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In-Hospital Clinical Course of Frail Home Haemodialysis Patients vs. Otherwise Well In-Centre Haemodialysis Patients: A Tertiary Care Experience from Saudi Arabia

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Abstract

Background: Patients undergoing haemodialysis, whether in-centre or at home, face a high risk of hospitalisation. At our centre, HHD is offered to patients with a high frailty index, multiple comorbidities, and need for assisted mobilisation. This study aimed to compare the in-hospital clinical course of frail patients receiving HHD with otherwise well ICHD patients. **Materials and Methods:** This retrospective chart review included 42 adult patients (aged ≥ 18 years), with 21 patients in each group: ICHD (n = 21) and HHD (n = 21); chart review was done from 1 August 2022 to 31 July 2023. The studied outcomes between the two groups included hospital admissions, in-hospital consultations, Estimated Length Of Stay (ELOS), readmission within 30 days of discharge, and Emergency Medical Service (EMS) presentations. **Results:** Of 88 hospital admissions, 67% (n = 59) were noted in the ICHD group and 33% (n = 29) in the HHD group (p = 0.0014). Inpatient consultations totaled 207, with 65% (n = 135) for ICHD and 35% (n = 72) for HHD (p < 0.001). Hospital stay duration (n = 336) was 65% (n = 218 days) for ICHD and 35% (n = 118 days) for HHD (p = 0.0000). Of the readmissions (n = 10), 80% (n = 8) occurred in the ICHD group and 20% (n = 2) in the HHD group (p = 0.06), indicating marginal significance. We observed EMS visits (n = 41), with 78% (n = 32) for ICHD and 22% (n = 9) for HHD (p = 0.0003). **Conclusion:** Despite having a higher frailty index, HHD patients demonstrated more favora-

ble clinical outcomes across studied parameters. A prospective multicenter study with a larger cohort and extended follow-up is required to further validate these findings.

Keywords

Home Haemodialysis (HHD), In-Centre Haemodialysis (ICHD), Renal Replacement Therapy, Clinical Outcomes, Hospitalization

1. Background

Home Haemodialysis (HHD) has emerged as a viable alternative to In-Centre Haemodialysis (ICHD) for patients with End-Stage Renal Disease (ESRD). Recent studies have highlighted the potential benefits of HHD, particularly regarding in-hospital clinical outcomes [1]. A primary advantage of HHD lies in its flexibility, enabling patients to tailor dialysis schedules to their personal needs, which leads to improved adherence and overall health outcomes [2].

Evidence indicates that hospitalisations are less frequent and hospital stays are shorter among patients receiving HHD compared with those receiving ICHD [3]. Additionally, better blood pressure control and reduced rates of cardiovascular complications—key contributors to hospital admissions in dialysis patients—have been observed in patients on HHD [4].

Moreover, HHD has been associated with improved quality of life and greater patient satisfaction.

[5] Performing dialysis in the comfort of one's home reduces the physical and emotional stress linked to frequent travel to dialysis centres. Improved mental health and a more positive treatment outlook have been reported as outcomes, further contributing to favourable clinical results [6].

In frail patients, who are often more susceptible to the demands of ICHD, HHD offers a less physically taxing alternative [7]. Comparable, if not superior, in-hospital clinical outcomes have been documented in frail patients receiving HHD relative to robust patients receiving [8]. This finding holds particular relevance in tertiary care settings, where comprehensive and patient-centred care is prioritised [9] [10].

As a single tertiary care centre, this study differs from prior research comparing HHD and ICHD because of the distinct characteristics of our patient population. Patients receiving HHD at our centre exhibited a higher frailty index, a greater burden of comorbidities, increased immobilisation, and unique HHD prescriptions and schedules. Prompted by the promising results of HHD reported in previous studies, we investigated the outcomes of HHD in our frail patient population, compared with those of relatively healthy ICHD patients, with a focus on the complexity of their in-hospital clinical course.

Our objective was to determine whether the positive impact of HHD reported in international studies is similarly observed in our study population. The absence

of region-specific data further highlights the importance of this study.

2. Methods

Study Setting and Participants

This retrospective chart review included all adult patients (aged ≥ 18 years) with ESRD who had completed one year of Haemodialysis (HD), either in-centre (ICHD) or at home (HHD), at King Faisal Specialist Hospital and Research Centre (KFSH&RC). Patient records were reviewed over one year, from 1 August 2022 to 31 July 2023. This study was approved by the Institutional Review Board (IRB) of KFSH&RC.

Patient Selection

A total of 42 patients were selected, with 21 in each group, all of whom had completed 6 months of their respective dialysis modality (HHD or ICHD). This criterion was applied to exclude the impact of elevated admission rates typically observed during the initial 6 months of renal replacement therapy. Of 38 patients receiving HHD, 21 were included based on the completion of 6 months of HHD. From a pool of 161 patients undergoing ICHD, 21 were chosen to match the demographic characteristics of HHD populations. These 42 patients were followed for one year.

Procedural Details

Patient selection:

HHD was prescribed for patients who were either bedridden or required assisted mobility with one or two attendants. Selection also considered the burden of comorbidities, including prior Cerebrovascular Accident (CVA), amputations, dementia, and a high frailty score, as defined by the CFS score [11].

All patients receiving HHD were initiated on ICHD before transitioning to HHD based on the aforementioned clinical comorbidities.

HHD prescription:

In 81% of cases (n = 17), patients received HHD four times per week, with each session lasting four hours (totaling 16 hours per week). In 19% of cases (n = 4), patients received three sessions per week, each lasting four hours (totaling 12 hours per week).

HHD machine and accessories:

HHD was conducted using an NX stage machine with either Dialyser 172 and tubing set or Dialyser 124 with variable dialyser size, adjusted according to the patient's body weight and kT/V. Water utilisation varied with the dialysate flow rate, ranging from 20 to 45 L per session, averaging 30 L.

In-centre Haemodialysis:

In-centre haemodialysis was administered to patients with independent mobility and a low CFS frailty score. Haemodialysis was performed by certified training staff under the supervision of a nephrologist, using appropriately sized high-flux dialysers (according to the HD clearance and body weight of the patient) with tubing sets compatible with haemodialysis machines.

Patients underwent clinical assessment, haemodialysis prescription, and laboratory review, similar to the HHD population, with an additional review following hospital discharge.

In-centre Haemodialysis Dose:

Patients received 3.5 hours of dialysis duration per session of in-center hemodialysis with a weekly dialysis dose of 10.5 hours per week.

Treatment cost:

Selection of dialysis modality was not influenced by patient financial factors. Treatment costs for both HHD and ICHD are funded by the Ministry of Health.

Data Collection and Analysis

Relevant data were retrieved from the patients' electronic medical records. Arrangement and analysis of data were conducted using the Statistical Package for the Social Sciences (SPSS) software and Microsoft Excel. Collected data encompassed demographic variables, comorbid features, calculated frailty scores, primary kidney disease, haemodialysis vascular access, duration and modality of dialysis, frequency of admission, in-hospital admission course, Estimated Length Of Stay (ELOS), readmission, all-cause mortality, and Emergency Medical Service (EMS) presentations.

Outcomes

Outcomes assessed in both groups included frequency of admission, in-hospital consultation burden regarding the number of consultations requested per admission, estimated length of stay, readmission within 30 days of discharge, and EMS presentations, in addition to admission encounters.

3. Results

Table 1 presents a comparison of the clinical and demographic characteristics of patients receiving HHD and those undergoing ICHD. Each group comprised an equal number of patients (n = 21), representing 50.0% of the total sample.

The mean age in the HHD group was 65.6 years (SD = 15.4), compared to 66.6 years (SD = 11.3) in the ICHD group. The sex distribution showed that 57.1% of the HHD group were female, compared to 52.4% in the ICHD group. Statistical analysis revealed no significant differences in age or sex between the two groups (p = 0.820 and p = 1.000, respectively).

Table 1. Comparative analysis of patient characteristics and comorbidities between Home Haemodialysis and In-Centre Haemodialysis Modalities.

		HHD	ICHD	Total	p value
Number of patients		21 (50.0)	21 (50.0)	42	
Age	Mean (SD)	65.6 (15.4)	66.6 (11.3)	66.1 (13.4)	0.820
Sex	Female	12 (57.1)	11 (52.4)	23 (54.8)	1.000
	Male	9 (42.9)	10 (47.6)	19 (45.2)	

Continued

No of admissions	No Admission	8 (38.1)	0 (0.0)	8 (19.0)	0.001
	1 - 2	11 (52.4)	10 (47.6)	21 (50.0)	
	>=3	2 (9.5)	11 (52.4)	13 (31.0)	
	Yes	6 (28.6)	10 (47.6)	16 (38.1)	
DM	No	7 (33.3)	3 (14.3)	10 (23.8)	0.277
	Yes	14 (66.7)	18 (85.7)	32 (76.2)	
HPN	No	4 (19.0)	0 (0.0)	4 (9.5)	0.107
	Yes	17 (81.0)	21 (100.0)	38 (90.5)	
ICHD	No	6 (28.6)	9 (42.9)	15 (35.7)	0.520
	Yes	15 (71.4)	12 (57.1)	27 (64.3)	
CVA	No	13 (61.9)	18 (85.7)	31 (73.8)	0.697
	Yes	8 (38.1)	3 (14.3)	10 (26.2)	
Arrhythmias	No	19 (90.5)	13 (61.9)	32 (76.2)	0.067
	Yes	2 (9.5)	8 (38.1)	10 (23.8)	
Assisted mobility	No	0 (0.0)	10 (47.6)	10 (23.8)	<0.001
	Yes	21 (100.0)	11 (52.4)	32 (76.2)	
CFS frailty score (Plus 6)	No	16	6	22	0.048
CFS frailty score (less than 6)	Yes	5	15	20	0.

Note. PVD, Peripheral Vascular Disease; GI, Gastrointestinal; DM, Diabetes Mellitus; HPN, Hypertension; ICHD, Ischemic Heart Disease; CVA, Cerebrovascular Disease.

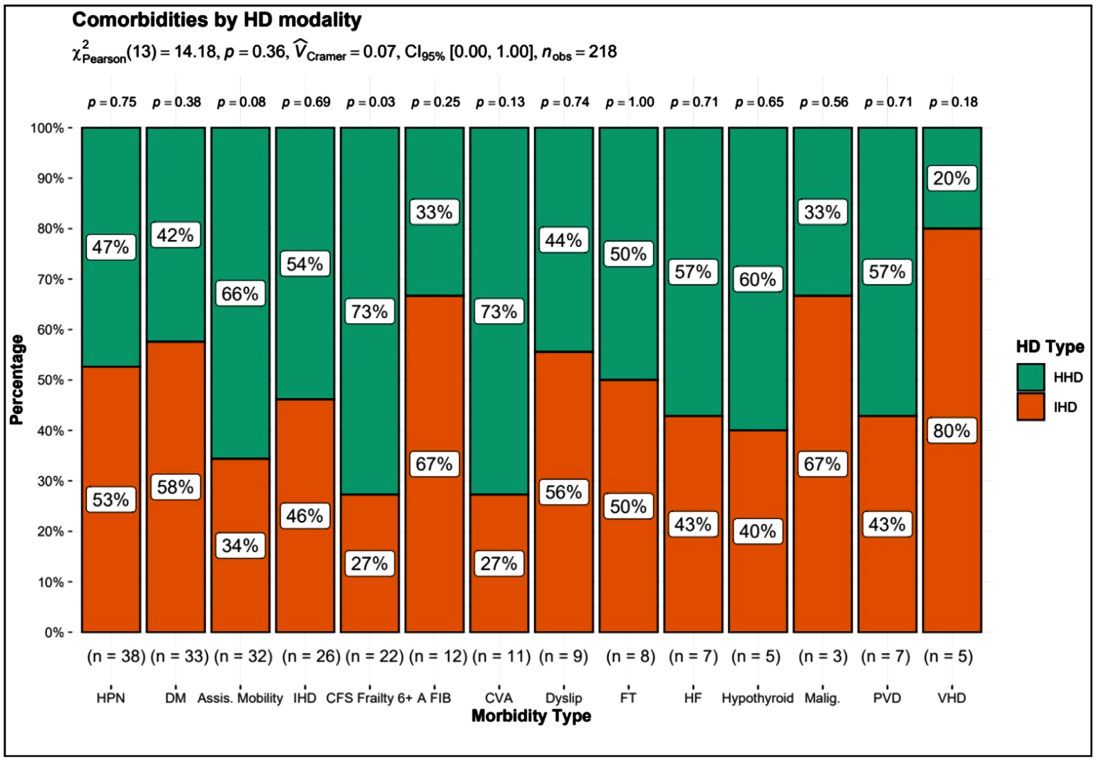

Figure 1. Comparison of comorbidity prevalence in Home Haemodialysis (HHD) vs. In-Centre Haemodialysis (ICHD) patients.

Figure 1 presents a stacked bar chart comparing the prevalence of various comorbidities among patients receiving HHD and ICHD. A significantly higher proportion of HHD patients (76.2%) had a CFS frailty score > 6 compared to ICHD patients (28.6%) ($p = 0.0048$). Additionally, 100% of patients in the HHD group required assisted mobility, in contrast to 52.4% in the ICHD group—a difference that was highly significant ($p < 0.001$). Stroke as a comorbidity was observed more frequently in the HHD group (n = 8) than in the ICHD group (n = 3), though this difference lacked statistical significance ($p = 0.697$). Other factors, including age, sex, and the prevalence of DM, HPN, and ICHD, showed no significant differences between the two haemodialysis modalities.

Over a follow-up period of 1 year, 29 admission encounters were recorded in the HHD group, compared with 59 in the ICHD group. In the HHD group, 38.1% of patients (n = 8) had no hospital admissions, whereas all patients in the ICHD group (100%) were admitted at least once ($p = 0.001$). A greater proportion of patients in the ICHD group (52.4%) experienced three or more admissions compared with those in the HHD group (9.5%). The most common reason for admission in the ICHD group was HD access malfunction (n = 18), whereas infection predominated in the HHD group (n = 12).

For in-hospital admissions in the ICHD group, 135 consultations were requested across 13 subspecialties. The most frequently consulted services were cardiology (n = 24), interventional radiology (n = 17), infectious disease (n = 16), ICU (n = 14), vascular surgery (n = 13), and haematology (n = 7). Anaesthesia (n = 18) was consulted for periprocedural clearance, and 26 consultations were made for miscellaneous services, including gastroenterology (n = 6), general surgery (n = 5), psychiatry (n = 4), pulmonology (n = 4), plastic surgery (n = 4), and dermatology (n = 3).

During in-hospital admission encounters for HHD patients, a total of 72 subspecialty consultations were recorded, involving 11 different specialties. Cardiology (n = 15) was the most frequently consulted service, followed by infectious diseases (n = 11), ICU (n = 9), vascular surgery (n = 9), and haematology (n = 4). Anaesthesia was consulted seven times for periprocedural assessment, and miscellaneous services were consulted 12 times. These departments included general surgery (n = 4), gastroenterology and pulmonology (n = 3 each), and psychiatry (n = 2).

Figure 2 presents a comparative analysis of the hospital consultation burden between ICHD and HHD across various medical consultation categories. The overall p-value (0.93) from Pearson's chi-squared test indicated no significant association across the categories. In the breakdown, cardiology and infectious disease consultations showed no significant differences, with p-values of 0.15 and 0.34, respectively. However, the anaesthesia ($p = 0.03$), interventional radiology ($p = 0.02$), and miscellaneous ($p = 0.02$) categories showed statistically significant differences, indicating a higher burden of consultations among ICHD admissions. The ICU, vascular, and haematology categories did not demonstrate significant differences, with p-values of 0.30, 0.28, and 0.37, respectively.

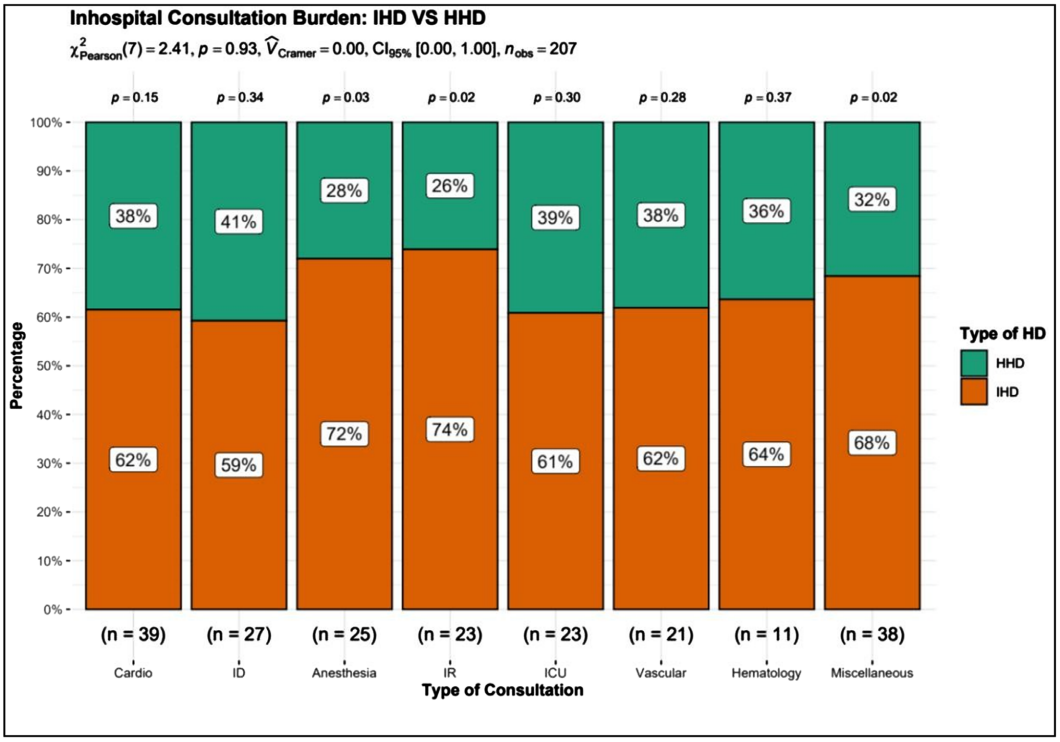

Figure 2. Comparative analysis of consultation types among In-Centre Haemodialysis (ICHD) and Home Haemodialysis (HHD) patients.

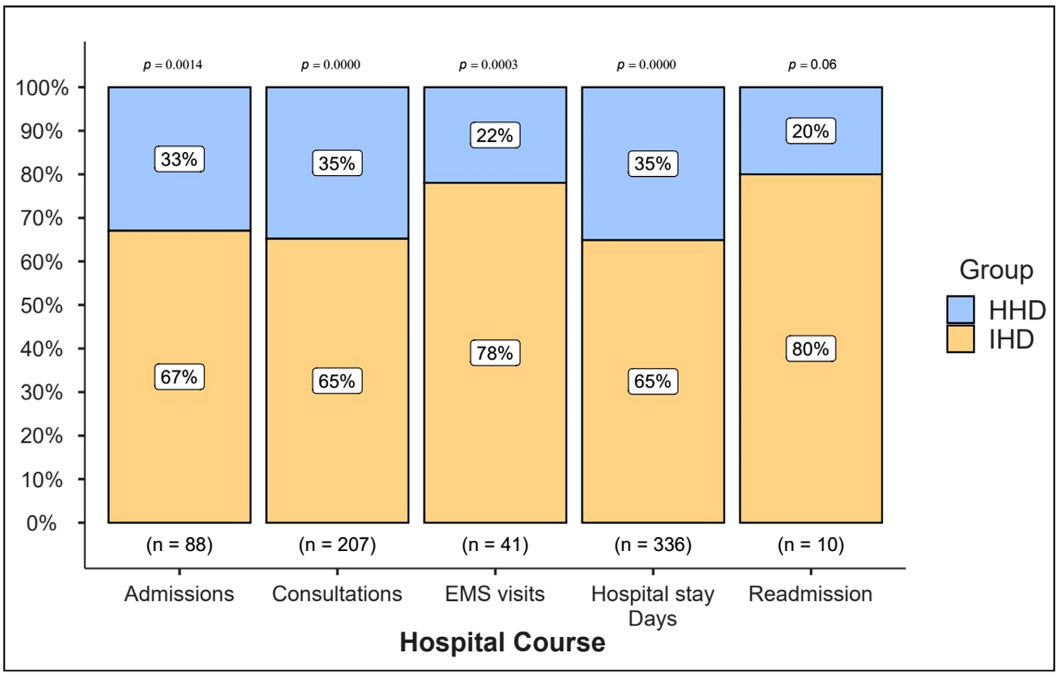

Figure 3. Hospital resource utilization in Home Haemodialysis (HHD) vs. In-Hospital Haemodialysis (ICHD) Patients.

Figure 3 illustrates the distribution of ICHD and HHD across multiple hospital admission indices: frequency of admissions, consultations, EMS visits, hospital

stay days, and readmissions. Statistical significance was determined using p-values for each category. Of 88 admissions, 67% were attributed to ICHD and 33% to HHD (p = 0.0014). Consultations totalled 207, with 65% for ICHD and 35% for HHD (p = 0.0000). Readmissions numbered 10, with 80% occurring in the ICHD group and 20% in the HHD group (p = 0.06), indicating marginal significance. EMS visits totalled 41, showing a pronounced difference: 78% for ICHD and 22% for HHD (p = 0.0003). The most common reason for EMS presentation in the ICHD group was volume overload requiring extra haemodialysis sessions, whereas fever predominated in the HHD group. Hospital stay days (n = 336) also showed a significant difference, with 65% for ICHD and 35% for HHD (p = 0.0000).

Overall, the data highlight a consistent trend of higher in-hospital admission indices for ICHD compared to HHD across all categories, with statistically significant differences in all but the readmission category, where the difference approaches significance.

4. Discussion

In this study, a frail population receiving HHD was characterized by a higher burden of comorbidities and a greater need for assisted mobilisation compared to the otherwise well in-centre haemodialysis population. Additionally, HHD was administered 3 - 4 times per week rather than 5 - 6 times per week, distinguishing this study from prior studies regarding both the HHD population's characteristics and the delivered dialysis dose.

Despite these factors, superior clinical outcomes were observed in the HHD group across all evaluated parameters, including frequency of hospital admission, in-hospital ELOS, hospital consultation burden, readmission by aetiology, and EMS presentations.

Notably, 38% of patients in the HHD group (n = 8) experienced no hospital admissions during a one-year follow-up, whereas all 21 patients in the ICHD group were admitted at least once. A lower frequency of admission was recorded in the HHD group (n = 29) compared with the ICHD group (n = 59), with a less eventful in-hospital clinical course observed in the former.

This trend persisted in cumulative hospital stay duration, with 118 days recorded for all HHD admission encounters compared with 218 days for ICHD encounters. The Estimated Length Of Stay (ELOS) per admission encounter was calculated as 4.1 days for HHD and 3.7 days for ICHD. This slightly longer duration of hospital stay was not statistically significant, and these findings do not undermine the fact that a significant percentage of HHD patients (38%) did not need admission during the 52-week follow-up. However, it can suggest an extended duration of hospital stay due to the additional burden of frailty in the HHD population.

This study appears to be the first to examine inpatient consultation burden, all-cause readmission, and EMS presentation between two haemodialysis modalities,

considering the population characteristics of frailty in the HHD group compared to the ICHD group.

We observed a lower number of subspecialties consulted during admission in the HHD group (n = 11) compared to the ICHD group (n = 13). The consultation burden was significantly lower in HHD admissions than in ICHD admissions (n = 72 vs. n = 135), with cardiology being the most frequently consulted service in both populations. This suggests a less complicated hospital course for HHD admissions compared to ICHD admissions.

Lower readmission rates were observed in the HHD group (n = 2) compared with the ICHD group (n = 8). This difference may reflect the beneficial effect of more frequent HHD sessions, which appeared to exert less impact on haemodynamic stability than ICHD sessions. Reduced exposure to hospital environments may also have decreased the risk of nosocomial infections, potentially contributing to the higher admission rates observed in the ICHD group.

A reduced incidence of all-cause EMS presentations was noted in the HHD group (n = 9) compared with the ICHD group (n = 32). Fever was the most common reason for EMS presentation in the HHD group, whereas shortness of breath related to volume overload predominated in the ICHD group. This disparity may be attributed to more frequent HD sessions with targeted ultrafiltration and dedicated nursing care in the HHD.

These findings align with a 2023 study reporting that HHD was associated with a 27.9% lower hospitalisation rate and a 52.1% reduction in hospital stay duration compared with ICHD.

That study also documented a hospitalisation rate of 2.2 per patient-year for HHD, significantly lower than 4.6 days per patient-year for ICHD [12]. Comparable results were reported in additional studies, indicating reduced hospitalisation, shorter hospital stays, and fewer dialysis-related complications—including vascular access issues—in patients receiving HHD compared with ICHD [13] [14].

Studies have reported [15] that frail patients with ESKD are expected to have higher admission rates, more complicated clinical courses, and longer hospital stays than less frail patients. In our study, a frail HHD population with similar demographic and clinical parameters was observed to have better clinical outcomes related to the hospital admission course compared to ICHD populations (**Figure 4**).

Our findings are similar to those of a study by Mowatt *et al*., which showed ELOS in HHD patients to be 5.9 days as compared to 6.7 days for the ICHD group, with cumulative hospital stays of 71 and 85 days, respectively [16].

Despite receiving a weekly dialysis dose of 12–16 hours, the HHD group—comprising a frail population with a higher burden of assisted mobility and stroke—demonstrated better clinical outcomes over a one-year period compared to the ICHD group. These findings may translate into more efficient use of healthcare resources, including clinical, human, and financial resources, as well as improve-

ments in quality indicators such as better patient experience, shorter ELOS, and fewer readmissions.

These findings encourage us to consider HHD as a potential HD therapy for frail patients and encourage us to explore its beneficial impacts in otherwise well patients traditionally receiving in-center hemodialysis.

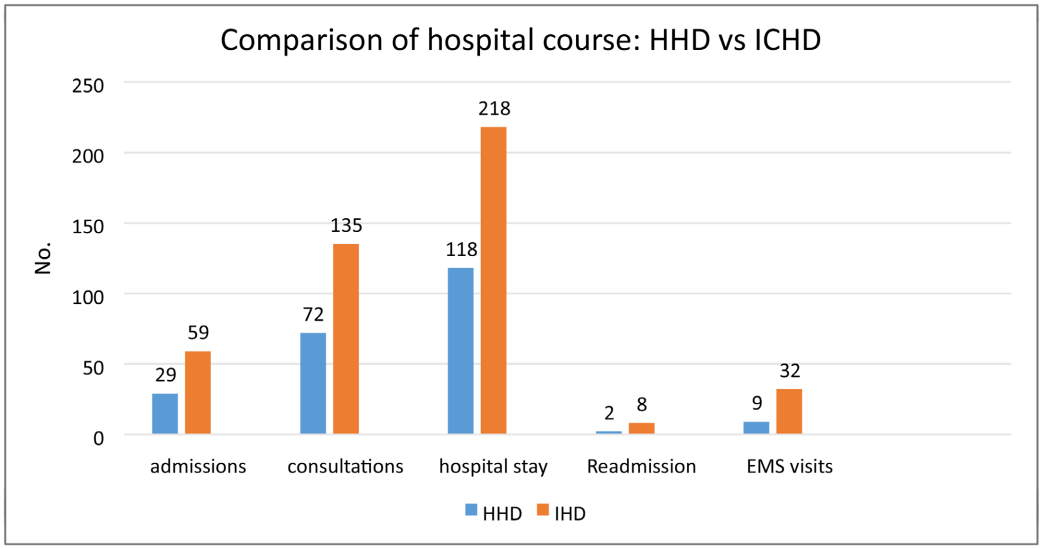

Figure 4. Comparison of hospital course: HHD vs ICHD.

5. Conclusion

Patients receiving HHD, despite their frailty and comorbidities, exhibited superior in-hospital clinical outcomes across all studied parameters compared to otherwise well ICHD patients. These findings, though limited by the single-centre, retrospective design and small sample size, provide insight into the potential benefits of HHD as a dialysis modality. A prospective multicentre trial is warranted to validate these observations and further elucidate the advantages of HHD.

Author's Contributions

Dr. Wael and Dr. Bilal contributed to the study design. Dr. Bilal, Dr. Nasir, and Dr. Lujain were involved in the writing of the article. Data analysis was done by Ms. Lama Hefni and Dr. Nadeem. Dr. Akber and Dr. Wafa contributed to the organization of the MS Excel sheet and writing of the study methodology. Dr. Talha was responsible for proofreading, formatting, and editing the article according to publication guidelines. Wael Habhab, Dr. Bilal, and Dr. Najla oversaw supervision and coordination of the work. Dr. Saeed was responsible for editing, critical review, and reorganization of the article. Dr. Bilal is the corresponding author.

Ethical Considerations

This retrospective study was conducted in accordance with the ethical standards

of the KFSHRC Institutional Review Board and adhered to the principles outlined in the Declaration of Helsinki (as revised in 2013). The study protocol was reviewed and approved by the ethics committee.

Consent to Participate

Given the retrospective nature of the study and the use of de-identified data from ESRD patients, the requirement for informed consent was waived by the IRB.

Consent for Publication

All patient details have been anonymized to ensure confidentiality in accordance with ethical guidelines and the Declaration of Helsinki.

Data Availability

The data supporting the findings of this study are available from the corresponding author upon reasonable request. Any data sharing will be conducted in strict compliance with ethical guidelines and subject to the approval of the relevant Institutional Review Board.

Writing Assistance and Third-Party Submissions

We utilized Enago article services for grammatical corrections and editing the article to fit the journal requirements.

Conflicts of Interest

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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