in chronic renal disease have been erythropoiesis-stimulating agents (ESAs) and adjuvant iron therapy (CKD).

Hemodialysis patients frequently develop hypertension, which can be difficult to manage.Salt restriction, sufficient sodium elimination during hemodialysis, and achieving a proper "dry weight" should be the first-line therapies for blood pressure control. Because of its established effectiveness on left ventricular hypertrophy, and potentially cardiovascular events, RAAS inhibitors (either ACE-I or ARB) should be the first-line pharmacologic medications for blood pressure control in hemodialysis patients. Beta-blockers (especially in patients with coronary artery disease), combined α and β blockers in patients with heart failure, CCBs, and alternative medicines such as direct vasodilators are examples of second-line agents. To achieve sufficient blood pressure control, hemodialysis patients require a combination of antihypertensive drugs.

## CHRONIC KIDNEY DISEASE

CKD is defined as chronic renal insufficiency where the glomerular filtration rate (GFR) is < 60 ml/min for 3 months or more often associated with structural kidney damage and loss of kidney functioning. **(3)**
According to NATIONAL KIDNEY FOUNDATION [NKF] DIALYSIS OUTCOMES AND QUALITY INITIATIVE [K/DOQI], CKD is classified into 5 stages based on the presence of structural and functional kidney damage for at least 3 months or more. **(4)**

| STAGE AND GFR [ml/min] | DESCRIPTION |
|---|---|
| STAGE 1<br>≥90 ml/min | Normal kidney functions with haematuria and proteinuria.<br>HIGH BP AND SWOLLEN LEGS. |
| STAGE 2<br>60-89 ml/min | Mild loss of kidney function.<br>HIGH BP, UTI, ABNORMAL URINE TEST |
| STAGE 3<br>30-59 ml/min | Mild to moderate loss of kidney function.<br>LOW BLOOD COUNT, NUMBNESS,<br>MALNOURISHED, DECREASED MENTAL SHARPNESS |
| STAGE 4<br>15-29 ml/min | Severe loss of kidney function.<br>ANEMIA, DECREASED APPETITE, BONE DISORDER, OR ABNORMAL LEVELS OF CALCIUM, PHOSPHORUS, AND VITAMIN D |
| STAGE 5<br><15 ml/min | Kidney failure and need for Dialysis or Transplantation<br>UREMIA,FATIGUE,NAUSEA,VOMITING,ABNORMAL THYROID LEVELS |

CKD causes are certain diseases or conditions that impair kidney functioning and worsen it over some time such as type 1 or type 2 diabetes, hypertension, glomerulonephritis, interstitial nephritis, polycystic kidney disease, pyelonephritis, enlarged prostate, renal calculi, and some cancers that obstruct urinary tract, vesicoureteral reflux-where urine backs up into kidneys **(5)**

Factors that may increase the risk of CKD are obesity, older age, high blood pressure, diabetes, cardiovascular diseases, Asian American, African, and native American races, cigarette smoking, autoimmune diseases, kidney stones, benign prostate hyperplasia, certain drugs use frequently that may damage kidney

## DIAGNOSIS - (6)

**Blood tests –**

**Serum creatinine**– Creatinine is the end product of muscle breakdown. Normal blood creatinine levels are 0.6 -1.2mg/dl. Levels >1.4 for men and >1.2 for women are indications of abnormal kidney function. Blood creatinine levels rise as kidney disease progresses

**GFR** – Measure for checking the efficacy of kidneys infiltration of blood. The normal GFR value is 125 ml/min. GFR < 60 indicates improper kidney function. GFR <15 is a sign of high-risk kidney failure and the need for dialysis or transplantation

**Blood Urea Nitrogen (BUN)** – The breakdown product of protein is urea nitrogen. Normal BUN values are 7-20mg/dl. As kidney function decreases BUN levels increases

**Urine tests –**

**Proteinuria**– A dipstick test is performed to check proteins in urine. A positive (+) dipstick test confirms proteinuria

**Microalbuminuria** – It indicates the presence of albumin protein in the urine. Usually, the albumin to creatinine ratio is taken into consideration

**Creatinineclearance** – The creatinine clearance test compares Creatinine in a 24-hour sample of urine to the blood Creatinine to show kidney functioning.

**Imaging techniques-**

**CT Scan**– Using X-rays the obstructions and structural abnormalities of a kidney can be figured out.

**Ultrasound** – Using sound waves the abnormalities of the kidney such as the presence of renal stones or any obstructions can be found.

**Treatment –**

CKD has no cure. Treatment usually involves –

1. Lifestyle Modifications
   - Stop smoking, Reduce alcohol consumption.
   - Restrict your salt intake.
   - Lose weight if you're overweight or obese
   - Avoid over-the-counter non-steroidal anti-inflammatory drugs (NSAIDs) such as ibuprofen, except when advised to by a medical professional as these medications can harm your kidneys if you have kidney disease
2. Medications to treat underlying causes
3. Dialysis – a procedure to replicate some of the kidney's functions, which may be necessary for advanced (stage 5) CKD
4. A kidney transplant – may be necessary for the advanced (stage 5) stage.

**DIALYSIS**

Dialysis is an artificial treatment method when the kidneys fail to function properly. It involves the elimination of excess water, solutes, and toxins from the blood by redirecting the blood to an artificial machine. Individuals with kidney failure or end-stage renal infection (ESRD) require dialysis. Injuries and conditions like hypertension, diabetes, lupus, glomerulonephritis, intestinal nephritis, etc. can harm kidneys prompting kidney disease.

**Types of dialysis:**

There are two primary types of dialysis:

1. Haemodialysis 2. Peritoneal dialysis.

**HAEMODIALYSIS:**

Haemodialysis is the process of filtration of blood through an artificial membrane using a dialysis machine. Before starting the dialysis procedure, the patient may need to undergo a minor procedure for easier access to the bloodstream. This includes:

**Temporary access:** Temporary vascular access includes access to the bloodstream with the use of a catheter to make adequate hemodialysis treatment possible.

Central Venous catheter: This type of catheter is used when hemodialysis is to be done right away and there is no time to wait for a fistula or graft. A central venous catheter (CVC) is a flexible, long, plastic, y-shaped tube that is threaded through the skin into a central vein in the neck, chest, or groin. **(7)**This catheter can be used for a maximum of 3 months therefore long-term dialysis patients will eventually require permanent access.

Types of central venous catheters:

1. Internal Jugular Access2. Femoral Access3. Permanent Catheter **(8)**

**Permanent Access**: It consists of

Arteriovenous fistula (AV fistula):An artery is connected to a vein under the skin to create a larger blood vessel. It can take months for a fistula to form. Some of the risks that have been seen include clot formation and infection at the access site.**(9)**

Arteriovenous graft (AV graft): If the blood vessels are not adequate to form a fistula, the doctor may use a soft plastic tube to join an artery and a vein under the skin. This is called a graft.

**Advantages:**

1. Can be done in the comfort of home. **(10)**
2. Usually done 3 times a week, leaving most of the week dialysis free.
3. Lower risk of infections.
4. Nocturnal hemodialysis done at home is a relatively gentle form of treatment, making the patient feel stronger.**(11)**
5. Nocturnal hemodialysis provides a sense of normality for regular work/school schedules.

**Disadvantages:**

1. Travel regularly for treatment
2. Intake of diet and fluid needs to be restricted
3. The Haemodialysis procedure must be strictly followed.
4. A fistula may be seen as ungainly and ugly to the patient.
5. Possible side effects include low blood pressure, shortness of breath, and nausea.

**PERITONEAL DIALYSIS:**

Peritoneal dialysis is an artificial method for the removal of wastes or toxins from the body involving the use of a peritoneal membrane in the abdomen as a filter. A surgeon places a soft, thin tube called a

catheter through the abdomen and into the peritoneum before starting peritoneal dialysis. This catheter is permanently implanted.

**ERYTHROPOIETIN STIMULATING AGENTS**

The peritubular cells of the kidney naturally produce a hormone known as erythropoietin. **(12)**ERYTHROPOIETIN stimulates the generation of red blood cells from the bone marrow into the bloodstream in response to low levels. They are widely used in the treatment of CKD-induced anemia, chemotherapy, surgeries, and AIDS treatment. These agents reduce the requirement for blood transfusions. Erythropoietin stimulating agents produced by recombinant DNA technology are the best substitutes to be used in place of transfusions.ESAs should be given to patients whose hemoglobin level is <10g/dl. **(13)**

**History:**

In 1977, the first human erythropoietin was isolated from a patient's urine **(14)**, and later in 1983, the gene was isolated **(15)**. EPO gene was cloned and expressed in Chinese hamster ovary (CHO) cells one year later by 2 groups and developed recombinant human EPO (rHuEPO) as a drug**. (16)**

Amgen manufactured the first rHuEPO, Epoetin Alfa in 1989 and sold it as Epogen® for dialysis patients in the US. In a long-standing licensing agreement, Amgen transferred the use to Johnson & Johnson and Ortho Biotech. **(16)**It is being marketed under the name Procrit by Ortho biotech. Ortho Biotech began to manufacture Epoetin Alfa in its facility in Puerto Rico and sells it under the brand name, Eprex® in most markets outside the US. Kirin Brewery in Japan manufactures Epoetin Alfa in its plant after a similar technology transfer.

Examples **:( 12)**

1. Methoxy polyethylene glycol-epoetin beta2. Epoetin3.Darbepoetin

**Use in caution with:**

1. Cardiovascular disease2. Hypertension3.Seizures4.Porphyria5. Pregnancy

**The risk associated with ESA:**

- An increase in hemoglobin levels can lead to major heart problems
- Increased risk for venous thromboembolism. Increased risk of developing tumors in cancer patient

**FDA approved uses of ESA:**

- Anemia associated with chronic kidney disease
- Anemia in cancer due to chemotherapy
- Anemia secondary to HIV infection
- Anemia in preterm infants
- In surgery

**Mechanism of Action**

Erythroid progenitor cell division and differentiation are stimulated by erythropoietin stimulating agents. **(17)**EPO receptors are found on the surface of CD34+ hematopoietic stem cells and erythrocytes. Endogenous EPO or recombinant analogs attach to EPO receptors, triggering a cellular signaling cascade that promotes cell proliferation and inhibits cell death. As a result of this, hemoglobin and hematocrit levels rise.

**Dose:**

1. Anaemia in CKD - 50 to 100units/kg IV or SC 3 times per week
2. Anaemia in cancer due to chemotherapy- 150 units/kg/dose SC 3 times weekly
3. Anaemia in HIV - 100units/kg/dose IV or SC 3 times per week
4. Surgery-induced anemia - For 15 days, 300 units/kg/dose SC

**Adverse effects:**

1. Thrombosis 2. Increased blood viscosity3.Nausea and vomiting 4.Diarrhea
5. Fatigue 6. Insomnia7.Peripheral edema8. Thrombocytopenia
9. Myalgia 10. Arthralgia11.Rashes
12. Pain in the abdomen
13. Headache 14. Paraesthesia

**Contraindications :(18)**

- Hypersensitivity reactions, History of DVT, PE
- Ischemic stroke, History of cardiovascular diseases
- Pregnant and lactating women, Neonates

**Monitoring parameters** :**(17)**

- Hemoglobin levels, Haematocrit range
- RBC count, CBC (Complete blood count)
- Blood pressure and electrolyte levels
- Serum transferrin level

**RESULTS:**

**Descriptive Statistics**

| | N | Minimum | Maximum | Mean | Std. Deviation |
|---|---|---|---|---|---|
| Age | 110 | 21 | 77 | 52.71 | 12.779 |
| Pre Dialysis weight | 110 | 38.1 | 98.0 | 65.265 | 13.5103 |
| Post Dialysis weight | 110 | 36.0 | 95.0 | 63.245 | 13.3927 |
| Valid N (listwise) | 110 | | | | |

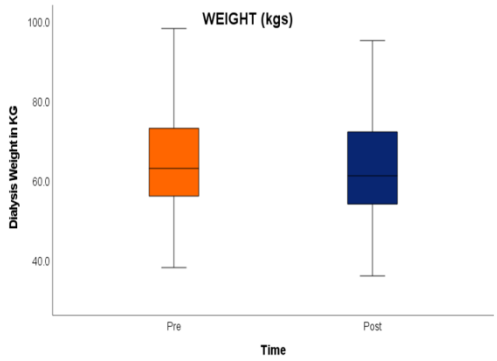



Figure 1.0

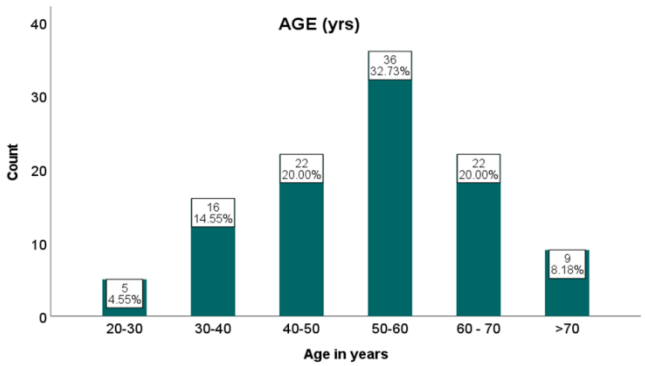



Figure 2.0

Figure 1.0
The figure shows the weight distribution of patients for pre dialysis and post-dialysis.
The mean reading shows pre-dialysis weight as 65.2 kg with a standard deviation of 13.51 and post dialysis weight as 63.2 kg with a standard deviation of 13.39.
Hence it can be concluded that there was a slight weight reduction in patients post-dialysis.

Figure 2.0
The above bar graph depicts the age distribution of 110 patients on hemodialysis due to chronic kidney disease.
It is observed that 4.55 % of patients were in the range 20-30 years, 14.55% of patients were in the age range 30-40 years, 20% patients were in the age range 40-50 years, 32.73% patients were in the age range 50-60 years, 20% patients were in the age range 60-70 and the patients above 70 years were 8.18%. Hence it can be concluded that most patients were from the age range of 30-70.

**Gender**

| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| Valid | Male | 77 | 70.0 | 70.0 | 70.0 |
| | Female | 33 | 30.0 | 30.0 | 100.0 |
| | Total | 110 | 100.0 | 100.0 | |

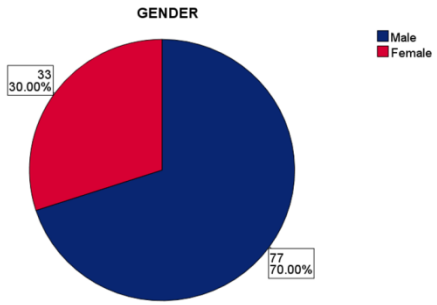



Figure 3.0

Figure 3.0
The gender distribution is shown in the above table and figure.
The figure here depicts the pie chart distribution of gender where 70% were found to be male with a frequency of 77 and the remaining 30% were found to be female with a frequency of 33.
Hence it can be concluded that the maximum number of patients i.e. 70

Figure 4.0

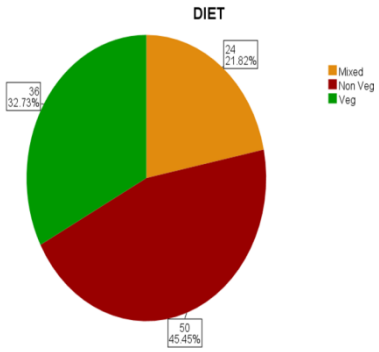



Figure 4.0
The diet distribution of hemodialysis patients is shown in the figure.
The figure here depicts the pie chart distribution of diet among hemodialysis patients. It was found that patients taking a vegetarian diet with a frequency rate of 36 were 32.73%, the patients taking a non-vegetarian diet with a frequency of 50 were 45.45% and the patients taking a mixed diet with a frequency of 24 were 21.87%.

Figure 5.0

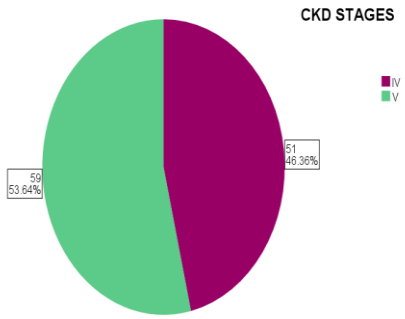



Figure 5.0
The above figure is related to patient distribution for CKD Stage IV and CKD Stage V.
From the pie chart, the patients of CKD V with a frequency rate of 59 were found to be 53.64% and the remaining patients of CKD IV with a frequency rate of 51 were found to be 46.36%. Hence it can be concluded that most patients were of CKD stage V.

Figure 6.0

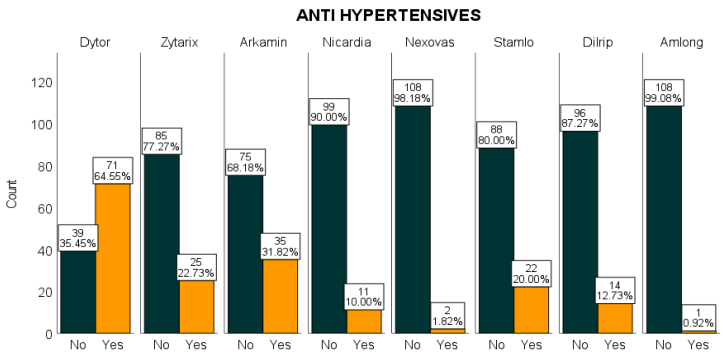



Figure 6.0
The figure is related to various antihypertensive used by hemodialysis patients
From the above bar graph, it can be observed that 64.55% of patients used Dytor, 22.7% of patients used zytanix, 31.8% patients used Arkamin, 10% patients used Nicardia, 1.8% patients used Nexovas, 22% patients used Stamlo, 2.7% patients used Embeta XR, 6.4% patients used Met XL, 12.7% patients used Dilnip, 0.9% patients used Amlong, 2.7% patients used Lasix, 0.95% patients used Minipress XL, 0.9% patients used Prazopress XL and 11.8% patients used Cardivas.

Figure 7.0
The pie chart shows that patients undergoing dialysis twice a week were 32.73% and the patients undergoing dialysis thrice a week were 67.27%.

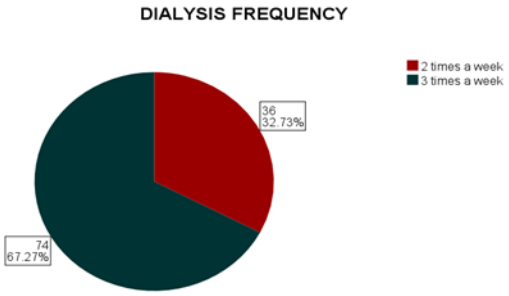



Figure 7.0

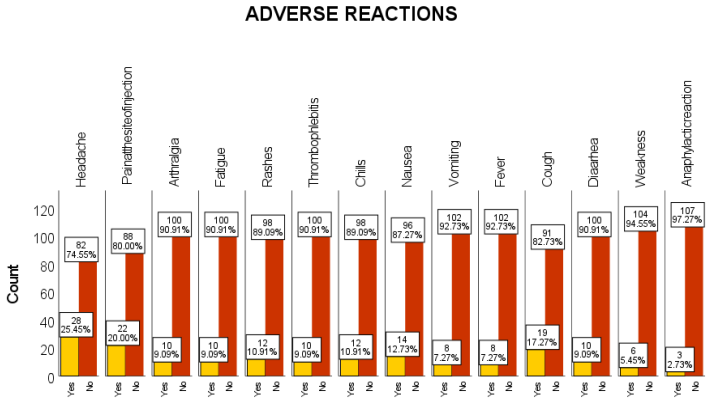



Figure 8.0
The figure is related to adverse drug reactions found in patients for erythropoietin stimulating agents during hemodialysis.
From the above bar graph, the most common adverse reactions reported were headaches in 25.45% of patients, pain at the site of injection is seen in 20% of patients, and 17.27% of patients had a cough.

Figure 9.0

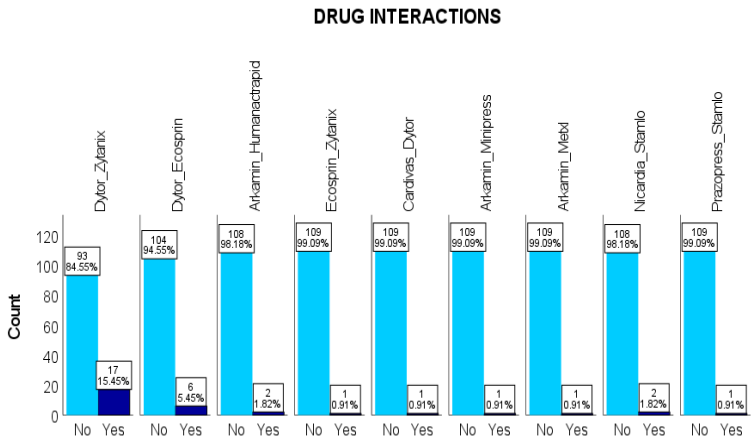



Figure 9.0
The figure is a bar graph regarding the various drug interactions found in the patients.
Of all the above drug interactions, Dytor-Zytanix drug interaction was the most common and is seen in 15.45% of patients.

Figure10.1

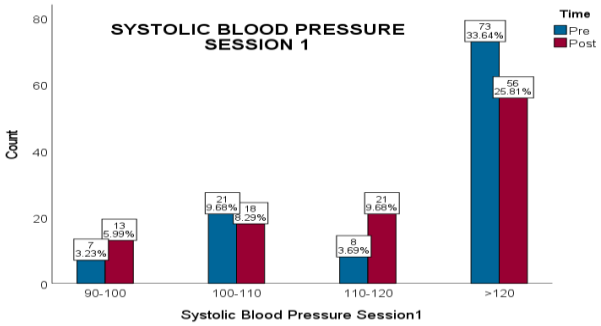
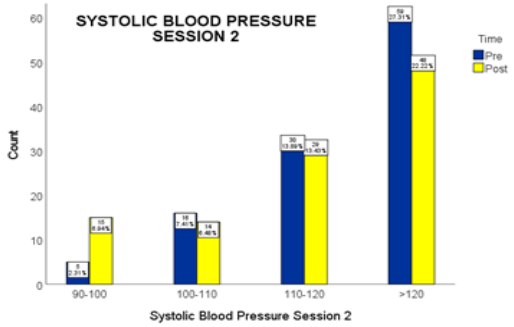



Figure 10.2




The above figures are related to the patient's Systolic Blood Pressure values during sessions 1 and 2.
Figure10.1 is a bar graph related to the Systolic Blood Pressure of patients during session 1 which shows that the maximum patients had a Systolic Blood Pressure value >120 mmHg.
Figure 10.2 is a bar graph related to the Systolic Blood Pressure of patients during session 2 which shows that maximum patients had a Systolic Blood Pressure value >120 mmHg.

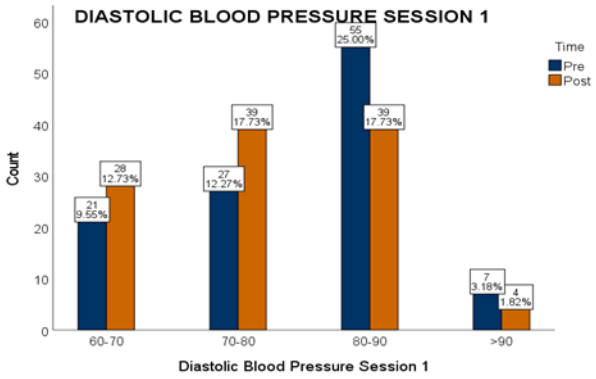



Figure 10.3

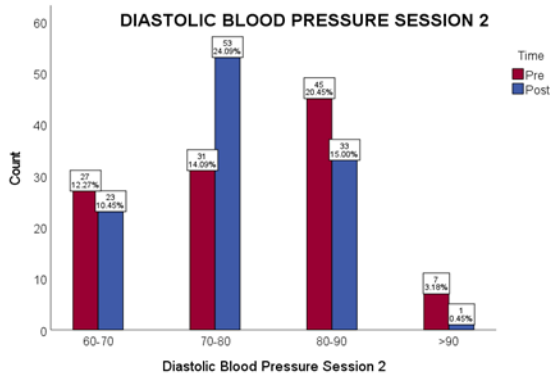



Figure 10.4

The above figures are related to the Diastolic Blood Pressure of patients during sessions 1 and 2.
Figure 10.3 is a bar graph related to the Diastolic Blood Pressure of patients during session 1 which shows that maximum patients had Diastolic Blood Pressure values in the range of 80-90mmHg.
Figure 10.4 is a bar graph related to the Diastolic Blood Pressure of patients during session 2 which shows that maximum patients had Diastolic Blood Pressure values in the range of 70-80 mmHg.

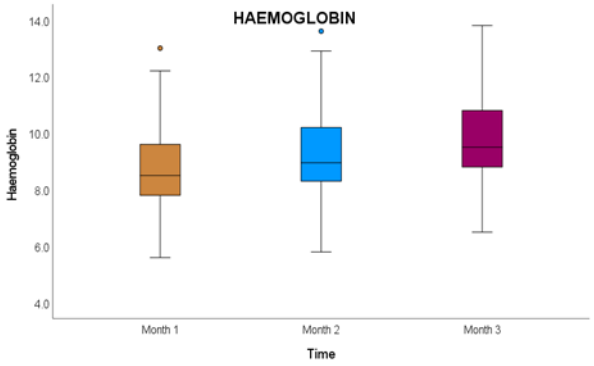



Figure 12.0

Figure 11.0
The above figure is related to the hemoglobin values of various patients for 3 months.
From figure 11.0, the mean Hemoglobin value for the month1 was 8.754, for month2 it was 9.223 whereas for month3 the mean Hemoglobin value was 9.710.

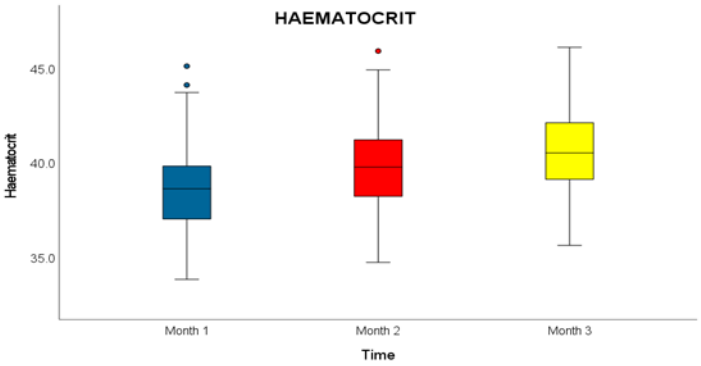



Figure11.0

Figure 12.0
The above figure is related to the hematocrit values of various patients for 3 months.
Figure 12.0 is a bar graph where during month1 maximum patients 25.15% had hematocrit values in the range of 35-40. During month 2; a maximum of 17.5% of patients had a 35-40 range whereas 19.70% of patients had a 40-45 hematocrit value during month3.

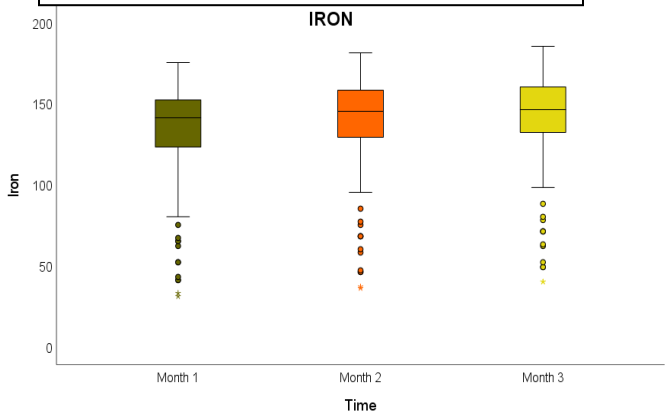



Figure 13.0
The figure is related to iron values of various patients for 3 months.
During month 1, the mean iron value was found to be 130.74
During month 2, the mean iron value was found to be 135.62
During month 3, the mean iron value was found to be 138.49

Figure 13.0

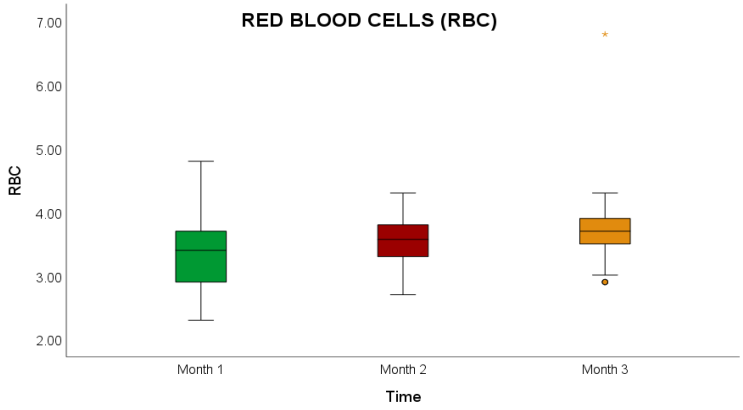



Figure 14.0
The above figure is related to the RBC value of various patients for 3 months.
During month 1, the mean RBC value was found to be 3.37
During month 2, the mean RBC value was found to be 3.54
During month 3, the mean RBC value was found to be 3.73]

Figure 14.0

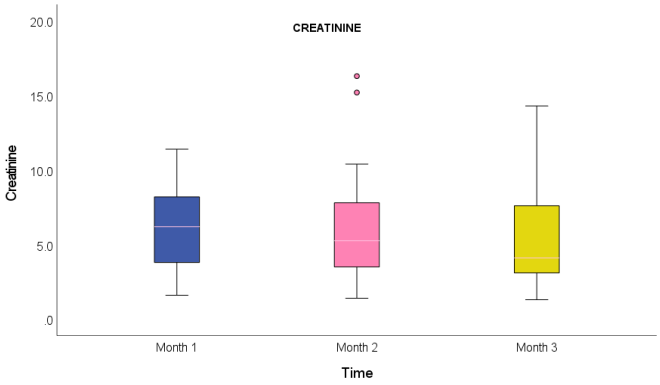
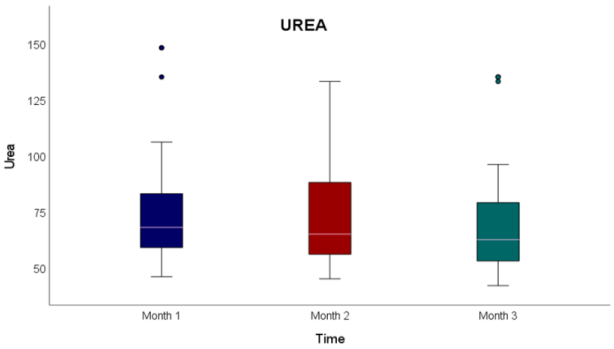



Figure 15.0

Figure 15.0 is a box and whisker graph which shows creatinine levels of hemodialysis patients for 3 months.
In Month 1, the mean value of creatinine is 6.118.
In Month 2, the mean value of creatinine is 5.609.
In Month 3, the mean value of creatinine is 5.189.




clinical data were obtained through patient

Figure 16.0

Figure 16.0 is a box and whisker graph which depicts urea levels of various hemodialysis patients for 3 months.
In Month 1, the mean value of urea is 73.05.
In Month 2, the mean value of urea is 70.833.
In Month 3, the mean value of urea is 67.270.

**METHODOLOGY:**

**Study site:** The study was conducted in the dialysis ward of Aster Prime Hospital, Ameerpet, Hyderabad

**Study duration:** The study was carried out for a period of 6 months from August 2021 – to January 2022

**Study design:** This was a prospective, observational study performed on hemodialysis patients in the department of Nephrology.

**Sample size**: The sample size was 110 patients undergoing hemodialysis which was calculated by using Slovin's formula.

**Data collection**: The data collection form was designed accordingly for the study including the necessary parameters. The patient demographics and interaction, the inpatient case sheets, dialysis diary, and lab reports of enrolled patients in the study.

**Inclusion criteria:**

1. Adults above 18yrs
2. Patients diagnosed with CKD
3. Patients on Hemodialysis
4. Renal Patients with hypertension and anemia

**Exclusion criteria:**

1. Patients below 18yrs
2. Patients on peritoneal dialysis
3. Pregnant and lactating women
4. Patients suffering from viral diseases such as HIV and Hepatitis
5. Patients without any renal impairment

**Study procedure:**

- The baseline characteristics such as age, sex, BP, pulse rate, hemoglobin, RBC, hematocrit, iron, urea, creatinine, and electrolytes were recorded.
- The adverse drug reactions and drug interactions observed in hemodialysis patients were also taken into consideration.
- The response to the use of ESA in hemodialysis anemic patients was studied using various laboratory investigations for 3 months.

**Statistical analysis**: Descriptive statistics were reported using mean ± SD for continuous variables. Frequency and percentage were reported for categorical variables. Paired t-test was used to assess the before and after effect. ANOVA was used to check the trend over the months for the lab parameters. P-value <0.05 was considered statistically significant. SPSS 28.0 was used for the statistical analysis.

## DISCUSSION:

- Patients suffering from anemia in CKD are usually treated with iron supplements, and vitamin supplements and in severe cases might require a blood transfusion. One method of treatment of anemia in CKD is using erythropoietin stimulating agents. This study aims to show the utility and efficacy of erythropoietin stimulating agents in hemodialysis patients. In addition, we also want to show the various antihypertensive used as well as the various adverse reactions reported due to the use of erythropoietin stimulating agents.
- For the study, we have collected the patient demographic details like age, gender, pre-dialysis, and post-dialysis weight, pre and post-dialysis blood pressure, and lab parameters like hemoglobin, hematocrit, iron, RBC, creatinine, and urea from the case sheets.
- From the age group of patients, it is observed that 4.55 % of patients were in the range 20-30 years, 14.55% of patients were in the age range 30-40 years, 20% of patients were in the age range 40-50 years, 32.73% patients were in the age range 50-60 years, 20% patients were in the age range 60-70 and the patients above 70 years were 8.18%. Hence it can be concluded that most patients were from the age range of 30-70.
- In our study, the patients of CKD V with a frequency rate of 59 were found to be 53.64% and the remaining patients of CKD IV with a frequency rate of 51 were found to be 46.36%. Hence it can be concluded that most patients were of CKD stage V.
- From the study patients undergoing dialysis twice a week were 32.73% and the patients undergoing dialysis thrice a week were 67.27%.
- Our study showed that the prevalence of males undergoing hemodialysis is predominant over females. For patients undergoing hemodialysis we have compared the pre and post dialysis weight and found out that there is a significant decrease in weight of the patients before (Mean=65.265, Standard deviation=13.5103) to after (Mean=63.245, Standard deviation=13.3927), t (109) =19.445, p=.000 (one-sided and two-sided). The mean decrease in the weight was 2.0200 with a 95% confidence interval ranging from 1.8141 to 2.2259.
- We have also compared the pre and post dialysis systolic and diastolic blood pressure for 2 sessions and in session 1 found a significant decrease in systolic blood pressure before (Mean=131.40, Standard deviation=19.996) to after (Mean=126.23, Standard deviation=21.675), t (109)= 3.178, p=.001 (one-sided), p=.002 (two-sided). The mean decrease in the systolic blood pressure was 5.173 with a 95% confidence interval ranging from 1.947 to 8.399 and significant decrease in diastolic blood pressure before (Mean=83.57, Standard deviation=10.936) to after (Mean=80.49, Standard deviation=10.631), t (109)= 2.935, p= .002 (one-sided), p=.004 (two-sided). The mean decrease in the diastolic blood pressure was 3.082 with a 95% confidence interval ranging from 1.001 to 5.163.
- In session 2 results shown a significant decrease in systolic blood pressure before (Mean=128.85, Standard deviation=17.758) to after (Mean=122.74, Standard deviation=18.864), t (109) =4.662, p= .000 (one-sided and two sided). The mean decrease in the systolic blood pressure was 6.109 with a 95% confidence interval ranging from 3.512 to 8.706 and significant decrease in diastolic blood pressure before (Mean=82.32, Standard deviation=10.061) to after (Mean=79.82, Standard deviation=9.235), t (109)= 2.719, p= .004 (one sided), p=.008 (two sided). The mean decrease in the diastolic blood pressure was 2.500 with a 95% confidence interval ranging from .678 to 4.322.
- We also carried out a study to see the antihypertensive used and the results showed that 64.55% of patients used Dytor,22.7% of patients used zytanix,31.8% of patients used Arkamin,10% patients used Nicardia,1.8% patients used Nexovas,22% patients used Stamlo,2.7% patients used Embeta XR,6.4% patients used Met XL,12.7% patients used Dilnip,0.9% patients used Amlong,2.7% patients used Lasix,0.95% patients used Minipress XL,0.9% patients used Prazopress XL and 11.8% patients used Cardivas.
- The use of erythropoietin stimulating agents was associated with a few adverse reactions and the most common adverse reactions reported were headaches in 25.45% of patients, pain at the site of injection is seen in 20% of patients, and 17.27% patients had a cough.

- We evaluated the effectiveness of erythropoietin stimulating agents by measuring lab parameters like hemoglobin, hematocrit, iron, and RBC over 3 months and our study suggests-

1. The results show a significant increase in hemoglobin levels from month 1 (Mean=8.75, Standard deviation=1.37) to month 2 (Mean=9.22, Standard deviation= 1.47) to month 3 (Mean=9.70, Standard deviation=1.50).
2. The results show a significant increase in hematocrit levels from month 1 (Mean=39.71, Standard deviation=2.06) to month 2 (Mean=39.74, Standard deviation=2.16) to month 3 (Mean=40.62, Standard deviation=2.19).
3. The results show a significant increase in iron levels from month 1 (Mean=130.74, Standard deviation=33.32) to month 2 (Mean=135.62, Standard deviation=33.06) to month 3 (Mean=138.49, Standard deviation=32.79).
4. The results show a significant increase in RBC levels from month 1 (Mean=3.37, Standard deviation=0.44) to month 2 (Mean=3.54, Standard deviation=0.37) to month 3 (Mean=3.73, Standard deviation=0.44).

## CONCLUSION:

- For the study, we have collected the patient demographic details like age, gender, pre-dialysis, and post-dialysis weight, pre and post-dialysis blood pressure, and lab parameters like hemoglobin, hematocrit, iron, RBC, creatinine, and urea from the case sheets.
- For patients undergoing hemodialysis, we have compared the pre and post-dialysis weight by using paired sample t-test and found out that there is a difference in weight before and after.
- We also compared the pre and post-dialysis blood pressure by using paired sample t-test and found that there is a slight decrease in blood pressure after dialysis.
- In this study, by using ANOVA we also found out that in the lab parameters such as hemoglobin, hematocrit, iron, and RBC levels there is a significant difference over some time and the values of these parameters were increasing over time.
- Based on the above findings we can suggest that erythropoietin stimulating agents help improve anemia in CKD patients undergoing hemodialysis.

## ACRONYMS

| S.NO | ABBREVIATION | DESCRIPTION |
|---|---|---|
| **1.** | ACEI | Angiotensin converting enzyme inhibitor |
| **2.** | ACR | Urine albumin to creatinine ratio |
| **3.** | AIDS | Acquired immunodeficiency virus |
| **4.** | AKD | Acute kidney disease |
| **5.** | ARF | Acute renal failure |
| **6.** | AV Fistula | Arteriovenous fistula |
| **7.** | AV Graft | Arteriovenous graft |
| **8.** | BP | Blood pressure |
| **9.** | BUN | Blood urea nitrogen |
| **10.** | CHO | Chinese hamster ovary |
| **11.** | CKD | Chronic kidney disease |
| **12.** | CI | Chloride |
| **13.** | CRF | Chronic renal failure |
| **14.** | CT scan | Computed tomography scan |
| **15.** | CVC | Central venous catheter |
| **16.** | DVT | Deep vein thrombosis |
| **17.** | EPO | Erythropoietin |
| **18.** | ESA | Erythropoietin stimulating agents |
| **19.** | ESRD | End stage renal disease |
| **20.** | g/Dl | Grams per deciliter |
| **21.** | GFR | Glomerular filtration rate |
| **22.** | GI | Gastrointestinal |
| **23.** | HIV | Human immunodeficiency virus |
| **24.** | IV | Intravenous |
| **25.** | K | Potassium |
| **26.** | K/DOQI | Kidney disease outcomes quality initiative |

| | | |
|---|---|---|
| **27.** | KDIGO | Kidney disease improving global outcomes |
| **28.** | MedDRA | Medical dictionary for regulatory activities |
| **29.** | mEq/L | Milliequivalents per liter |
| **30.** | mg/dl | Milligrams per deciliter |
| **31.** | mg/g | Milligrams per gram |
| **32.** | MI | Myocardial infarction |
| **33.** | ml/min | Milliliters per min |
| **34.** | Na | Sodium |
| **35.** | NKF | National kidney foundation |
| **36.** | NSAID | Non steroidal anti-inflammatory drugs |
| **37.** | PE | Pulmonary embolism |
| **38.** | RBC | Red blood cells |
| **39.** | rHuEPO | Recombinant erythropoietin |
| **40.** | SC | Subcutaneous |
| **41.** | SOC | System organ classification |
| **42.** | UTI | Urinary tract infection |
| **43.** | U/kg | Units per kilogram |
| **44.** | US | United states |

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