

Analysis of the effect of the new Internet hospital + home nursing model: A mixed methods study

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Analysis of the effect of the new Internet hospital + home nursing model: A mixed methods study

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Abstract

Background: Internet hospitals and Internet + nursing service have recently emerged as new medical and nursing care models, respectively. Both use Internet-based information platforms and combine online applications and offline services to provide appropriate services. The rapid growth in the number of Internet hospitals in China has given rise to the Internet hospital + home nursing (IHHN) service model. Research on this new model is limited, and the effectiveness of its implementation remains to be clarified.

Objective: We sought to examine the effectiveness of IHHN model implementation by investigating service workload, patients' satisfaction, and nurses' perception to provide a strategic reference for IHHN development.

Methods: Data from patients who received for IHHN were collected from a hospital database. We analyzed the frequency of patients' applications and the timeliness of IHHN using descriptive statistics and Chi-squared tests. We used a frequency table to assess the classification of patients' illnesses, service items, and geographic distribution. Geographical distribution of patients was visualized using spatial mapping techniques. Finally, we compared the cost of transferring patients to hospital by ambulance for nursing services with that of IHHN using a simulation technique and t-test. Patients' satisfaction at two time periods was compared using a Mann-Whitney U-test. Nurses' perceptions regarding IHHN were examined using a questionnaire survey.

Results: Medical records from 2,459 IHHN patients were examined. Most IHHN patients were over 60 years old (86.21%). The number of IHHN applications differed significantly between age groups ($2 = 29.86$, $P < 0.01$). Oncological patients were the most common type of IHHN users (19.80%). Intravenous blood collection was the most common service item (66.07%). IHHN patients were mainly from six regions around the physical hospital (86.17%). All patients were served within 2 days after their appointment. The waiting time length varied significantly with appointment time ($2 = 290.88$, $P < 0.01$). The cost of routine and specialized service of IHHN was lower than the cost of transporting patients by ambulance to hospital ($t = 53.63$, $P < 0.001$, $t = 22.98$, $P < 0.001$). However, there was no significant difference between the costs of IHHN long distance services and transferring patients to hospital ($t = 3.08$, $P = 0.77$). Patient satisfaction was consistently high in two time periods, with no significant difference (Mann-Whitney $U = 5090149.00$, $P = 0.38$). Nurses' perceptions were positive.

Conclusions: IHHN demonstrates as an effective approach for providing convenient, accessible, and economical home nursing, addressing the shortcomings of online medical and nursing services such as difficulties in accessing medical care for the elderly and mobility-impaired patients. IHHN has high patient satisfaction degree and nurse positive perceptions. As population aging progresses, IHHN services may expand. However, it is necessary to optimize services to ensure the safety of patients and nurses, and to provide corresponding policy support.

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Original Manuscript

of the effect of the new Internet hospital + home nursing model: A mixed methods

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Keywords

Internet hospitals; home nursing; services; effectiveness; mixed-methods

Introduction

The Internet hospital model is a comprehensive medical service platform that utilizes network information technology to integrate the functions of consultation, prescription, payment, and drug delivery into a single platform using online follow-up and routine consultation [1]. Doctors at Internet hospitals can effectively conduct disease diagnosis and consultation, and deliver medicines to patients' homes through express delivery. However, patients who require nursing services such as pressure injury care, wound care, and intravenous blood collection are still required to visit a physical hospital after online consultation. Thus, home nursing services could potentially make up for the service shortcomings of Internet hospitals. Internet + nursing service (INS) refers to the provision of nursing services by registered nurses from medical institutions utilizing an "online application and offline service" approach for discharged patients, patients with mobility impairments, and patients with chronic or common diseases using the Internet and other information technologies [2]. INS is considered to be an economical and efficient supplement to physical hospital nursing services, resolving the time and space limitations of the traditional nursing model and integrating nurses' fragmented time to provide nursing services [3,4]. In 2019, the China Health Commission formally released the "Notice on Pilot Work of INS," which began the implementation of INS. Subsequently, nurses from public hospitals and community health centers in China have been encouraged to provide home nursing through the "Nursing Plus" cloud-based care platform, and patients can make online appointments for home nursing in Ningbo, Zhejiang Province. In December 2020, the "Notice on Further Promoting INS Pilot Work" was issued. The INS model has been widely applied to specialty care, chronic disease management, and geriatric care [6]. In 2021, Wuhan Central Hospital released an "e-Home Nursing" platform, which was combined with community health service centers to provide home nursing care for discharged patients and patients with disabilities, advanced age, cancer, and unconsciousness through an online appointment system [7]. In

addition to the case studies mentioned above, studies of INS have examined patient demand analysis [8,9], treatment effect comparison [10,11], nurse's cognition and willingness [12,13], and comprehensive evaluation indices [14]. In the previous INS studies, the Internet has served only as an information transmission channel and carrier for home nursing appointment, which can not integrate online medical service by doctors or ensure the continuity of medical and nursing services. However, in the context of the rapid development of Internet hospitals, patients with chronic or common diseases have received online diagnosis and treatment. Some Internet hospital patients may also require online nursing guidance or home nursing after online consultation, leading to the development of the IHHN. IHHN refers to integrating both doctors' medical services and nurses' care services via an internet-based platform, so patients can obtain integrated online and offline medical care services which also facilitates services supply. However, few studies have empirically examined the innovative IHHN model.

Home-based care was developed relatively early in foreign countries, and has been widely used in rehabilitation care, palliative care, geriatric care, maternal and child care, and wound care. Reference source not found. In the American Home Health Medical Care model, an interdisciplinary team is led by a physician or advanced practice nurse, and provides longitudinal healthcare management (including comprehensive health assessment, multidisciplinary care coordination, and patient education) primarily for long-term household patients with chronic diseases and those over 85 years old. The American Home Health Care model is primarily delivered by registered nurses or caregivers who provide nursing care to patients with mild cases and people with disabilities through an appointment or governmental assessment process, and the service program requires the support of a physician for prescribing medications [16,17,18]. Japanese home nursing has been independently developed by different levels of medical institutions, which have formed professional teams of caregivers, therapists, and general practitioners to provide primary care, medical care, and activities of daily living support for elderly people who are unable to take care of themselves because of disability, postoperative rehabilitation, or chronic disease [19]. The Hospital at Home department was established in Australian public hospitals using My Health Record to share medical information, enabling the multidisciplinary nursing teams to conveniently provide professional services such as injections, wound care, and health education to meet the needs of the elderly patients with chronic diseases, post-acute rehabilitation, and disabilities at home. Studies related to home-based care in other countries have included comparative effectiveness research [22,23], nursing method research [24,25], comprehensive evaluation [26], case promotion and application research [27], and nurse training [28]. However, home-based care in foreign countries is mainly carried out by physical hospitals, and no cases of IHHN have been reported.

In the context of the rapid development of Internet hospitals in China, and under the guidance of INS policy, IHHN has emerged as a new nursing model that connects online medical with offline nursing services. We hypothesized that this new model is convenient, accessible, and economical, and that it has high patient satisfaction degree and nurse positive perception. A mixed methods

design was used to test our hypotheses.

Methods

Data Source

We examined the Internet Hospital of Tianjin Medical University General Hospital (TMUGH) as the research objective in the current study. This Internet hospital was established in March 2020 to improve patients' access to medical care and medication in the context of the prevention and control of the COVID-19 pandemic. However, patients who needed to provide blood, urine, and stool specimens, and those who required other nursing operations after online diagnosis and consultation via the Internet hospital still needed to attend a physical hospital. To address the limitations of Internet hospital services and patients' needs for home nursing care, the Internet hospital implemented home nursing services in November 2020, and established IHHN as a new service mode. IHHN takes into account the service needs of patients in both Internet hospitals and physical hospitals, adopts the service mode of online application in Internet hospital platform and offline home nursing by registered nurses at the patient's home, and provides diversified nursing services. IHHN comprises three distinct service categories: specialized service, and long distance service. Regular service refers to a nurse scheduling to serve multiple patients. Specialized service refers to a nurse scheduling to serve a single patient. Long distance service refers to a nurse scheduling to serve a single patient, with a distance of greater than 10 km and less than 100 km. The basic fees for these three service types are shown in Table 1. The fee for each IHHN service item is charged separately, which is the same system employed at physical hospitals.

At the IHHN we examined, a total of 24 IHHN service items are available, as follows: intravenous blood collection, urine and stool retention, vital signs monitoring, blood glucose monitoring, pressure injury care, wound care, hypodermic injections, peripherally inserted central catheter (PICC) maintenance, intramuscular injections, stoma care, health education, urinary catheterization, drainage bag replacement, peripheral intravenous needle maintenance, breast feeding guidance, neonatal percutaneous bilirubin measurement, oxygen inhalation therapy, incontinence care guidance, indwelling catheterization care, specialty wound care (pacemaker wounds, perineal lateral incision wounds, bone traction one-stage healing wounds), extubation, oral care, incontinence dermatitis care, and stress injury prevention. For every IHHN item, there are detailed instructions regarding appropriate patients, service content, precautions, cancellation of appointments, and refund mechanisms for patients' understanding.

Table 1 Basic fees for three types of IHHN (Unit: Yuan)

Service type	Distances≤3 km	3<Distances≤5 km	5<Distance≤ 10 km	10<Distances≤30 km	30<Distance≤ 100 km
Regular service	80	90	100		
Specialized service	140	160	189		
Long distance service				300	450

We collected medical records of patients using IHHN from November 1, 2020 to October 31, 2024 from the hospital database. A total of 7,516 IHHN records were extracted, which included patients' age, gender, home address, appointment time, service time, service item, service cost, major disease diagnosis, and comprehensive evaluation data. We excluded 101 records with incomplete identification information or disease diagnosis. Finally, 7,415 records attributed to 2,459 patients were included. There were 498 patients with mobility impairments such as paralysis, bone fracture, leg disease, unconsciousness, and being bedridden.

Study Design

We collected data on patients using IHHN and nurses' perceptions. IHHN service flow was compared with the physical hospital nursing service to verify its convenience. The distribution of patients using IHHN and the service waiting time were used to verify its accessibility. The basic IHHN fee was compared with the cost of transferring patients by ambulance to a physical hospital, to validate its relative cost. Patients' comprehensive evaluation scores were used to analyze the degree of patient satisfaction. A questionnaire survey was used to obtain nurses' perceptions.

Quantitative and Qualitative Methods

We used the chi-square test to analyze the distribution of patients of different genders and ages in IHHN applications. Frequency tables were used to count the main disease diagnoses, geographical distribution, and service items of IHHN patients. We mapped the geographic distribution of patients at the district level using Arcmap 10.8 software. A Python program was written to access the Gaode Map (Amap Software Co., Ltd, Beijing, China) web service application programming interface to simulate the transport routes for patient with mobility impairments and to calculate the corresponding distances and transfer costs. The details of the simulated cost of transferring patients to hospital are provided in Attachment 1. A t-test was used to compare the basic cost of IHHN with patient transfer costs.

From November 1, 2020 to October 31, 2021, IHHN was evaluated by patients using three indicators: nurse professionalism, service punctuality, and service attentiveness, with 100 points for each, and the mean of three indicator scores was the degree of satisfaction. To evaluate the degree of satisfaction with IHHN in more detail, the evaluation index was modified on November 1, 2021. The degree of satisfaction with IHHN was evaluated comprehensively using five indicators: service attitude, service skill, service price, service punctuality, and service experience, with 100 points for each, and the mean of five indicators scores was the degree of satisfaction. A Mann-Whitney U-test was used to compare and analyze the degree of patient satisfaction during two time periods.

A questionnaire was developed and distributed to nurses who had participated in IHHN, which included four sections: nurses' basic information, attitudes toward IHHN, perceptions of IHHN, and other suggestions for IHHN improvement as showed in Attachment 2.

Ethics Consideration

The current study involved an analysis of patient data from the hospital database and nurse data from survey, did not involve human experimentation or compensation. The data used for this research were extracted from the hospital information system and questionnaire of nurses who participated in IHHN with previous approval. To ensure patient and nurse privacy and confidentiality, identifying information such as names, addresses, and contact details were removed during data extraction. All patients and nurses related datasets met ethical and legal requirements for data protection. In addition, the research team complied with all relevant local, national, and international laws and regulations regarding the protection of personal information, privacy, and human rights. The Ethics Committee of the Tianjin Medical University General Hospital granted approval for this study following a thorough review of the research protocol (approval number IRB2024-YX-066-01).

Results

Patients apply for home nursing services through mobile phone app of IHHN (Create Medical Information Co., Ltd., Tianjin, China) after receiving medical service from the Internet hospital, which eliminates the need to go back and forth to the physical hospital for making appointments, payment, and receiving service. Patients can conveniently obtain medical service and home nursing via IHHN at home.

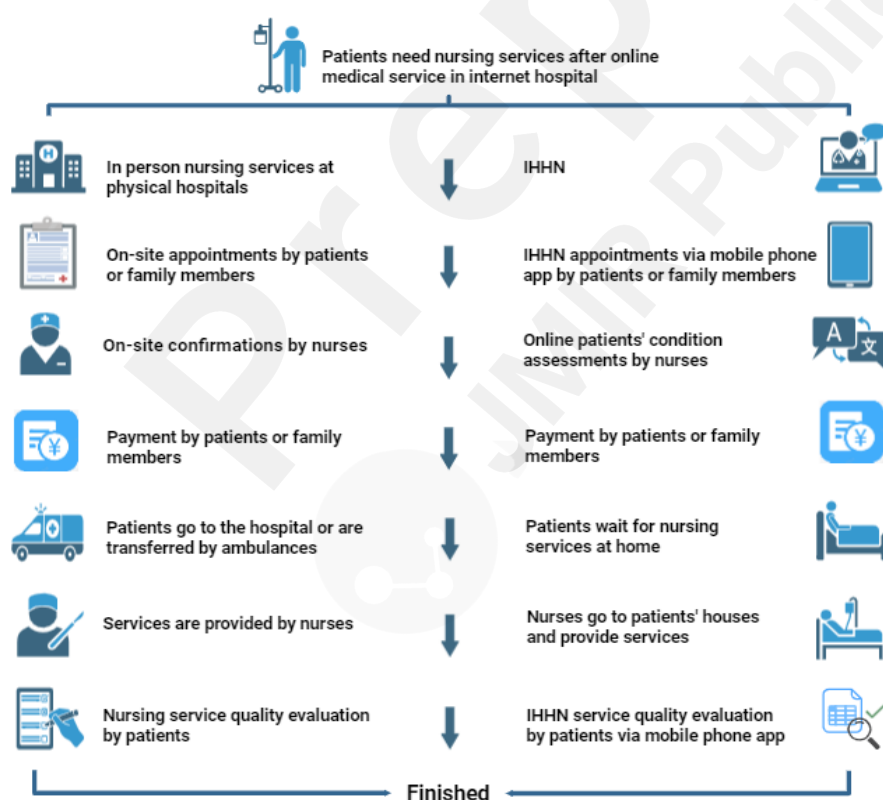


Figure 1 Flowchart of patient receiving nursing service in physical hospital and IHHN

Number of IHHN applications

The results revealed no gender-related differences in the number of IHHN applications ($P = 0.54$). However, we found a significant difference in the number of IHHN applications between

patient cohorts of different ages ($P < 0.01$). Among age groups, patients over 60 years old had the highest number of IHHN applications (2,120/2,459, 86.21%). Patients under 20 years old had the lowest number of IHHN applications (8/2,459, 0.33%).

Table 2. Distribution of patients using IHHN by gender and age cohort (N = 2,459)

Characteristics	One time, n(%)	Two times, n(%)	≥Three times, n(%)	χ ²	P value
Gender, n (%)					
Female	738 /1350(54.67)	235 /1350 (17.41)	397 /1350(29.41)	1.23	0.54
Male	569 /1109(51.31)	182 /1109(16.41)	338/1109 (30.48)		
Age(years), n(%)					
≤20	2/8 (25.00)	1 /8(12.50)	5 /8(62.50)	29.86	<0.01
20<a≤40	105/151 (69.54)	24/151 (15.89)	22 /151(14.57)		
40<a≤60	100 /180(54.95)	28 /180 (15.56)	52 /180 (28.89)		
60<a≤80	607/1214 (50.00)	214/1214 (17.63)	393/1214 (32.37)		
>80	493/906 (54.42)	150 /906(16.56)	263 /906(29.03)		

Patients' major disease diagnosis classification

Patients with a major oncological disease diagnosis accounted for the largest proportion of IHHN applications (1,468/7,415, 19.80%), while those with cardiovascular disease diagnosis (876/7,415, 11.81%) and neurological disease diagnosis (747/7,415, 10.07%) had the second and third highest number of IHHN applications, respectively.

Table 3. Top 10 major disease diagnoses of patients receiving IHHN

Major diagnosis	Applications, n (%)	Patients, n (%)
Oncological diseases	1468 (19.80)	415 (16.88)
Cardiovascular diseases	876 (11.81)	416 (16.92)
Neurological diseases	747 (10.07)	350 (14.23)
Metabolic diseases	665 (8.97)	129 (5.25)
Hematologic diseases	597 (8.05)	177 (7.20)
Autoimmune diseases	407 (5.49)	167 (6.79)
Respiratory diseases	360 (5.49)	74 (3.01)
Dermatological diseases	358 (4.83)	96 (3.90)
Genitourinary diseases	218 (2.94)	103 (4.19)
Renal diseases	187 (2.52)	95 (3.86)

Number of IHHN service items

Intravenous blood collection was the service that was most frequently applied for (4,899/7,415, 66.07%), followed by PICC maintenance (927/7,415, 12.50%) and urinary catheterization (506/7415, 6.82%).

Table 4. Top 10 service items of patients receiving IHHN

Service items	Applications, n (%)	Patients, n (%)
Intravenous blood collection	4899 (66.07)	1919 (78.04)
PICC maintenance	927 (12.50)	164 (6.67)
Urinary catheterization	506 (6.82)	161 (6.55)
Pressure injury care	322 (4.34)	55 (2.24)
Wound care	181 (2.44)	70 (2.85)
Peripheral intravenous needle maintenance	140 (1.89)	50 (2.03)
Indwelling catheterization care	71 (0.96)	6 (0.24)
Stoma care	63 (0.85)	21 (0.85)
Specialized wound care	43 (0.58)	18 (0.73)
Intramuscular injection	38 (0.51)	12 (0.49)

Patients' geographic distribution

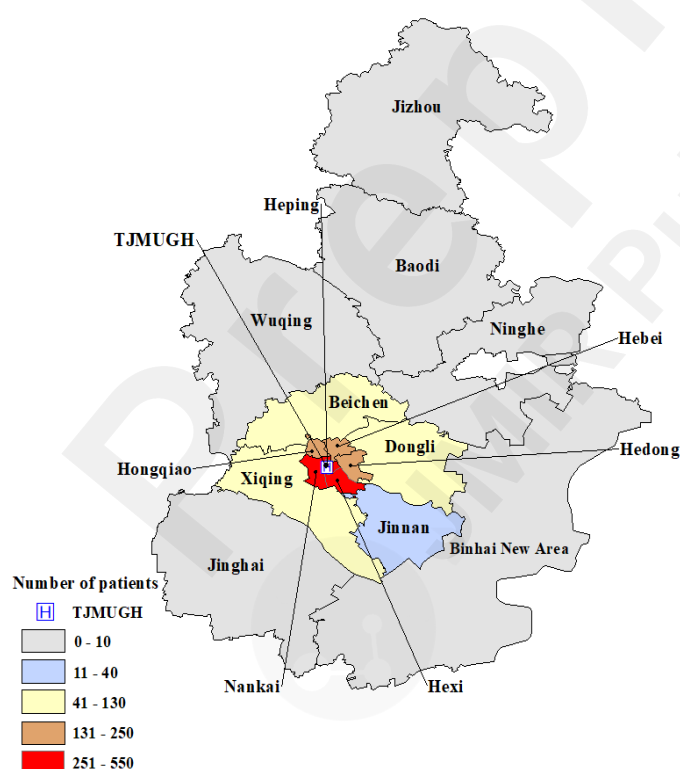
Patients using IHHN were mainly concentrated in the Nankai, Hexi, Heping, Hedong, Hebei,

and Hongqiao districts (2,119/2,459, 86.17%). Of these regions, Nankai district accounted for the largest number of IHHN patients (524/2,459, 21.31%), and the largest number of times IHHN was used (1,739/7,415, 23.45%). Jinnan, Binhai, Jinghai, and Jizhou districts were further away from TJMUGH, and had fewer patients in Table 5. The regional distribution map of patients showed that the patients' locations were mainly centered around TJMUGH as showed in Figure 2.

Table 5. District-level geographical distribution of patients receiving IHHN

District of Tianjin City	Patients, n (%)	Applications, n (%)	Applications per person, mean
Nankai District	524 (21.31)	1739 (23.45)	3.32
Hexi District	487 (19.80)	1439 (19.41)	2.95
Heping District	407 (16.60)	1002 (13.51)	2.46
Hongqiao District	241 (9.80)	592 (7.98)	2.46
Hedong District	232 (9.43)	809 (10.91)	3.49
Hebei District	228 (9.27)	712 (9.60)	3.12
Xiqing District	128 (5.21)	535 (7.22)	4.18
Dongli District	90 (3.66)	183 (2.47)	2.03
Beichen District	76 (3.09)	277 (3.74)	3.64
Jinnan District	36 (1.46)	104 (1.40)	2.89
Binhai New Area	7 (0.28)	13 (0.18)	1.86
Jinghai District	3 (0.12)	10 (0.13)	3.33

Figure 2: District-level geographic distribution of patients.



Patients' appointment time and service waiting time

All patients had access to services within 1–2 days after making their IHHN appointments. Table 6 showed that the different appointment times resulted in the variable waiting times ($P < 0.001$).

Table 6. Patients' appointment time and waiting time ($N = 7,415$, $\chi^2=290.88$, $P<0.001$)

Time	Waiting one day n/N(%)	Waiting two days n/N(%)	χ^2	p
------	---------------------------	----------------------------	----------	-----

Appointment between 6:00-12:00	1873/2885 (64.92)	2022/4530 (44.64)		
Appointment between 12:00-18:00	1012/2885 (35.08)	2508/4530 (55.36)	290.88	<0.001

Comparison of patients' fees between IHHN and patients transferring to hospital

We examined the addresses and floors of 498 patients with limited mobility, and used a simulation method to calculate the cost of transferring them to physical hospitals for nursing service. These processes are described in detail in Attachment 1. There was a significant difference between the basic fees of routine and specialized services of IHHN compared with the cost of transferring patients to physical hospitals ($P < 0.001$). There was no difference in the basic fee for long distance service compared with the cost of transferring patients to physical hospitals ($P = 0.767$).

Table 7. Transferring patients to hospital costs and IHHN basic fees (Unit: Yuan)

Service type	Transferring patients to hospital (Mean±SD)	IHHN (Mean±SD)	T-value	P value
Regular services	260.13±53.24	93.28±7.77	53.63	<0.001
Specialized services	283.41±63.84	173.62±12.18	22.98	<0.001
Long distance services	490.00±72.11	407.14±70.32	3.08	0.77

Patients' degree of satisfaction

A total of 6,980 patients' comprehensive evaluation scores of IHHN were available until October 31, 2024. Patients' degree of satisfaction with IHHN was consistently high in the two time periods, with no significant difference between them ($P = 0.38$) in Table 8.

Table 8. Patients' degree of satisfaction in two time periods (N=6980, Mann-Whitney U = 5090149.00, $P = 0.38$)

Period	Number, n(%)	Mean±SD	Mann-Whitney U	P value
2020.11.1 to 2021.10.31	2068 (29.63)	99.80±2.65	5090149.00	0.38
2021.11.1 to 2024.10.31	4912 (70.37)	99.89±1.50		

Nurses' perceptions

We distributed 120 questionnaires to nurses who had engaged in IHHN, and 107 were returned (recovery rate: 89.16%). Nurses' basic information and the results of the questionnaire survey are provided in Attachment 2. In summary, nurses supported IHHN (93/107, 86.91%) whose attitudes toward IHHN were positive. Specialized training of IHHN was necessary (88/107, 82.24%). Detailed knowledge of the patient's medical and allergy history was very important (97/107, 90.65%). The key factors affecting IHHN quality was the professional skill and experience of nurses (91/107, 85.05%). The main factor affecting the safety of patients was sudden illness deterioration without timely medical team support (97/107, 90.65%). The main factor affecting the safety of nurses was the violent behavior of the patients or their family members (93/107, 86.92%). It is very necessary to equip a video recorder and record the service process (100/107, 93.46%) as well as to have a special person to accompany nurses (92/107, 85.98%). It needs to clarify price standards and insurance reimbursement policies (98/107, 91.59%). In the future, it is expected that specialized nursing care (88/107, 82.24%), rehabilitation training (84/107, 78.50%) as well as comprehensive IHHN information system (90/107, 84.11%) should be provided.

Discussion

Principal Findings

In the current study, we analyzed the measures and results of IHHN using various methods, and verified its convenience, accessibility, and relative cost, as well as patients' degree of satisfaction and nurses' perception. The results revealed that IHHN was able to effectively meet patients' medical service and home nursing needs, and with particular convenience for those with mobility impairments, high patients' satisfaction degree and positive nurses' perceptions.

IHHN is designed to bridge the gap between medical and nursing services. INS platforms that only recruit nurses to provide home nursing services were previously reported to have inconsistent reliability and a lack of standardization [6]. The Internet hospital examined in this study relies on a brick-and-mortar hospital, and provides patients with online consultation and diagnosis, prescriptions of medicines, examinations, tests, nursing services. At this Internet hospital, it is also possible to triage patients with critical conditions to the outpatient department, emergency department, or inpatient department of a physical hospital for further treatment. However, patients with chronic diseases such as cancer, cardiovascular diseases, and neurological disorders, as well as those with mobility impairments who only require home nursing following consultations can avoid subsequent in-person visits to physical hospitals. Thus, Internet hospitals need home nursing services such as Intravenous blood collection, PICC maintenance and urinary catheterization to make up for the limitations of their care provision. Because nurses lack prescription authority, which necessitates physician-ordered treatments. Therefore, IHHN can effectively address the limitations of both internet hospitals and INS, achieving all-round services of online consultation, diagnosis, prescriptions and offline medication delivery, home nursing, and patient referral. This hybrid model ensures care continuity while significantly improving patient accessibility and convenience.

IHHN expands the accessibility of treatment to a broader group of patients. Internet hospitals have extended the service radius of physical hospitals, and an increasing number of patients are choosing Internet hospital-based medical service[29]. INS is also widely accepted by patients and nurses, and has been reported to effectively resolve the problem of access to nursing care for mobility-impaired patients [8,12]. IHHN enhances the delivery method of delivering medical and nursing care services by optimizing online and offline medical and nursing care services based on the Internet hospital information platform, thereby providing integrated medical and nursing services to all patients. The results indicate that patients preferred the IHHN, with many patients (735/2,459, 29.89%) using it more than three times. Of the various districts, Xiqing District exhibited the highest number of usage frequency (mean: 4.18 times per patient). The IHHN mobile application, combined with a guaranteed 2-day service response, significantly enhanced healthcare accessibility. With the progression of population aging, the demand for INS has risen steadily [9], which is projected to drive an increase in the number of IHHN patients.

IHHN should broaden its nursing care portfolio to address diverse needs. Through internet hospital platforms, physicians deliver specialized diagnoses and treatment plans, while nurses offer 24 standardized in-person services, covering routine care procedures. In the current study,

intravenous blood collection, PICC maintenance, and urinary catheterization were the three most commonly requested service items, which differs from the service item composition of INS platform for elderly patients reported in a previous study [30]. Low patient or family member's perceiving degree is the primary barrier to implementing new IHHN services. Therefore, the advancement of IHHN necessitates a comprehensive understanding and assessment of patient's health status to ensure safety. From the perspective of ensuring patient safety, it is important for nurses to have clear definitions regarding which patients are appropriate for IHHN. The feasibility of home nursing interventions must be evaluated based on specific clinical needs and disease profiles. Subsequently, IHHN services including specialized care and rehabilitation programs should be systematically expanded to address these requirements.

The IHHN model can reduce the cost of treating diseases. Internet hospitals are widely considered to overcome the limitations of time and space [31]. IHHN can not only overcome time and space constraints, but can also reduce the costs related to transportation, time and accompanying personnel. When considering single-patient transportation cost, the cost of transferring mobility-impaired patients to hospitals is much higher than that of IHHN. The economic advantage is evident for patients who choose IHHN routine services and specialized services. The cost of long distance service is the same as that of transferring patients to hospital by ambulance. Long distance service involves increased transportation costs, but still saves patients and their family members indirect costs such as time and companionship. At present, the number of patients receiving IHHN long distance service is small, which also contributes to its high cost. In the future, long distance service cost will gradually decrease as the number of service instances increases and economies of scale can be achieved. Compared with the pricing model of single-patient dedicated ambulance transfer per trip, long distance service demonstrates comparative cost-effectiveness once economies of scale are achieved.

IHHN was supported by both patients and nurses. As a patient-centered care model, adopts an approach analogous to personalized private healthcare services integrating medical treatment and specialized nursing. Nurses who carry out IHHN have comprehensive professional knowledge and clinical experience. Before working in IHHN, these nurses needed to receive specialized training to cope with emergencies such as additional requests, verbal threats, and physical confrontations from patients or family members in the process of home nursing. Previous research has demonstrated that competency-based training programs significantly enhance patient satisfaction scores [28]. During clinical implementation, nurses must systematically evaluate patient's medical histories and allergy profiles to determine IHHN eligibility, followed by the formulation of evidence-based, individualized care plans tailored to specific diagnostic categories. Patients receiving home nursing experience care quality comparable to hospital settings, leading to enhanced care experiences and satisfaction degree. In the present study, systematic patient assessments revealed consistently high satisfaction degrees with IHHN, as measured through standardized evaluation instruments. Nurses generally hold favorable perceptions of IHHN. In the context of IHHN, it is crucial to emphasize that

attention must be devoted to nurses' professional proficiency as well as their accumulated experience. Moreover, the implementation of multi-functional information systems is indispensable to guarantee both the quality assurance and the safety assurance of IHHN.

Several critical challenges require urgent resolution in IHHN implementation. Primarily, the ambiguity in liability attribution during acute clinical deterioration episodes poses significant risks, particularly for patients requiring time-sensitive emergency interventions that exceed the scope of home nursing care capabilities. It is necessary to establish a dynamic mechanism to evaluate the patient's condition and to define IHHN items clearly. To protect patients' safety and IHHN quality, it is recommended that demands beyond the scope of IHHN following a nurse's assessment be addressed at a physical hospital. Second, the lack of safety measures and legal protection for nurses is not only a major concern for hospitals but also the main reason why many nurses are reluctant to participate in IHHN. It will be necessary to use a variety of measures such as body-worn cameras, remote monitoring systems, one-button alarm systems, and assigning specialized personnel to accompany nurses during home nursing services to ensure nurses' safety and to enhance the transparency and traceability of the service process, as well as to provide effective evidence for handling IHHN disputes [32]. Third, well-defined health insurance and standardized pricing frameworks are necessary to ensure the availability of comprehensive and specialized home nursing services.

Strengths and Limitations

To the best of our knowledge, this study is the first to systematically describe IHHN as an innovative approach to implementing the INS policy. We evaluated implementation outcomes from multiple perspectives, and the results offer an empirical foundation for enhancing IHHN. However, the study has several limitations that should be considered. First, as this was a single-center study, the findings may not account for variations in care model, pricing, and home nursing services across different hospital types. Additionally, the results could be influenced by selection bias; therefore, future multi-center studies are needed. Second, we used a standardized patient evaluation method to measure patients' satisfaction degree, with relatively simplified indicators design and measurement dimensions. Therefore, future research should adopt more detailed indicators tailored to the IHHN context, which would enhance patient feedback collection and service quality improvement. Third, while the IHHN provided citywide coverage across Tianjin City, only a small proportion of patients utilized long distance services. This limitation requires further investigation to identify barriers and develop strategies for scaling up service delivery efficiently.

Conclusions

This study comprehensively analyzed the effect of the IHHN services as an innovative model of INS, which offers the advantages of convenience, accessibility, and relatively cost. IHHN can address limitations of online medical and nursing services, improve access to medical and nursing

care for the elderly and mobility-impaired patients, and achieve high patient satisfaction degree and nurse positive perception. As population aging progresses, IHHN services are likely to become increasingly widespread. It is important to optimize these services from the perspective of ensuring patients' treatment safety and nurses' personal safety, and corresponding policy support.

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Data availability

The datasets generated or analyzed during this study are available from the corresponding author on reasonable request.

Author contributions

YL contributed to the conceptualization and writing-original draft. YW contributed to the methodology and validation. ZJ contributed to the writing-review & editing. CJ contributed to the data curation. FH contributed to the supervision. TY contributed to the project administration and funding acquisition.

Conflicts of interest

None declared.

Multimedia Appendix

- 1.Comparison of costs between IHHN and transferring patients to hospital based on GIS (geographic information system)-based simulation technology
- 2.Nurses' basic information and questionnaire survey results

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Epub 2019 Mar 7. PMID. 30852167; PMCID: PMC6599557.

Abbreviations

INS: internet + nursing service

IHHN: internet hospital + home nursing

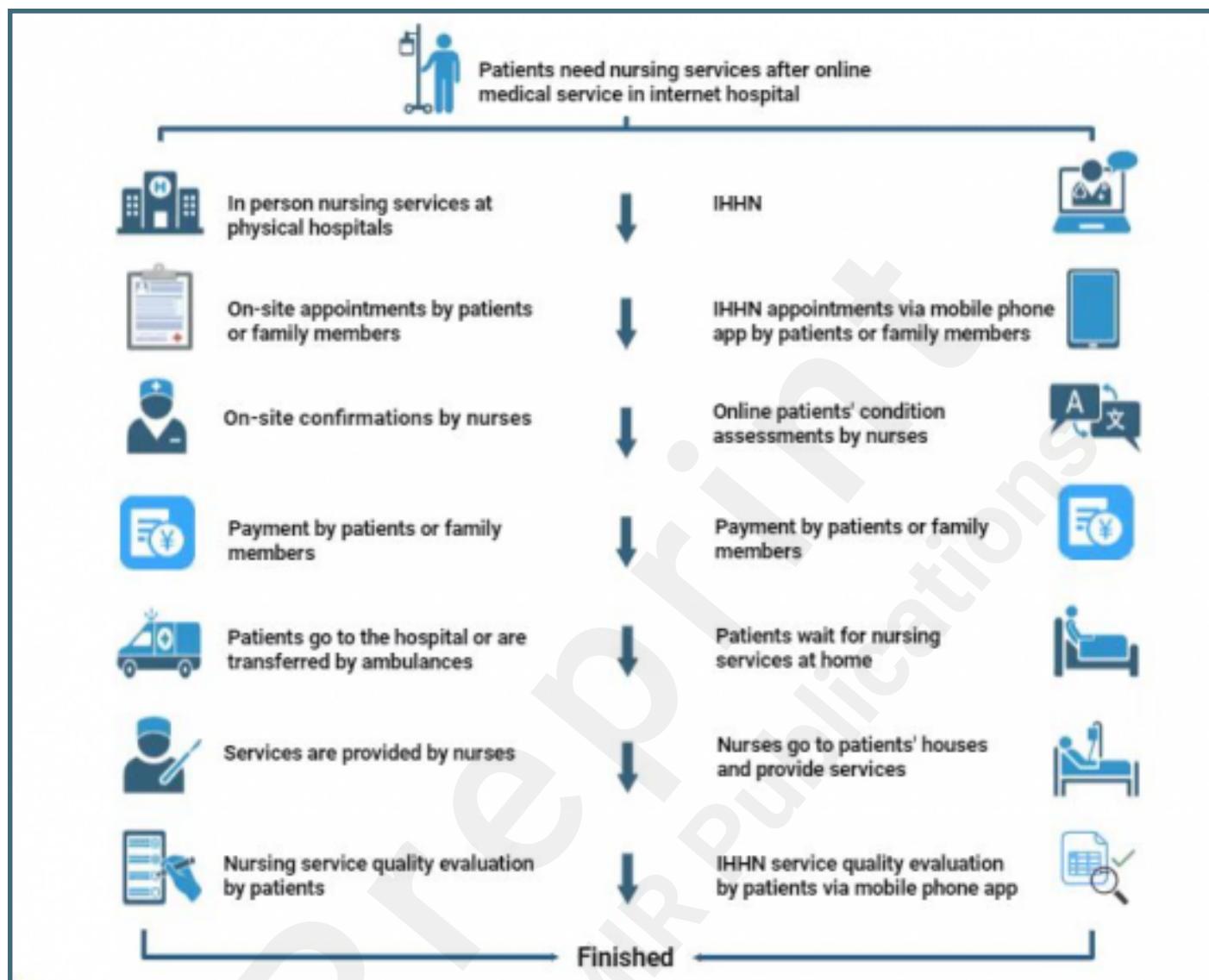
PICC: peripherally inserted central catheter

TJMUGH: Tianjin Medical University General Hospital

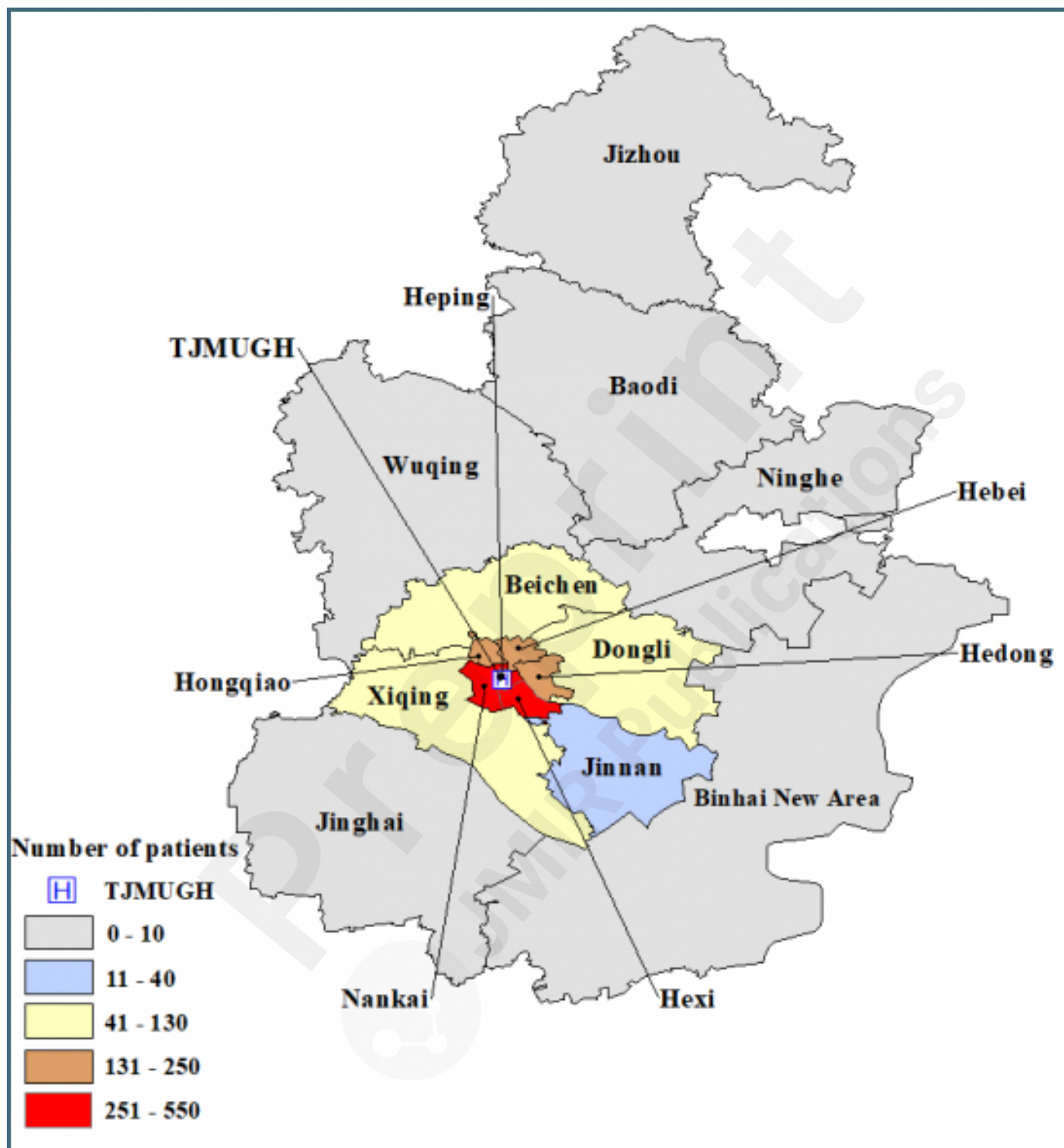
Supplementary Files

Figures

It is flowchart of patient receiving nursing service in physical hospital and IHHN.



It shows patients district-level geographic distribution.



Multimedia Appendixes

We compare costs between IHHN and transferring patients to hospital using GIS (geographic information system)-based simulation technology.

URL: <http://asset.jmir.pub/assets/9fff0cda6bdb29a77a14ca87b67407e9.docx>

We conclude nurses' basic information and questionnaire survey results.

URL: <http://asset.jmir.pub/assets/845cbfd50ec94cd3e9920b3506168f5a.docx>



TOC/Feature image for homepages

The figure shows that a doctor visits patients after online consultation.

