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Original Research

Improving Healthcare Efficiency with Virtual Services: A Retrospective Economic Study from Rafha General Hospital

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Abstract

Introduction: In response to the growing use of digital health technologies, it is essential to evaluate their cost-effectiveness and efficiency. Virtual clinics, especially during the COVID-19 pandemic, have emerged as key healthcare delivery solutions, allowing remote patient interactions with healthcare professionals. Seha Virtual Hospital, a pioneering initiative in Saudi Arabia, exemplifies this shift by offering specialized healthcare services to 170 hospitals across the Kingdom. Despite the increasing adoption of virtual care, evidence assessing the economic effectiveness of virtual hospitals remains limited. This study aims to evaluate the cost-effectiveness of Seha Virtual Hospital services at Rafha General Hospital, addressing a gap in the literature and providing crucial insights for health care system. **Methods:** This study was a retrospective observational study including 3.728 patients' records . The study was conducted in a Rafha General Hospital in collaboration Seha Virtual Hospital. The duration of the study spanned from January 2023 to March 2024 encompassing a total of 1 year. **Results:** A total of 3,728 patients received Seha Virtual Hospital services at Rafha General Hospital. Of which, 3035 patients received virtual radiology service, followed by ICU virtual services (545 patients), then virtual Inpatient consultation service (40 patients), virtual stroke services (39 patients), virtual EEG services (35 patients), virtual outpatient services (27 patients), then national virtual heart committee services NVHC (6 patients) and lastly, virtual oncology services (1 patient). These virtual services saved costs a total of SAR 9.152.600 from part-time contracting with healthcare practitioners and the patients' travelling expenses. The overall costs saved from travelling to receive ICU services, outpatient services, NVHC services, radiology services, stroke services, INP-consultation, EEG services, and oncology services were SAR 4.705.000, SAR 54.000, SAR 13.500, SAR 1.062.250, SAR 1.209.600, SAR 1.702.800, SAR 403.200, and SAR 2250, respectively. **Conclusion:** The findings of current study provide a clear evidence that the virtual services from Seha Virtual Hospital to the patients at Rafha General Hospital have reduced the costs for the healthcare provider in terms of patients' living expenses and temporary contracting with specialized health practitioners in each required specialty for delivering optimal healthcare services and reduce the referral to tertiary hospital.

Keywords: Virtual Hospital, Cost-Effectiveness, Tele-ICU, Tele-Radiology.

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INTRODUCTION

In a quickly developing culture, the growth of digital technology used to enhance human health and well-being requires to be continuously assessed, both in its effectiveness and efficiency. The definition of eHealth according to The World Health Organization is "the cost-effective and secure use of information and communications technologies in support of health and health-related areas, involving health-care services, health surveillance, health literature, and health education, knowledge and research"[1]. Virtual clinics have appeared as a possible answer to advance healthcare delivery, particularly during the coronavirus disease (COVID-19) pandemic. By leveraging telehealth technology, virtual clinics help patients to connect remotely with healthcare professionals, removing the need for an in-person visit[2].

Seha Virtual Hospital is a specialized hospital that uses the newest innovative technologies to deliver specialized services and support health facilities in the Kingdom of Saudi Arabia. It provides its services in 170 hospitals around the Kingdom of Saudi Arabia, and offers 29 basic specialized health services, furthermore, it provides services to more than 73 sub-specialties, and employs more than 150 male and female doctors, with a capacity of more than 480,000 patients per year. The Seha Virtual Hospital is one of the most important initiatives in the health sector transformation program that serves the vision, improves the culture of virtual medicine in health authorities, and offers the best virtual health services at the national and global levels, Moreover this hospital provides many services by providing specialized medical care in a timely manner, regardless of the geographical distance. Rafha General Hospital is a member of Northern Borders Health Cluster serving more than 85K people living in Rafha city and surrounded rural area. It is a 100 beds capacity healthcare institution providing its healthcare services in general medical specialities.

A review of the literature proposes that there is a lack of actual evidence that fully assess the economic effectiveness of virtual clinics and hospitals. There are numerous diverse costs linked to the development and application of these systems. Some of the expenses, among others, are equipment expenses, staffing expenses, and communications expenses.

At the current time, it is supposed that telehealth could reduce costs on the health system, mainly when telehealth services prevent health system-funded travel, causing reductions in secondary care, and when telehealth alleviates the need for costly specialist interventions by providing quality care in an effective way, including telemonitoring. Moreover, it has been described that telemedicine has the ability to offer substantial cost savings by increasing patients' working ability, independent living ability, quality of life, and reducing travel costs[5]. Furthermore, virtual medical care reduces the need for patients to travel to hospitals, which can be particularly useful for those who live in rural areas. This can save patients money on transportation costs, as well as reduce the need for time off work. Patients can access healthcare services from the comfort of their own homes and save fuel, money for parking, and public transportation fares. Overall, virtual medical care has the ability to make primary care more reachable and affordable for patients who would otherwise have to travel long distances to receive it[6]. The ability to decrease the cost of health care is one of the major reasons for the attention given for implementing virtual medical care services, followed closely by a desire to enhance access to health care. Virtual health care services are frequently used to substitute a proportion of in-person encounters, and this substitution raises the question of a relative cost reduction[7]. Regardless of the institutional fervour and extensive applicability of virtual health approaches, healthcare facilities and services are facing difficulties to assess the cost-effectiveness of different solutions. The absence of protocols and tools for the comparative evaluation of the effectiveness and value of speedy-developing virtual health solutions exacerbates the persistent necessity for quality evidence to navigate normative change[1]. Accordingly, the current study aimed to assess the cost-effectiveness of Seha Virtual Hospital in Rafha Hospital, Saudi Arabia. Given the deficiency of evidence in the literature on the cost-effectiveness of virtual hospital care, it is believed that the results of this study will offer valuable data to health policymakers and can deliver additional guidance on the economic implications of increasing virtual hospital care services.

METHOD

Study Design

The research methodology employed in this study was a retrospective cohort study design. This design facilitated the identification of all eligible patients received virtual medical services from Seha Virtual Hospital.

Study Setting and Duration

The study was conducted in a Rafha General Hospital in collaboration Seha Virtual Hospital. The duration of the study spanned from January 2023 to March 2024.

Study Subjects/Participants

Inclusion Criteria:

All patients in Rafha General Hospital who received virtual medical services from Seha Virtual Hospital with complete medical records during the period between January 2023 and March 2024.

Exclusion Criteria:

Patients with incomplete records and patients who were treated before January 2023 and after March 2024.

Recruitment

Patients meeting the inclusion criteria were identified through a review of medical records. Subsequently, these patients were contacted to obtain consent for participation in the study.

Ethical Approval

The Ethical approval was obtained from the research ethical committee at Northern Border Health Cluster. The participants' privacy and confidentiality were maintained.

Sample Size Estimate and Data Analysis

Based on previous studies sampling, the study aimed to include all eligible patients during the study period to ensure an adequate sample size. Descriptive statistics were used to summarize demographic characteristics.

RESULTS

A total of 3.728 patients received Seha virtual Hospital services in Rafha General Hospital. Of which, 3035 patients received virtual radiology services, followed by ICU virtual services (545 patients), then virtual Inp-consultation services (40 patients), virtual stroke services (39 patients), virtual EEG services (35 patients), virtual outpatient services (27 patients), then virtual NVHC services, and lastly, virtual oncology services (1 patient).

The average costs of travelling to Arar for hospital services (per patient) by car SAR, 491 SAR, respectively. While the average costs of travelling to Riyadh for hospital services (per patient) by 973 SAR, respectively.

The monthly salary of hiring an employee with 2 years of experience to 23 years is 12.275 SAR per month, thus, 147.300 SAR/year.

ICU virtual services

545 patients were treated virtually in the ICU department. Males (59.8%) were more than females (40.2%), and the mean age was found to be 54.7 years. The majority of cases (67.9%) were discharged to the ward, while (14.1%) were transferred to another facility, (9.4%) died, and (8.4%) were DAMA. The average length of stay in the ICU was found to be 4.78 days, compared to an average length of stay of 7 days in hospitals. The average costs saved from ICU in non-medical city type provider and medical city & tertiary type provider were 24.741 SAR and 29.138 SAR, respectively. Average costs saved from travelling to Riyadh for ICU by flight were 530.285 SAR, respectively.

Outpatient virtual services

Two referral physicians covered the outpatient. The primary physician was a pediatrician and the secondary physician was a general practitioner. A total of 27 patients were treated virtually in the outpatient. Females (70.4%) were more than males (29.6%), and the mean age was found to be 14 years. Of which all patients were dependent (100%). (74.1%) of patients were scheduled for follow up. From which, the majority (88.0%) completed the appointment successfully, while (11.1%) of patients did not show up. The average costs saved from travelling to Riyadh for outpatient by flight were 26.271 SAR, respectively.

NVHC virtual services

Regarding virtual NVHC services, 6 patients were treated. Males (66.7%) were more than females (33.3%), and the mean age of patients was found to be 54.5 years. The majority (83.3%) were Saudi, while (16.7%) were non-Saudi. Two referral physicians attended virtually. No changes of treatment plan were made (100%). Further investigations were requested for (33.3%) of the patients, while (66.7%) were referred for a higher center. In the follow up, all patients (100%) were treated successfully, in which the majority of cases (83.3%) were treated by the local team, while only one case (16.7%) was referred to a higher center. The average costs saved from travelling to Riyadh for NVHC by flight were 5.838 SAR, respectively.

Radiology virtual services

A total of 3035 patients received virtual radiology service. Of them, (94.6%) came from the outpatient, followed by the inpatient (4.2%), then the emergency department (1.2%). The most common study done was MRI (54.9%), followed by CT (27.7%), then mammogram (10.8%) then lastly MRA (6.6%). Neuroradiology (50.5%) was the most used specialty used virtually, followed by musculoskeletal (23.1%). In regard with reporting turn-around-time, (38.4%) took 2 hours or less, followed by 24 hours or less (21.8%). The average costs saved from travelling to Riyadh for imaging by flight were 2.953.055 SAR, respectively.

Stroke virtual services

Regarding virtual stroke services, 39 patients were included. Males (66.7%) were more than females (33.3%), and the mean age group was found to be 61.7%. The majority (89.7%) were Saudi, while (10.3%) were non-Saudi. The majority of patients (79.5%) did not wake up, while (20.5%) woke up. The majority (53.8%) had normal CT findings, while the rest showed abnormal and old strokes (23.1%, each). The means of NIHSS and Modified RS (Pre-Stroke) were found to be 7.2 and 0.3, respectively. (15.4%) of patients received IV Tpa, and (5.1%) received mechanical thrombectomy. The final diagnosis was found to be stroke in 74.4% of patients. The average costs saved from travelling to Riyadh for stroke check-up by flight were 37.947 SAR, respectively.

INP-consultation virtual services

Regarding virtual INP-consultation services, 40 patients were included. From which, females (60%) were more than males (40%), and the mean age was found to be 45 years.

Neurology (25%) was the most requested specialty, followed by gastroenterology (17.5%), then respiratory medicine (15%), endocrinology (12.5%), followed by both hematology and internal medicine (10%, each), and lastly both nephrology and rheumatology (5%, each). The average costs saved from travelling to Riyadh for INP-consultation by flight were 38.920 SAR, respectively.

EEG virtual services

35 patients received EEG. Of them, males (54.3%) were more than females (35.7%), and the mean age was found to be 24 years. The majority (94.3%) received routine EEG, while (5.7%) received long-term electroencephalographic monitoring (LTM). The majority of cases (94.3%) came from the outpatient, while (5.7%) came from the ward. The average number of virtually reviewed reports was 275.7 reports, as the majority of reports (82.9%) were normal, (14.3%) were abnormal, and (2.8%) were technically unsatisfactory. The average costs saved from travelling to Arar for EEG by car, and driving were 2.590 SAR, and 40.810 SAR, respectively.

Oncology virtual services

Regarding virtual oncology services, only one case of a Saudi 49-year-old female with newly diagnosed breast cancer was included. Further investigations were requested. The average costs saved from travelling to Riyadh for oncology services by flight were 973 SAR, respectively.

Thus, a total of 3.728 patients received Seha virtual services in Rahfa Hospital. These virtual services saved patients a total of 1.886.389 SAR from travelling, in which the overall costs saved from travelling to receive ICU services, outpatient services, NVHC services, radiology services, stroke services, INP-consultation, EEG services, and oncology services were 275.406 SAR, 13.644 SAR, 3.032 SAR, 1.533.686 SAR, 19.708 SAR, 20.213 SAR, 20.195 SAR, and 505 SAR, respectively. Furthermore, the virtual services saved a total of 98.200 SAR per month from hiring a specialist in each department, which is 1.178.400 SAR per year.

According to Table 1**,** A total of 3.728 patients received Seha virtual services in Rahfa Hospital. Of which, 3035 patients received virtual radiology services, followed by ICU virtual services (545 patients), then virtual INP-consultation services (40 patients), virtual stroke services (39 patients), virtual EEG services (35 patients), virtual outpatient services (27 patients), then virtual NVHC services, and lastly, virtual oncology services (1 patient).

According to Table 2, The average costs of travelling children patients to Riyadh is SAR 3625, while adult patients might cost SAR 2550.

According to Table 3, The average monthly saved cost from Part-time consultants in each specialty is SAR 100.800, while respiratory specialists might cost a roughly SAR 31.500 / month for covering Respiratory therapy service in ICU.

According to Table 4, 545 patients were treated virtually in the ICU department. Males (59.8%) were more than females (40.2%), and the mean age was found to be 54.7 years. The majority of cases (67.9%) were discharged to the ward, while (14.1%) were transferred to another facility, (9.4%) died, and (8.4%) were DAMA. The average length of stay in the ICU was found to be 4.78 days after the activation tele-ICU service, compared to an average length of stay of 7 days prior the commencement of virtual ICU service. The average costs saved from reducing the occupancy rate in ICU was SAR 3.117.400, whilst approximately SAR 1.587.600 was saved from temporary contracting with consultant intensivists and respiratory therapists. Clearly that the activation of tele-ICU service saved a total of SAR 4.705.000 during the period between Apr. 2023 to Mar.2024.

Table 5 demonstrates the virtual outpatient services, in which two referral physicians covered the outpatient. The primary physician was a pediatrician and the secondary physician was a general practitioner. A total of 27 patients were treated virtually in the outpatient. Females (70.4%) were more than males (29.6%), and the mean age was found to be 14 years. Of which all patients were dependent (100%). (74.1%) of patients were scheduled for follow up. From which, the majority (88.0%) completed the appointment successfully, while (11.1%) of patients did not show up. The average costs saved from travelling to Riyadh for outpatient appointment were around SAR 54.000.

In Table 6, virtual NVHC service is described, in which 6 patients were treated. Males (66.7%) were more than females (33.3%), and the mean age of patients was found to be 54.5 years. The majority (83.3%) were Saudi, while (16.7%) were non-Saudi. Two referral physicians attended virtually. No changes of treatment plan were made (100%). Further investigations were requested for (33.3%) of the patients, while (66.7%)

Table 1. Showing overall demographics of virtual Seha services in Rahfa Hospital.

Services	Number of patients
Virtual ICU services	545
Virtual outpatient services	27
Virtual NVHC services	6
Virtual radiology services	3035
Virtual stroke services	39
Virtual INP-consultation services	40
Virtual EEG services	35
Virtual oncology services	1
Total	**3.728**

Table 2. Shows the average costs of travelling patients who requires tertiary hospital services in Riyadh.

Variables	Category	Count	Total
Average costs of travelling to Riyadh for hospital services (per patient) Note: For children, 2 companions are allowed, For adult, only 1 companion is allowed	Living expenses	**SAR 300/person a day,** • For children: 3 persons= SAR 900 a day; • For adult: 2 persons = SAR 600 a day	Child patient- Living expenses + Flight Tickets 900 + 2725 = ***SAR 3625***
	Flight Tickets	**Adult seat: SAR 975 ,Child seat: SAR 775** • For children: 3 persons= SAR 2725; • For adult: 2 persons= SAR 1950	Adult patient – Living expenses + Flight Tickets 600 + 1950 = ***SAR 2550***

*Costs were calculated based on[14].

Table 3. Shows the average monthly cost of part time healthcare practitioners contract.

Variables	Category	Monthly hours	Required number of healthcare practitioners in each medical specialty / month	Fare / hour	Monthly cost / health practitioner	Monthly cost
Average salaries saved from Part-time in each specialty	Physicians (Consultant)	63 hrs	4	SAR 400	SAR 25.200	SAR 100.800
	Respiratory Therapist	63 hrs	4	SAR 125	SAR 7875	SAR 31.500

*The part time contracting cost was calculated based on The Temporary Contracting Guidelines, Saudi Ministry of Health, 2021.[15]

Table 4. Showing baseline demographics of virtual ICU services.

Variables	Category		Count	Percentage
Gender	Male		326	59.80%
	Female		219	40.20%
Age (mean)	54.7 years			
Condition on discharge	Ward		370	67.90%
	Other facility		77	14.10%
	Active		1	0.20%
	DAMA		46	8.40%
	Deceased		51	9.40%
Average length of stay before activating Tele-ICU service	7 days			
Average length of stay after activating Tele-ICU service	4.78 days			
Average saved cost from ICU bed occupancy rate	Occupancy rate diff.	2.2 day		2.2 * 2600 *545=
	Daily cost of ICU bed	SAR 2600		SAR 3.117.400
	Number of patients	545		
Average saved cost from Part-time contracting in each specialty	Consultant Intensivists	**SAR 100.800**		**Apr. 2023 to Mar 2024** **SAR 132.300 * 12**
	Respiratory Therapists	**SAR 31.500**		**SAR 1.587.600**
The total Saving amount	3.117.400 + 1.587.600			SAR 4.705.000

Table 5. Showing baseline demographics of virtual outpatient services.

Variables	Category	Count	Percentage
Number of attending physicians	Two physicians		
Specialty of physicians	Pediatrics	1	
	General practice	1	
Patients' information			
Gender of patients	Male	8	29.60%
	Female	19	70.40%
Age of patients (mean)	14 years		
Is the patient dependent?	Yes	27	100%
	No	0	0
Virtual follow up	Yes	20	74.10%
	No	7	25.90%
Appointment status	Completed Successfully	24	88.90%
	Patient didn't join	3	11.10%
Average costs saved from travelling to Riyadh for outpatient	24 * 2250	SAR 54.000	

Table 6. Showing baseline demographics of virtual NVHC services.

Variables	Category	Count	Percentage
Gender of patients	Male	4	66.70%
	Female	2	33.30%
Age of patients (mean)	54.5 years		
Nationality	Saudi	5	83.30%
	Non-Saudi	1	16.70%
Number of referral physicians	Two physicians		
Changes in treatment plan	Yes	0	0%
	No	6	100%
Recommendation	Further investigation	2	33.30%
	Referral to higher center	4	66.70%
Follow up status	Treated	6	100%
	Not treated	0	0%
Treatment done by	Local team	5	83.30%
	Referral to higher center	1	16.70%
Average costs saved from travelling to Riyadh for NVHC	6 * 2250 = SAR 13.500		

were referred for a higher center. In the follow up, all patients (100%) were treated successfully, in which the majority of cases (83.3%) were treated by the local team, while only one case (16.7%) was referred to a higher center. The average costs saved from travelling to Riyadh for NVHC a roughly SAR 13.500.

In Table 7, virtual radiology services are presented. A total of 3035 patients received virtual radiology service. Of them, (94.6%) came from the outpatient, followed by the inpatient (4.2%), then the emergency department (1.2%). The most common study done was MRI (54.9%), followed by CT (27.7%), then lastly mammogram (10.8%), MRA (6.6%). Neuroradiology (50.5%) was the most used specialty used virtually, followed by musculoskeletal (23.1%). Regarding duration, (38.4%) took 2 hours or less, followed by 24 hours or less (21.8%). The average costs saved from private outsource reporting of medical imaging were SAR 1.062.250 roughly.

Table 8 demonstrates the demographics of virtual stroke services, in which 39 patients were included. Males (66.7%) were more than females (33.3%), and the mean age group was found to be 61.7%. The majority (89.7%) were Saudi, while (10.3%) were non-Saudi. The majority of patients (79.5%) did not wake up, while (20.5%) woke up. The majority (53.8%) had normal CT findings, while the rest showed abnormal and old strokes (23.1%, each). The means of NIHSS and Modified RS (Pre-Stroke) were found to be 7.2 and 0.3, respectively. (15.4%) of patients received IV Tpa, and (5.1%) received mechanical thrombectomy. The final diagnosis was found to be stroke in 74.4% of patients. The total saved cost from part time contracting with stroke consultants since the commencement of tele-stroke service on Mar 2023 was roughly SAR 1.209.600.

Regarding demographics of virtual INP-consultation services displayed in Table 9, 40 patients were included. From which, females (60%) were more than males (40%), and the mean age was found to be 45 years. Neurology (25%) was the most requested specialty, followed by gastroenterology (17.5%), then respiratory medicine (15%), endocrinology (12.5%), followed by both hematology and internal medicine (10%, each), and lastly both nephrology and rheumatology (5%, each). The total saved costs from Part-time contracting with subspecialized consultants in eight specialties since the commencement of virtual INP Consultations on Feb 2024 was around SAR 1.612.800. while the cost of SAR 90.000 was saved from travelling 40 patients to Riyadh for outpatient consultations.

In Table 10, The demographics of virtual EEG services are presented, in which 35 patients received EEG. Of them, males (54.3%) were more than females (35.7%), and the mean age was found to be 24 years. The majority of cases (94.3%) came from the outpatient, while only (5.7%) came from the ward. The

Table 7. Showing baseline demographics of virtual radiology services.

Variables	Category	Count	Percentage
Source of patients	Emergency department	36	1.20%
	Inpatient	127	4.20%
	Outpatient	2872	94.60%
Study done	CT	843	27.70%
	Mammogram	328	10.80%
	MRA	199	6.60%
	MRI	1665	54.90%
Specialty	Breast	426	14%
	Cardiothoracic	34	1.10%
	Body	342	11.30%
	Neuroradiology	1533	50.50%
	Musculoskeletal	700	23.10%
Duration	Equal or less than 2	1164	38.40%
	Equal or less than 4 hours	300	9.90%
	Equal or less than 6 hours	261	8.60%
	Equal or less than 24 hours	663	21.80%
	Equal or less than 48 hours	331	10.90%
	Equal or less than 72 hours	167	5.50%
	More than 72 hours	149	4.90%
	Report cost	**Total no. of reports**	**Total cost**
Average costs saved from private outsource reporting of medical imaging	SAR 350	3035	SAR 1.062.250

Table 8. Showing baseline demographics of virtual stroke services.

Variables	Category	Count	Percentage
Gender of patients	Male	26	66.70%
	Female	13	33.30%
Age of patients (mean)	61.7 years		
Nationality	Saudi	35	89.70%
	Non-Saudi	4	10.30%
Patient woke up	Yes	8	20.50%
	No	31	79.50%
CT finding	Normal	21	53.80%
	Abnormal	9	23.10%
	Old stroke	9	23.10%
NIHSS (mean)	7.2		
Modified RS (Pre-Stroke) (mean)	0.3		
Patient received IV Tpa	Yes	6	15.40%
	No	33	85.60%
Patient received Mechanical Thrombectomy	Yes	2	5.10%
	No	28	71.80%
	Missing	9	23.10%
Diagnosis	Stroke	29	74.40%
	Other	10	25.60%
Average saved cost from Part-time contracting with stroke consultants	Total no. of monthly required part time contracts	Cost / contract	Total saved costs/ month
	4	SAR 25.200	SAR100.800
Total saved costs since the commencement of Tele-stroke service on Mar 2023	12 * 100.800 = SAR 1.209.600		

average number of virtually reviewed reports was 35 reports, as the majority of reports (82.9%) were normal, (14.3%) were abnormal, and (2.8%) were technically unsatisfactory. The total saved cost from part-time contracting with neurology consultant for EEG reporting since the commencement of the service on Dec 2023 was SAR 403.200.

Regarding virtual oncology services presented in Table 11, Only one case of a Saudi 49-year-old female with newly diagnosed breast cancer was included. Further investigations were requested. The average costs saved from travelling to Riyadh for oncology services by flight were 973 SAR, respectively.

According to Table 12, A total of 3.728 patients received Seha Virtual Hospital services in Rafha General Hospital. These virtual services saved cost of a total of SAR 9.152.600 from part-time contracting with healthcare practitioners and patients' travelling expenses.

DISCUSSION

This study was conducted in order to assess the saved costs for both the service provider and the patients across all the medical specialties at Seha Virtual Hospital in Rafha Hospital in Saudi Arabi.

Table 9. Showing baseline demographics of virtual INP-consultation services.

Variables	Category		Count	Percentage
Gender of patients	Male		16	40%
	Female		24	60%
Precedence	Inpatient		40	100%
	Other		0	0%
Age of patients (mean)	45 years			
Request/Requested Specialties	Endocrinology		5	12.50%
	Gastroenterology		7	17.50%
	Hematology		4	10%
	Internal medicine		4	10%
	Nephrology		2	5%
	Neurology		10	25%
	Respiratory Medicine		6	15%
	Rheumatology		2	5%
Average saved cost from Part-time contracting with subspecialized consultants	No. of virtual INP Consultations specialties	Total no. of monthly required part time contracts / specialty	Cost / contract	Total saved costs/ month
	8	32	25.200 SAR	SAR 806.400
Average costs saved from travelling patients to Riyadh for outpatient consultations	**40* 2250 = SAR 90.000**			
Total saved costs since the commencement of virtual INP Consultations on Feb 2024	**(2 * 806.400) + 90.000 = SAR 1.702.800**			

Table 10. Showing baseline demographics of virtual EEG services.

Variables	Category	Count	Percentage
Gender of patients	Male	19	54.30%
	Female	16	45.70%
Patient Age Group	Adult	24	68.60%
	Pediatric	11	31.40%
Age of patients (mean)	24 years		
Source	Outpatient	33	94.30%
	Ward	2	5.70%
Average number of reports	35 reports		
Impression of report	Normal	29	82.90%
	Abnormal	5	14.30%
	Technically unsatisfactory	1	2.80%
Average saved cost from Part-time contracting with neurology consultant for EEG reporting	Total no. of monthly required part time contract	Cost / contract	Total saved costs/ month
	4	25.2	SAR100.800
Total saved costs since the commencement of Tele-EEG on Dec 2023	4 months * 100.800/ month = SAR 403.200		

Various and different published studies were done about the same topic as the present article:

A systematic review study was conducted by Andrea Gentili et al. in Italy in the year 2022 to analyze the evidence on the cost-effectiveness of digital health interventions. Search identified 1,476 results, 552 of which were selected for abstract and 35 were included in this review. The studies were heterogeneous by country (mostly conducted in upper and upper-middle income countries), type of eHealth intervention, method of implementation, and reporting perspectives. The qualitative analysis identified the economic and effectiveness evaluation of six different types of interventions: (1) seventeen studies on new video-monitoring service systems; (2) five studies on text messaging interventions; (3) five studies on web platforms and digital health portals; (4) two studies on telephone support; (5) three studies on new mobile phone-based systems and applications; and (6) three studies on digital technologies and innovations. Findings on cost-effectiveness of digital interventions showed a growing body of evidence and suggested a generally favorable effect in terms of costs and health outcomes. The findings of the previously done study align with the ones found in the current study, in which the virtual services of Seha Virtual Hospital in Rafha Hospital saved patients a total of 1.886.389 SAR from travelling, in which the overall costs saved from travelling to receive ICU services, outpatient services, NVHC services, radiology services, stroke services, INP-consultation, EEG services, and oncology services were 275.406 SAR, 13.644 SAR, 3.032 SAR, 1.533.686 SAR, 19.708 SAR, 20.213 SAR, 20.195 SAR, and 505 SAR, respectively. Furthermore, the virtual services saved a total of 98.200 SAR per month from hiring a specialist in each department, which is 1.178.400 SAR per year[1].

When comparing the findings of another study that was conducted in Saudi Arabia by Manal Faleh AlMutairi et al. in the year 2021 to evaluate the cost-effectiveness of telemedicine for patients with uncontrolled type 2 diabetes mellitus, with

Table 11. Showing baseline demographics of virtual oncology services.

Variables	Category	Count	Percentage
Gender	Male	0	0%
	Female	1	100%
Age	49 years		
Nationality	Saudi	1	100%
	Non-Saudi	0	0%
Diagnosis	Newly diagnosed	1	100%
	Already diagnosed	0	0%
Type of treatment	Further investigation	1	100%
	Chemotherapy	0	0%
	Radiation therapy	0	0%
	Surgical management	0	0%
Average costs saved from travelling to Riyadh for oncology services	SAR 2250		

the findings of the current study, it can be noticed that the two studies showed different results, in which the patients of the previously done study in the telemedicine care model had a mean reduction in their HbA1c level of 1.82 (95% CI = 1.56–2.09, $p < 0.001$), while those in the traditional care model had a mean reduction of 1.54 (95% CI = 1.23–1.85, $p < 0.001$). Consequently, the incremental effect was 0.28 (95% CI = −0.194 to 0.546). The mean total costs were SAR 4819.76 (US$1285.27) and SAR 4150.69 (US$1106.85) for patients in the telemedicine and traditional care models, respectively. Consequently, the incremental cost was SAR 669.07 (US$178.42) [95% CI = SAR 593.7 (US$158.32)–SAR 1013.64 (US$270.30)]. The ICER was estimated to be SAR 2372.52 (US$632.67) per 1% reduction in the level of HbA1c. Moreover, the telemedicine care model resulted in a higher cost and better outcome (i.e. reduction in the HbA1c level) with an 81.80% confidence level. While in the current study, a reduction of costs was found, in which Seha Virtual Hospital in Rafha Hospital saved patients a total of 1.886.389 SAR from travelling. Moreover, these services saved the hospital a total of 98.200 SAR per month from hiring a specialist in each department, which is 1.178.400 SAR per year[5].

Regarding the study that was done in Finland by Erkki Soini and Saku Väätäinen, at the HUS level, the average predicted annual PHCF with VH2.0 was around €42 million for first five years, summing up to around €208 million in five years. Most important key value drivers were treatment calls, revisits, and treatment visits. Average predicted annual PHCF with VH2.0 was around €261 million at national level for first five years, summing up to around €1.3 billion in five years. Most important drivers were revisits, treatment calls, and travelling. Again, the results of the previously done study agree with the results of the current study[6].

Table 12. Showing the financial impact after the commencement of virtual services.

Services	Average costs saved
Virtual ICU services	SAR 4.705.000
Virtual outpatient services	SAR 54.000
Virtual NVHC services	SAR 13.500
Virtual radiology services	SAR 1.062.250
Virtual stroke services	SAR 1.209.600
Virtual INP-consultation services	SAR 1.702.800
Virtual EEG services	SAR 403.200
Virtual oncology services	SAR 2250
Total	**SAR 9.152.600**

Meanwhile, in UK, a study was carried out by Abdollah Jalilian et al. in the year 2022 to evaluate the length of stay difference and its economic implications between hospital patients and virtual ward patients. The virtual ward patients had a shorter stay in the hospital before being admitted to the virtual ward (2.89 days, 95% CI 2.1 to 3.9 days). Chronic kidney disease (CKD) and frailty were associated with a longer length of stay in the hospital (58%, 95% CI 22% to 100%) compared with patients without CKD, and 14% (95% CI 8% to 21%) compared with patients with one-unit lower CFS. The frailty score was also associated with a higher rate of readmission within 6 months and lower survival. Being admitted to the virtual ward slightly improved survival, although when readmitted, survival deteriorated rapidly. The cost of a 24-hour period in a general hospital bed is £536. The cost of a day hospital saved by a virtual ward was £935. Similarly, the current study revealed that Seha Virtual Hospital in Rafha Hospital saved patients a total of 1.886.389 SAR from travelling. Also, these services saved the hospital a total of 98.200 SAR per month from hiring a specialist in each department, which is 1.178.400 SAR per year[7].

Furthermore, a study was conducted by Oskari Hakanen et al. in Finland in the year 2023 to compare the costs of two different telemedicine-assisted tonsillitis care pathways with traditional face-to-face visits at the Department of Otorhinolaryngology – Head and Neck Surgery (ORL-HNS) at Helsinki University Hospital. At least a third of the tonsillitis patients were eligible for telemedicine. The digital care pathway was 12.6 % less expensive for the public payer compared to the previous virtual visit model. For the Department, the expense of the digital care pathway was 58.8 % less per patient than the virtual visit model. Patient fees decreased 79.5 %. The digital care pathway reduced the doctor's resource from 30.28 min to 19.78 min, which accounts for a 34.7 % reduction. Patients finished the digital care pathway in a median of 62 min (SD = 60) compared to the 2–4 h which they would spend on an outpatient clinic visit. The findings of this study highlight the advantages of virtual medical services for both patients and the

healthcare center, which is once again, proved by the results of the current study[8].

In 2021, Aisha Salsabilla et al. participated in another study that was done in Indonesia, in which a total of 870 articles were identified from two databases: PubMed (n = 689 articles) and EBSCO (n = 181 articles). After removing 181 duplicates, 689 articles were screened by title and abstract, excluding 665 records. After the full-text screening on 24 articles, 8 articles were selected for further analysis. Various perspectives were applied in the included studies, such as societal, healthcare, and program perspectives. All studies applied different time horizons, such as 3-month, 25-year, 40-year, and lifetime. Among all included studies, several studies applied mathematical modeling. The implementation of telemedicine in Asia can be a promising intervention since it can enhance the effectiveness of health services by saving time and travel costs. It also can reduce the overall costs of treatment, improve patients' quality of life, and expand access to essential health services. Once again, the previously done study showed similar results as the ones of the current study, which strengthens the found evidence[9].

In Indonesia, a systematic review study was carried out by Joko Tri Atmojo et al. in the year 2020 which showed similar findings as the current study. 8 articles were selected for this previously done study[12]. These studies reported that telemedicine utilization in dermatology, radiology, pediatrics, and intensive care unit (ICU) rooms reduced health cost by 56% and patients travel cost to health care by 94%. Telemedicine advantages for patients were reduced transportation time or cost, eliminated time off of work, on-demand option, and reduced time in the waiting room, so that it can increase patient's satisfaction. A study reported that telemedicine utilization at the pediatrics department increased hospital's revenue by USD 101,744 per year[10].

Lastly, regarding the study that was conducted in Florida in the year 2023 by Krupal B. Patel et al. to estimate patient travel, time, and cost savings associated with telehealth for cancer care delivery, the study included 25 496 telehealth visits with 11 688 patients[13]. There were 4525 (3795 patients) new or established visits and 20 971 (10 049 patients) follow-up visits. Median (IQR) age was 55.0 (46.0-61.0) years among the telehealth visits, with 15 663 visits (61.4%) by women and 18 360 visits (72.0%) by non-Hispanic White patients. According to cost models, the estimated mean (SD) total cost savings ranged from $147.4 ($120.1) at $0.56/mile to $186.1 ($156.9) at $0.82/mile. For new or established visits, the mean (SD) total cost savings per visit ranged from $176.6 ($136.3) at $0.56/mile to $222.8 ($177.4) at $0.82/mile, and for follow-up visits, the mean (SD) total cost savings per visit was $141.1 ($115.3) at $0.56/mile to $178.1 ($150.9) at $0.82/mile. Meanwhile, in the current study, Seha Virtual Hospital in Rafha Hospital saved patients a total of 1.886.389 SAR from travelling. Moreover, these services saved the hospital a total of 98.200 SAR per month from hiring a specialist in each department, which is 1.178.400 SAR per year[11].

As a summary, it was noticed that the results of almost all of the previously done studies align with the ones found in the current study in regard to the costs saved by virtual medical services, supporting the evidence and diminishing the gap found in the literature review. However, only one study showed different results, which could be due to the targeted population (children/adults), or the differences of different regions. However, our study is limited by the full access to the patients records at the receiving hospital. activating **NAPHES** platform may provide a unified digital health recodes that help to track all medical interventions across all healthcare facilities in Saudi Arabia.

CONCLUSION

The findings of this study provide clear evidence that Seha virtual services in Rafha General Hospital have reduced costs for both the healthcare provider and the patients as well, as they saved transportation costs to other hospitals for patients, as well as costs of hiring specialists in each department for the healthcare provider. A dedicated study for each virtual service is recommended to improv healthcare system.

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