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Research Article

Assessment of Efficacy and Cost-Effectiveness of Oral and IV Iron Therapy in Chronic Kidney Disease

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Abstract

Introduction: Long-term iron therapy for anemia in chronic kidney disease patients is creating an economic burden and discontinuation of the treatment. Objective: The purpose of this study was to assess the cost-effectiveness and efficacy of oral and intravenous iron therapy and iron therapy. Methods: the patients were distributed into group 1 and group 2 and were administered with oral and intravenous iron therapy respectively. Baseline hemoglobin and packed cell volume were recorded and subsequently monitored in the next follow-up visit to assess the efficacy of the iron therapy. Results: Among oral therapy, ferric citrate and ferric ascorbate were administered in 61 % and 39% of patients respectively. Among intravenous Iron sucrose and carboxymalotose were administered in 76% and 24% of patients respectively. There was a mean increase of 1.15g/dl and 2g/dl of hemoglobin with oral ferrous ascorbate and intravenous carboxymaltose therapy respectively. Conclusion: Thus, iron sucrose is found to be a cost-effective treatment. Ferrous ascorbate had more effect than ferric citrate and a lower cost compared to ferric citrate. This study revealed that oral ferrous ascorbate treatment is found to be cost-effective in chronic kidney disease with anemia.

Keywords: Iron therapy, cost-effective, anemia, hemoglobin, kidney disease.

INTRODUCTION

The rising burden of chronic kidney disease (CKD) in developing countries like India puts a strain on current health systems due to a lack of financial resources and infrastructure[1]. Certain risk factors such as hypertension, and diabetes mellitus can lead to the development of CKD or can exacerbate the likelihood of developing the disease[2]. Since 1988, the frequency of CKD stages 2–5 has increased, as has the prevalence of diabetes and hypertension, which account for approximately 40% and 25% of CKD cases, respectively[3]. The most common cause of anemia in individuals with end-stage kidney disease is relative iron deficiency, which is defined as a total ferritin store of 200ng/ml or a percentage transferrin saturation of 20%[4]. On dialysis, approximately 20-30% of patients acquire Iron Deficiency anemia (IDA) [4]. Poor nutritional intake, impaired gastrointestinal absorption, continuous blood loss from repeated blood tests, minute gastrointestinal bleeding, and hemodialysis filters are all potential causes of iron deficiency[4].

Iron deficiency not only exacerbates the consequences of anemia in hemodialysis patients, but it also causes a decreased and inadequate response to erythropoiesis-stimulating drugs (ESAs), necessitating greater ESA dosages to attain the necessary hemoglobin (Hb)[5]. Iron repletion is available in both oral and intravenous (IV) forms for individuals with CKD. The decision of which agent to use is frequently influenced by therapeutic aims, tolerability, and convenience[6].

Long-term iron therapy for anemia in CKD patients is creating an economic burden and discontinuation of the treatment. Cost-effectiveness analysis (CEA) is a pharmacoeconomic technique that compares the health benefits and resources used by competing healthcare systems. When comparing the oral iron treatment option to the IV iron therapy, the ICER can be used to determine the additional cost and efficacy[7]. This study aims at the selection of oral and IV iron drugs for the treatment of CKD with better efficacy and cost effectiveness[8].

MATERIALS AND METHODS

This prospective observational, study was conducted for a duration of 6 months from January 2022 to June 2022. A total of 170 CKD patients were screened, and 140 CKD patients with anemia were included in this study as per the inclusion and exclusion criteria. Both males and females with ages greater than 18 years Outpatients on CKD therapy, both dialysis and non-dialysis patients, and Patients willing to give informed consent were included in the study. Pregnant and breast-feeding women, Blood transfusion within 2 months before enrolment, severe liver disease, severe psychiatric disorder, Anticipated surgery, or renal transplantation during the study were excluded from the study. We used various study materials including a self-designed data collection form, an informed consent form, patient information leaflets, and patient case notes.

Patients undergoing treatment for CKD complying with inclusion criteria were recruited as subjects for the study after receiving the informed consent. A designed data collection form was used to collect the required information such as Demographic details: Age, Gender, Financial background, Clinical examination, Medication, Disease-related information, Diagnosis, date of diagnosis with CKD, and duration of treatment. Hematological findings: red blood cells, hemoglobin, mean corpuscular volume, packed cell volume, mean corpuscular hemoglobin concentration, and mean corpuscular hemoglobin. Patient's treatment and medicine cost.

Enrolled subjects were divided into two groups and each group had 70 patients. Group 1 consists of patients with oral iron therapy and group 2 with IV iron therapy. Baseline data was collected at the time of enrolment and the Hb level of each patient was collected once in 30 days for 6 months to review the efficacy of the treatment. Cost-effectiveness was assessed at the end of the study by using an incremental cost-effectiveness ratio (ICER)[11].

The data were entered into Microsoft Excel 2019 and further analyzed using statistical software SPSS version 21. The categorized variables were presented as frequency and percentage and the continuous variables were reported using mean and standard deviation. P value <0.05 were considered statistically significant

RESULTS

A total of 170 patients were screened and 142 patients who fulfilled inclusion criteria were included in the study. Finally, 135 patients completed the follow-up and 7 were dropped out due to poor follow-up.

The patients were distributed to four age groups, in which most of the population belonged to the age group above 51-70 years. Out of 135 patients,77(57.04 %) patients were male 58 (42.96 %) were females, majority of the patients were taking dialysis for 4 to 5 years (40.74%).

Table 1: Patient Demographics

S. No	Demographics	Frequency	Percentage
	Sex		
1.	Male	77	57.04
2.	Female	58	42.96
	Age (Years)		
3.	18-30	13	09.63
4.	31-50	36	26.67
5.	51-70	64	47.41
6.	71-90	22	16.30
	Duration of Dialysis		
7.	<12 Months	09	6.67
8.	1-2 Years	21	15.56
9.	2-4 Years	22	16.30
10.	4-5 Years	55	40.74
11.	>5 Years	28	20.74

The baseline hemoglobin (Hb) values for IV and oral iron therapy were 9.3±0.94 and 10.7±0.63 respectively. The hemoglobin values increased to to10.9±0.88 and 11.6±0.60 for IV and oral iron therapy during the follow-up.

Table 2: Assessment of Haemoglobin

S.NO	Review	Haemoglobin (Mean ±SD)	
		Oral Iron Therapy	IV Iron Therapy
1	Baseline	10.7 ± 0.63	9.3 ± 0.94
2	I- Review	11.2 ± 0.63	10.3 ± 0.91
3	II- Review	11.6 ± 0.60*	10.9 ± 0.88*

** p < 0.05*

The baseline Packed Cell Volume (PCV) values for IV and oral therapy were 28.71 ± 1.40 and 30.78±1.01 respectively. The PCV values increased to 34.72 ± 1.40 and 36.81 ± 0.95 for IV and oral iron therapy during the follow-up.

Table 3: Assessment of PCV

S.NO	Review	PCV (Mean ±SD)	
		Oral Iron Therapy	IV Iron Therapy
1	Baseline	29.78 ± 1.01	29.71 ± 1.26
2	I- Review	31.83 ± 0.95	33.72 ± 1.32
3	II- Review	32.81 ± 0.95*	38.72 ± 1.40*

** p < 0.05*

Among oral iron therapy, improvement from baseline value of Hb was more in oral Ferrous ascorbate (1.15 ± 0.35) as compared to all other drugs. However, oral Pyrophosphate achieved greater improvement in PCV with a value of 11.1 ± 0.02.

Table 4: Assessment of Efficacy

Therapy	Generic Name	Average Efficacy		Mean Cost
		Hb	PCV	
Oral	Ferric citrate	0.65 ± 0.49	5.04 ± 0.36	4770.23
	Ferrous Bis-glycinate	0.81 ± 0.02	4.41 ± 0.16	3533.97
	Ferrous Ascorbate	1.15 ± 0.35	4.21± 2.54	4052.01
	Iron pyrophosphate	0.52 ± 0.19	11.12 ± 0.02	2836.52
Intravenous	Iron sucrose	1.62 ± 0.12	5.89 ± 0.19	5264.82
	Iron Isomaltoside	1.81 ± 0.07	6.01 ± 0.07	16470.04
	Carboxymaltos	2.01 ± 0.12	4.83 ± 0.02	11136.03

At the end of the study, PCV was similar in the two groups 5.72 ± 0.48 and 5.67 ± 2.92 respectively. However, the increase in Hb was significant with injection iron (1.67 ± 0.21) compared with oral iron (0.81 ± 0.38).

Table 5: ICER Calculation of Oral Drugs

S.NO	DRUGS	Mean Cost (Rs.)	Effect (Hb)	ICER
1	Ferric Citrate	4770.23	0.65	-8241.52
	Ferrous Bis-glycinate	3533.97	0.81	
2	Ferric Citrate	4770.23	0.65	-1436.44
	Ferrous Ascorbate	4052.01	1.15	
3	Ferric Citrate	4770.23	0.65	12891.31
	Iron Pyrophosphate	2836.52	0.52	
4	Ferrous Bis-glycinate	3533.97	0.81	1480.15
	Ferrous Ascorbate	4052.01	1.15	
5	Ferrous Bis-glycinate	3533.97	0.81	2324.91
	Iron pyrophosphate	2836.52	0.52	

Oral Ferrous ascorbate requires only 1436.44 extra cost per extra unit of healthcare effect as compared to other oral iron drugs

The average difference of the Hb value of baseline and follow-up was considered as the effect of calculating ICER. The effect of the drug for Iron sucrose, iron isomaltoside, and carboxymaltose are 1.6, 1.8, and 2 respectively. By calculating ICER, injection carboxymaltose caused greater improvement in Hb than injection iron sucrose. However, the injection of carboxymaltose is more expensive compared with the injection of iron sucrose. Thus, the injection of iron sucrose was established to be the most cost-effective compared to other IV iron drugs.

Table 15: ICER calculation between IV therapeutic drugs

S.no	Drugs	Mean Cost of Drugs (Rs)	Mean Effect of Drug	ICER
1	Iron sucrose	5264.82	1.6	56025.04
	Iron Isomaltoside	16470.12	1.8	
2	Iron sucrose	5264.82	1.6	14677.95
	Carboxy maltose	11136.02	2.0	
3	Iron Isomaltoside	5264.82	1.8	26670.12
	Carboxymaltose	11136.04	2.0	

Injection of iron sucrose requires only Rs14677.95 extra cost per extra unit of healthcare effect as compared to other drugs.

DISCUSSION

Our study revealed a significant improvement of 1.67 ± 0.21 and 5.67 ± 2.92 for Hb and PCV in IV iron therapy. The least effective one was found to be oral iron therapy where they have a significant improvement of 0.81 ± 0.38 and 5.72 ± 0.48 for Hb and PCV in oral iron therapy.[9]

Based on our study in oral iron therapy, there was a significant improvement in initial and final Hb values for each drug. Accordingly, ferrous ascorbate with an average efficacy of 1.15±35 was found to have more benefit when compared with all other oral therapies with almost similar efficacy.[10]

In a study conducted with IV iron therapy, injection of carboxymaltose with an average efficacy of 2.0 ± 0.12 was found to have more benefit compared to injection of iron sucrose. which differed from the other studies [11]

Analyzing oral iron therapy, ferric citrate was established to be more expensive with a mean total cost of Rs .4770.23 as compared to ferrous ascorbate which had a mean total cost of Rs. 4052.01 which was claimed to be true in the various studies. [12]

Based on our study of intravenous iron therapy, iron sucrose was established to be the least expensive with a mean total cost of Rs.5264.82 as compared to the most expensive drug iron isomaltose with a mean total cost of Rs.16470.04 which was matched with similar studies.[13]

CONCLUSION

The study findings indicated that the utilization of intravenous iron therapy yielded superior efficacy in patients with chronic kidney disease (CKD) compared to oral iron treatment. Our research demonstrated that patients who received IV iron therapy experienced greater effectiveness when compared to those who received oral iron therapy. In the context of IV iron therapy, it was observed that patients treated with carboxymaltose exhibited higher effectiveness in comparison to those treated with iron sucrose. However, when evaluating the incremental cost-effectiveness ratio (ICER), iron sucrose was proven to be a cost-effective alternative.

Conflict of Interest

The authors have no conflicts of interest regarding this investigation.

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