Geographical accessibility to the hemodialysis centers in Ardabil, Iran

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A R T I C L E   I N F O

A B S T R A C T

Introduction: Hemodialysis patients should receive hemodialysis three times per week and 140-160 times annually. The financial and temporal costs of continuing travel to hemodialysis centers affect the type of vascular access, treatment coherence, geographical distribution and mortality of patients.

Objectives: In this study, the spatial distribution and geographical accessibility of patients to the hemodialysis center and its effect on mortality and vascular access have been investigated.

Patients and Methods: This descriptive-analytic study was conducted on 315 patients with chronic renal failure undergoing hemodialysis in Bou-Ali hospital of Ardabil. Accessibility to the hemodialysis center was determined by calculating the time spent from the residence to the treatment center and analyzed by ArcGIS-10. In this study, accessibility was considered in less than 10 minutes. Logistic regression was used to investigate the relationship between spatial accessibility and mortality and vascular access. To verify the correlation between different variables, Pearson's correlation, Phi and Cramer's V, and Eta tests were applied.

Results: Among 315 patients, 161 patients (51.1%) were male and 277 (87.9%) patients were married. The mean age of patients was 62.7 ± 16.6 years. There were 170 illiterate patients (54%), 275 patients living in urban area (87.3%) and 132 patients as housewife (41.9%). Hospital records, showed 186 patients with arteriovenous fistula (AVF) (59%), 113 patients with central venous catheter (35.9%), since in 16 patients type of vascular access (5.1%) was not mentioned. Twenty patients (6.3%) died due to end-stage renal disease (ESRD), of which 11 were female. Additionally, eight patients (2.5%) were forced to migrate to nearby areas due to inappropriate accessibility to the hemodialysis services. The results showed a negative correlation between proximity to hemodialysis center and the prevalence of hemodialysis in women and men and the number of population in each time period. The spatial accessibility to the hemodialysis center did not correlate with the patient's mortality and type of vascular access.

Conclusion: Due to the high prevalence of hemodialysis patients in the vicinity of the hemodialysis center, there is a concern that ESRD patients in rural or remote areas are not properly diagnosed or died without referral to health centers. It can be declared that one of the main reasons for the low-prevalence in remote areas is the issue of spatial accessibility. The results of this study indicated the need for further studies on the prevalence and identification of ESRD in rural areas and the causes of the disease, in order to clarify the issue's dimensions.

Implication for health policy/practice/research/medical education:
It can be said that for the fair distribution of hemodialysis services in Ardebil, the geographic information system and factors such as population density, number of patients in each area and spatial accessibility should also be used.

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Introduction

Patients with end-stage renal disease (ESRD) are dramatically increasing worldwide (1). Kidney failure is a permanent or temporary damage to the kidneys (2), which leads to loss of normal functioning of the kidneys and causes many problems and complications for the patient (3). Epidemiological studies have shown that the incidence and prevalence of this disease in the world and in Iran is increasing (4). The incidence of this disease is different in different regions of the world. However; in general, the incidence of this disease in most countries is more than 200 cases per million people per year (5).

The prevalence of ESRD in the United States, Europe and Iran is estimated at 1500, 800 and 360 cases per million. The incidence of this disease in Iran in 2006 was 130% higher than in 2000. As the incidence of this disease increases, the need for increased services and medical facilities is also felt (4). The population of chronic renal failure patients with ESRD treated with renal replacement therapy increases annually (6).

In kidney dysfunction properly, renal replacement therapy methods, including kidney transplantation, hemodialysis and peritoneal dialysis are used, while hemodialysis is the most common dialysis modality (7). Currently, the best treatment for patients with ESRD is renal transplantation; however, due to organ donation difficulties and lack of medical eligibility for organ transplantation; almost all of these patients are undergoing dialysis care for a long time (8).

At the end of 2016, around 29 200 people were treated in hemodialysis in Iran. The prevalence of hemodialysis patients in different provinces of the country at the end of 2016 was varied from 225 to more than 450 people per million people. The prevalence of hemodialysis patients in Semnan province was 457 people in one million, in Qom and West Azerbaijan, were 446 people in one million. The prevalence of hemodialysis patients in Ardabil province is varied from 300 and 400 people in one million (6).

With the increasing number of patients requiring dialysis, there is more necessary to take care of these patients (9). Hemodialysis patients receive three or four hours a week in specialized treatment centers three times a week (10).

Equal access to health services for dialysis patients is one of the management priorities in providing health care and accessibility to dialysis services. Since, it has an important role in the quality of care of dialysis patients (11). Accessibility to the dialysis centers is an important necessity for dialysis patients who need hemodialysis center three times a week. Failure to pay attention to this can have adverse health outcomes such as increased disease and mortality in this group of patients (11, 12). Many studies have pointed to the usefulness of geographic information system (GIS) for calculating the accessibility of patients with dialysis (11).

Objectives

So far, in Iran, there has been no study on the geographic accessibility of the hemodialysis patients and its impact on the mortality and type of vascular access for dialysis. We have followed this goal for the first time in Ardabil using the GIS.

Patients and Methods

Patients and study design

This descriptive-analytic study was conducted on 315 patients with chronic renal failure undergoing hemodialysis in Bou-Ali hospital of Ardabil in 2013. The main stages of the implementation in this study are presented in Figure 1. Two types of information were used in this study including the available information from the medical records of the dialysis center and nephrology clinic, and also the digital layers of the studied area.

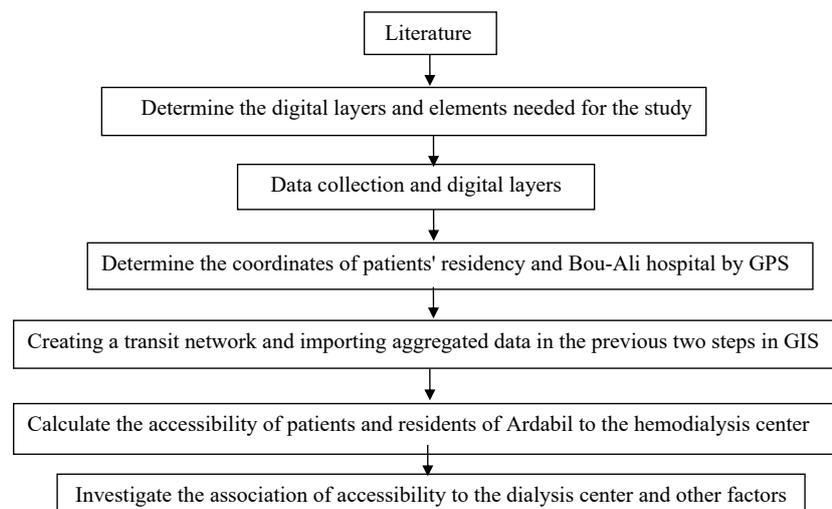Extractive data are age, gender, marital status, occupation,

Figure 1. Research Methodology.

address of residence, educational level, life status and vascular access and also comorbidity, patient migration due to hemodialysis and number of dialysis annually. Due to the impact of accessibility to hemodialysis on the patients' health, the data related to at least five years, from 2013 to 2018 were reviewed. Additionally, the data related to the patient's life status were obtained through a review of the dialysis centers' records, the provincial registry of mortality and telephone contacts with the patient or close relatives. To calculate the accessibility, at first spotting was conducted by the Global Positioning System (GPS), based on the information in the medical records, the location of the patients and Bou-Ali hospital of Ardabil, then entered into the GIS-10 software. Other digital layers including the division of the urban and rural areas of Ardebil, the digital distribution layer and the population density of this city (based on the 2011 census) consisted of demographic blocks, digital layers of roads connected to urban area along with road types such as highway, tarmac and dirt roads, and also one-way or two-way roads.

In the next stage, the data extracted from the medical records linked with the digital layer of the patients. Transit network of Ardebil was created by the digital layer and maps. ArcGIS-10 analysis was used to assess the accessibility of vehicles to hemodialysis centers. Each patient's accessibility to the hemodialysis center was determined by calculating mile and time.

Accessibility of patients and residents of Ardabil was calculated by seconds. Considering that, no agreed index for determining the appropriateness of time and place accessibility to health services, the interval of 10 minutes was for those who had the best accessibility to the facility and more than 10 minutes for people who did not have appropriate accessibility to hemodialysis facilities (13). The output of this stage was the number of people with appropriate and inappropriate accessibility.

Statistical analysis
The data of GIS was entered into the SPSS software version 19. Logistic regression was used to investigate the relationship between spatial accessibility and patient mortality, and vascular access. *P* value less than of 0.05 was considered significant. Correlation between vascular access and vital status was investigated using Phi and Cramer's V. Correlation between time accessibility with the number of dwelling population, hemodialysis prevalence in women, men and overall prevalence was investigated using Pearson's test. The significance level in the present study was less than 0.05.

Results
The main objective of this study was to determine the spatial accessibility of hemodialysis services in Ardabil and its impact on mortality and vascular access type of patients. All 315 patients with chronic renal failure undergoing hemodialysis in Bou-Ali hospital were included, in which 161 patients (51.1%) were male and 277 (87.9%) patients were married. The mean age of patients was 62.7 ± 16.6 years. There were 170 illiterate patients (54%), 275 patients living in urban area (87.3%) and 132 patients as housewife (41.9%).

The records showed, around 186 patients with arteriovenous fistula (AVF) (59%) and 113 patients with hemodialysis access (35.9%) while 16 patients were with unknown type of vascular access (5.1%). Twenty patients (6.3%) died due to ESRD disease, of which 11 were female. In addition, eight patients (2.5%) were forced to migrate to nearby areas due to inappropriate accessibility to the hemodialysis services, 199 patients (63.2%) also had one or more comorbidity in addition to ESRD. All 315 patients had hemodialysis three times a week and 156 times each year. Six patients (1.9%) had kidney transplants.

The patients' accessibility to the hemodialysis center was measured using GIS in seconds and minutes. Due to the fact that information about the location of 38 patients was not available, therefor the accessibility of 277 patients was investigated. The mean time of accessibility by vehicle to the hemodialysis center was 6.42±5.01 minutes with median of five minutes. All patients had accessibility to the hemodialysis center in less than 32 minutes and the residents in the urban area had accessibility to the hemodialysis center in less than 45 minutes. More than 93% of patients and more than 71% of residents in the urban area had accessibility in less than ten minutes by a vehicle to the hemodialysis center. The results of accessibility to the hemodialysis center by gender, life status, kidney transplant and non-referral for treatment outside of Ardabil are presented in Table 1.

In this study, the prevalence of hemodialysis patients was also determined by measuring the accessibility to the hemodialysis centers (Table 2). Pearson's correlation analysis showed a negative and significant correlation between the time accessibility to the hemodialysis centers and the number of population in each time period, the overall prevalence of hemodialysis, and the prevalence of males and females. Besides, the Phi Cramer's V. correlation test also showed a significant correlation between vital status and vascular accessibility. The correlation coefficient of Eta also showed a significant correlation between time accessibility and vital status; however, no significant correlation with vascular accessibility was detected. The results of correlations and its severity and effect size are presented in Table 2.

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In the next step, using a logistic regression test, the relationship between spatial accessibility with a number of independent variables that seemed to have a predictive role was investigated. The results showed that age, gender, marital status, education, and comorbidity did not affect the relationship between spatial accessibility and patients' mortality and type of vascular access.

Table 1. Accessibility of patients and residents to the hemodialysis center and the number of mortality, kidney transplant

Access (minute)	No. of population	No. of patients	Hemodialysis prevalence	Female	Male	Mortality	Male mortality	Female mortality	Transplant	Male transplant	Female transplant	Non-referral	Male non-referral	Female non-referral
0-5	179580	140	0.00078	77	63	10	6	4	5	0	5	5	2	3
5-10	244176	119	0.00049	63	56	9	2	7	1	0	1	3	2	1
10-15	17272	5	0.00029	3	2	0	0	0	0	0	0	0	0	0
15-20	14640	2	0.00014	1	1	0	0	0	0	0	0	0	0	0
20-25	18720	2	0.00011	0	2	0	0	0	0	0	0	0	0	0
25-30	9740	7	0.00072	3	4	0	0	0	0	0	0	0	0	0
30-35	5864	2	0.00034	1	1	1	1	0	0	0	0	0	0	0
35-40	52332	0	0	0	0	0	0	0	0	0	0	0	0	0
40-44	47160	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	589484	277	0.00047	148	129	20	9	11	6	0	6	8	4	4

Table 2. Correlation and its severity and effect size between variables of accessibility and prevalence, vascular accessibility and vital status

Vital status	Vascular accessibility	Vascular accessibility	Vital status	Time accessibility	Female prevalence	Male prevalence	Prevalence	Population	Spatial accessibility
0.240	Phi Cramer's V	0.072	0.179	Eta squared	-0.325	-0.331	-0.365	0-.632	Pearson's correlation
0.005	Approximate P value	0.475	0.001	P value	0.031	0.028	0.015	0.001	P value
Moderate	Strength of association	Weak	Moderate	Strength of association	Moderate	Moderate	Moderate	Strong	Strength of association
Small	Effect size	Small	Large	Effect size	Medium	Medium	Medium	Large	Effect size

Discussion

In the present study, vascular accessibility was found in 59% of cases with AVF, which is similar to the study of Pisoni et al (9) in the United States (54-84%). Regarding hemodialysis access in the present study (36%), our results were similar to the United States (38-39%). In the present study, the number of AVF is comparable with Switzerland statistics, thereby it is higher in countries such as Canada and Belgium (14). Given that, AVF is the preferred choice for vascular accessibility for hemodialysis patients (15,16). According to the results of our study, AVF was the most vascular access.

The results of geographical accessibility also showed that patients and rural residents had more distance to get accessibility to only the hemodialysis center in Ardabil. On the other hand, due to the increasing number of ESRD patients, the need for another hemodialysis facility is required. It is better to consider the accessibility of rural residents more. We found, 7% and 29% of patients and residents of Ardabil have no appropriate accessibility to the hemodialysis center, while all of them are residents of the rural area. Although in the present study, both groups of patients and residents in less than 45 minutes can refer to the hemodialysis center, however it is consistent with the results from the study by White et al in Wales (9).

In the present study, with an increase in distance from the hemodialysis center, its prevalence declined, many studies confirm this result (9,17). Therefore, we detected that proximity to the dialysis centers is an important factor for determining the regional incidence of dialysis (9). One of the challenges for patients and residents of rural areas is accessibility to nephrologists (18). Furthermore, the results of this study and other studies emphasize that the mapping of patients' distribution and internal travel costs to reach the dialysis centers can help health policymakers to allocate health resources to areas that are most in need (14,20).

Conclusion

The results of this study indicated the need for further studies on the prevalence and identification of ESRD in rural areas and the mortality from this disease to clarify the issue's dimensions. Finally, it can be said that for the equitable distribution of hemodialysis services in Ardebil province, the geographical information system and factors such as population density, number of patients in each area and space accessibility should also be used.

Limitations of the study

This study was carried out on a limited number of hemodialysis patients. Our results should be generalized by large-sample size studies.

Authors' contribution

Author MM designed the study, wrote the protocol and wrote the first draft of the manuscript. Author SB and BH performed the statistical analysis. SMK managed the analyses of the study and performed sampling. MA managed the literature searches, performed sampling. MA, HSN, RB and SB managed the study, edited and wrote the manuscript. SMK and SH prticipated in submitting and editing of manuscript. All authors read and approved the final manuscript.

Conflicts of interest

The authors declare no conflict of interest.

Ethical issues

Ethical issues (including plagiarism, data fabrication, double publication) have been completely observed by the authors. Human rights were respected in accordance with the Helsinki Declaration 1975, as revised in 1983. The ethical committee of Ardabil University of Medical Sciences (Ethical code# 2015.06.10) approved the study. Informed consent was taken from the participants.

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