



Evaluation and design of public health information management system for primary health care units based on medical and health information



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ARTICLE INFO

Article history:

Received 28 September 2019

Received in revised form

16 November 2019

Accepted 25 November 2019

Keywords:

Medical and health

Public health information management system

Primary medical units

Residents' files

ABSTRACT

Objective: The objective is to understand the role of information management systems in the public health perspective of primary care units more accurately.

Methods: A public health information management system for primary medical units, which is based on electronic health records, virtual private network technology, real-time data storage, and other technologies, is designed on the premise of economical and straightforward operation. Besides, Xinhua Community Health Service Center Around the Wulong Street, Longsha District, Qiqihar City is selected as the experimental unit of the public health information management system, and the work efficiency of the system in the public health perspective of the primary medical unit is evaluated after 12 months of system operation.

Results: The public health information management system of primary medical units has following comprehensive management functions: health record management, child health, maternal health, health of the elderly, health of patients with chronic diseases, health of severe psychiatric patients, health education, infectious diseases and public emergencies, health events, health supervision, and management information. In addition, after 12 months of information management system operates in the grassroots units, the results show that patients and doctors have a very high satisfaction rate with the system. The system not only cultivates the excellent health and disease prevention awareness of residents but also improves the efficiency of primary care institutions, as well as reducing the number of patients seeking medical cares.

Conclusion: The public health information management system of primary health care units based on medical and health information design is rich in functions with prominent work efficiency, which significantly improves the public health of grass-roots medical units. The research is useful and significant for follow-up studies on public health care systems.

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Introduction

In the past, the traditional public health services are provided by community health service centers and township health centers, including health records management, child health, maternal health, health of the elderly, health of patients with chronic diseases, health of severe psychiatric patients, health education,

infectious diseases and public health emergencies, and health supervision and management information. All these services are recorded and kept in paper format. However, with the development of society [1], paper records have been difficult to serve the masses efficiently and conveniently [2,3]. In order to solve the problems of traditional paper records, such as difficulty in storage, difficulty in verifying the quantity and quality, repeated service by various agencies, loss of records due to the flow of residents, waste of paper and waste of paper records, limited exchange of information by time and space, difficulty in business sharing. Meanwhile, in order to integrate the various health records and health service records of various medical institutions [4], as well as establishing a unique

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and life-long health record containing various public health service records for each resident, it is necessary to establish a public health information management system for primary medical institutions and units [5].

The feature of essential public health service is to provide life-long, project-wide, accurate, and complete health services for residents or migrants in the jurisdiction [6], while information technology can make public health services more efficient and complete [7]. With the establishment of the public health information management system [8], the residents' electronic health records and various follow-up data can be more effectively managed and utilized; therefore, the public health services of the primary medical institutions are deepened in further [9], which can facilitate the health administrative department to conduct statistics and analysis on the service status of various primary medical institutions [10]. At present, with the rapid development of computer technology, all countries have studied the use of information technology to regulate and control national health. For example, the president of the United States announced the promotion of medical and health information construction to facilitate later preservation and data sharing. However, up to now, less than 50% of medical units have the system [11]. When establishing the national health network system, the Canadian government announced that it would improve the database of medical and health records in the next few years [12]. In China, the application of information technology in public health service is a little late, but it is in the process of vigorous development and improvement [13].

To sum up, in order to make medical institutions provide residents with better and more efficient basic public health services, in this study, the public health information management system is designed, and its work in primary medical units is studied. Under the premise of economy and simple operation, the public health information management system of primary medical units is designed based on electronic health records, virtual private network technology, real-time data storage backup and other technologies. The system is analyzed to provide some guidance for the future research of the primary public health information management system, which is a valuable research topic.

Methods

Significance of research

The public health information management system of grassroots medical institutions established in this study enables medical institutions to provide residents with better, more efficient, and more complete essential public health services. According to the standards issued by the Ministry of Health, the health information of various medical institutions is collected and organized, the health record management system throughout the life cycle of residents and the public health service management functions based on health records are established, thereby residents can receive convenient and comprehensive health services, such as health education and medical consultation for pregnant women, children, chronic patients or the elderly, which cultivates the awareness of residents for health and disease prevention and enhances the physical fitness and health of residents. At the same time, the public health service work of the primary medical institutions is simplified, standardized, modularized, and integrated so that the information construction is convenient for the staff and better serves the residents.

Ideas of design

In primary medical institutions, the leading technologies in the research, development, and implementation processes of the public health service information management system include Electronic Health Records, Virtual Private Network technology, and real-time backup technology for data storage, which can help the system realize its vital functions and ensure the regular operation of the system.

Electronic Health Records (EHR): An electronic health record refers to a collection of all personal public health information and necessary personal data of a patient. This information is stored by means of the Internet and computers, including information on the health care of an individual. The supervision department of the national government has clearly stated that: Health records are the most important, core, and critical information in an individual's acceptance of all kinds of medical treatments. They are in contact with one's life cycle from birth to death, which are comprehensive collections of all essential public health services, the comprehensive records of all past medical visits from the patients, and officially recognized medical record information [14]. The EHR utilizes modern computers to save and use the information. The most significant purpose of EHR is to share the information. Second, it provides the data from being lost and keeps the data accurate, which cannot be easily modified.

Virtual Private Network (VPN) technology: The VPN technology can easily connect any medical institutions, public health service institutions, and public health systems that need to be accessed in the area or even outside the area. Users in the local Intranet utilize the Intranet to connect, and remote users rely on the Internet to access the Intranet by using VPN technology to achieve information interconnection.

Data storage and real-time synchronization technology: the core of public medical data storage is synchronization, i.e., the synchronous synchronization of stored source data. When the core saving module needs to change the stored data of the system, the data will be saved in the cache module and then changed. It is not directly stored in the disk; at the same time, the backup save module sends a message that can be changed. After the data in the backup storage has been modified, the core storage and the backup storage simultaneously input the data into the disk. Thus, it will always ensure that the data between the core storage device and the backup device is the same, and its flowchart is shown in Fig. 1.

Analysis of systematic functions

The most important thing for the design of the system is to understand the tasks that the system needs to accomplish and the functions of the system. In addition to the most common requirements, the functions of the system need to be targeted at different positions and different capabilities for personalized customization of specific needs. If the problem is not taken into account when designing the system, the result will be that many users and personnel cannot use the system smoothly, leading to low work efficiency and difficulty in a large-scale promotion and utilization.

Health record management function: The management function of the user's health data is based on each user's personal health record data. The core function is to create archives for newborn children and those who have recently moved in. It is the operation of modifying and revoking the deceased person and the ineffective file registration materials, as well as the statistical and research functions of the doctors and patients' archives of the primary medical institutions.

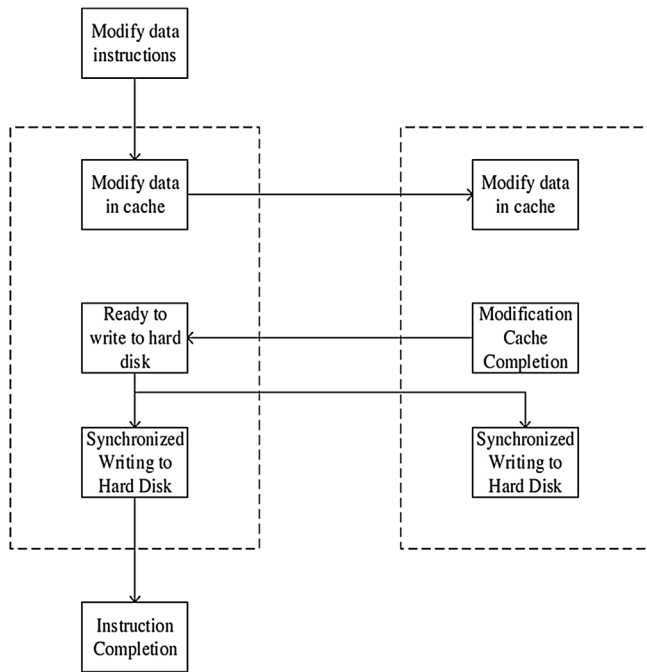


Fig. 1. The flowchart of real-time synchronization technology of data storage.

Child health management function: Child health management in the grassroots public health information management system refers to the recording and reviewing of all data such as the physical condition and growth environment of children from 0–6 years old in the managed area, including the detailed statistics of children, visit forms of newly born children, health checkups and management for children from 0–6 years old, and reminder operations corresponding to related operations in the managed area.

Maternal health management function: The maternal health management refers to the monitoring and understanding of all maternal and pregnant women’s health in the managed areas, including detailed statistics of pregnant women in the managed areas. During all the time periods, the family follow-up data records for the pregnant women before delivery, as well as the emergency stop follow-up data records after delivery, the health checkup monitoring and management of delivery women after 40 days of delivery, and the related corresponding reminder operation is operated.

The health management function of the elderly: The management of the health level of the elderly refers to the monitoring and recording of the health and illness of the elderly in the managed area older than 65 years old, mainly including the detailed statistics, family follow-ups, and health check-up monitoring and management of the elderly in the managed areas in all time periods, as well as reminder operations corresponding to the relevant operations.

Management function of patients with chronic diseases: The health function of patients with chronic diseases refers to monitoring and recording the status of all patients with hypertension and diabetes in the managed area, including the detailed list of chronic patients in the managed area, all home follow-up data records for chronic patients, as well as patient health and health check-ups and management and reminder operations that correspond to related operations.

Psychiatric health function: The management of the health level of mental patients refers to the monitoring and understanding of the health of all mentally ill patients in the managed area, including the detailed statistics of mental patients in the managed areas. There is also a family follow-up data record for mental patients

during the required time period, as well as revisions and supplements for patient information, health checkups, and management, and reminder operations corresponding to related operations.

Management of public health in emergencies and infectious diseases: The health management of sudden and infectious diseases refers to the function of timely processing and reporting the time of sudden accidents when working in public health. This includes the establishment of a report card for incidents of emergencies or infectious diseases.

Design of the system

The primary medical information management system involved in this study can be roughly divided into two parts: the patient medical health information system and the public medical health management service system; in addition to these two systems, there is also a unique system for maintenance and overhaul.

Patient Health Information System: PHIS is the key to the public health care management system. First, it is between the clinic, the first-level medical unit, the secondary medical unit, the health care units, and many medical institutions. The data information is collated and integrated; then, the data in the database are converted and stored by using a consistent data format, and a data record for each patient’s medical visit service is recorded for each patient, which includes the necessary individual information on health care of each patient and is the core and foundation of the entire public health information system.

Public Health Care Health Management Service System: The job requirement of the Public Health Medical Health Management Service System is to ensure that all functions related to public health can be smoothly implemented. That is to say, in the patient medical health information system, health care services for pregnant women, the elderly, chronic diseases patients, children, and other specialized personnel, as well as reporting the infectious diseases, health education, and public health events. Users can modify, review, and delete the confidence of these resources. They can also plan their own plans and then implement them accordingly. The public health information system for managers also provides rich and comprehensive reports and data.

The management and maintenance system: The task of management and maintenance system is mainly to ensure the regular and healthy operation of the overall system. Some parameters are modified to ensure the stability and regular operation of the overall system for an extended period of time. Redesign and planning development is required, as well as corrections to the system’s schedule work, changes and additions, deletions of data and roles, and modification of the user’s login privileges.

Resident Health Record Management System: This system module is shown in Fig. 2. Its role is to update, modify, relocate, and recover the patient’s system data in real-time, ensuring that the file data is updated in a timely manner. In addition, the patient’s file has an extraordinary point. Once the patient’s public medical service file is created, it cannot be deleted under any circumstances. It will follow every user forever, which will always exist. The user data file can be revoked, but it can be recovered at any time. The system also has a search function. Each resident’s health file can be searched in the system according to personal information such as name, address, and ID card number.

Database design: the database of this system stores the health files of all residents in the whole jurisdiction, including the information of mental patients, infectious diseases, etc., involving the privacy of residents. Therefore, database software is required to provide a higher level of security. At the same time, the database of the system has a large storage capacity. About 150 users query, modify and add information such as residents’ health files at the

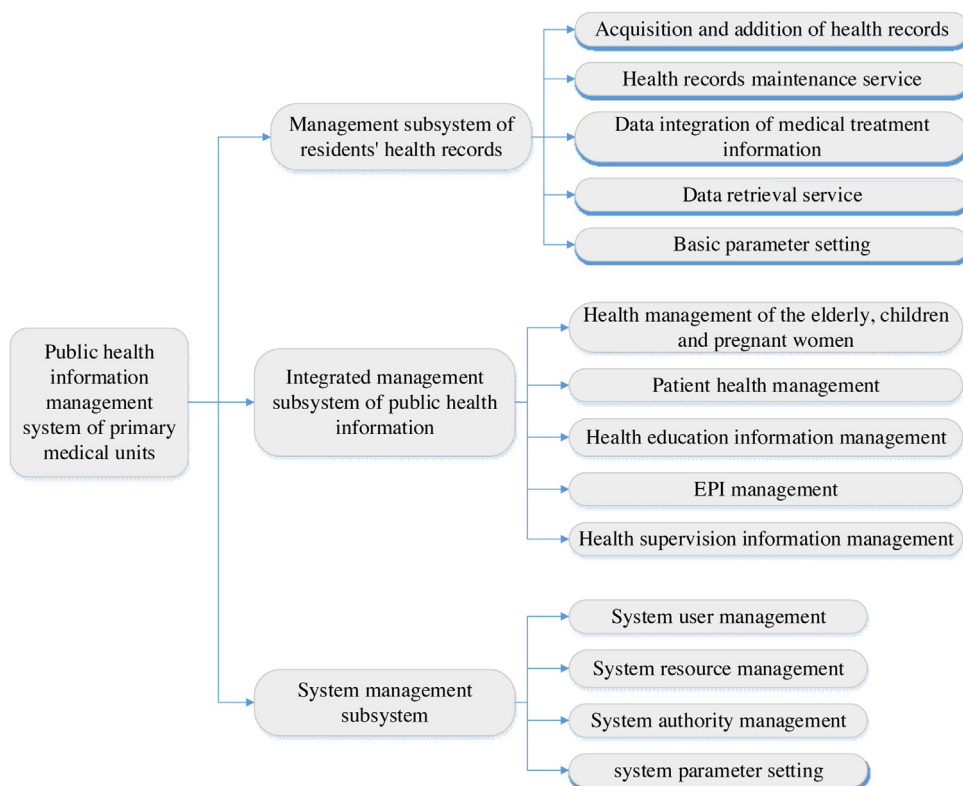


Fig. 2. Functional module diagram of public health information management system in primary medical units.

same time every day. Therefore, the processing speed, concurrency and other performance requirements are high.

System module function

In this study, the functional modules of the system are shown in Fig. 2. The specific functions of some key modules are as follows:

Child Health Management Module: The Child Health Management Module is based on the resident health records and provides health management services for children aged 0–6 years depending on the age of the month in accordance with the National Public Health Service Code. It includes the child health management list, new family mode record, child medical examination within 1-year-old, physical examination management for children aged 1–2, physical examination management for children aged 3–6, and plan reminders.

Health Education Management Module: The Health Education Module is a functional module for statistical reporting of activities organized by health service agencies at all levels, such as activities organized by health education, established publicity columns, distributed video or text materials, and work meetings. At the same time, it has the functions of searching, analyzing, evaluating, generating, and printing reports.

Infectious Diseases and Public Health Emergency Management Module: The infectious disease and public health emergency management module are mainly for reporting the infectious diseases and the public health incidents in the jurisdictions where the residents in the jurisdiction have infectious diseases that must be reported by the state, as well as filling in the report card. This module contains the filling function of two kinds of report files and the function of reviewing and confirming the file submitted by the higher-level management organization.

Health supervision and management information management module: Health supervision and management information management is a functional module for the supervision of public places, medical institutions, secondary water supply, schools, and childcare institutions in the whole district. It mainly includes functions such as registration of the supervised units, daily inspection records, unlicensed business records, and illegal medical records.

System performance simulation

On the basis of the above analysis, this study selects the IBM DB2 V9.7 Enterprise Edition as the database library software of the system and uses Dell R710 server, Windows Server 2008 R2 operating system, and Dell PS6010E storage as the operating environment of this system. The DB2 of IBM corporation is a relational database management software. DB2, such as Windows, Linux, and UNIX, is a relational database management software that can run smoothly on platforms such as Windows, Linux, and UNIX. It has high parallel performance and workload, ISO security certification with the highest standards, high level of data utilization, integrity, recoverability, and small to large-scale application execution capabilities, which can satisfy the needs of public health information management systems in primary health care institutions. In this study, Qiqihar Medical University basic medical institutions are selected as the experimental unit of the public health information management system, to evaluate the working effect of the system within 12 months. It mainly includes the survey of residents' satisfaction, the evaluation of medical treatment effect, the analysis of work efficiency and the evaluation of residents' health awareness.

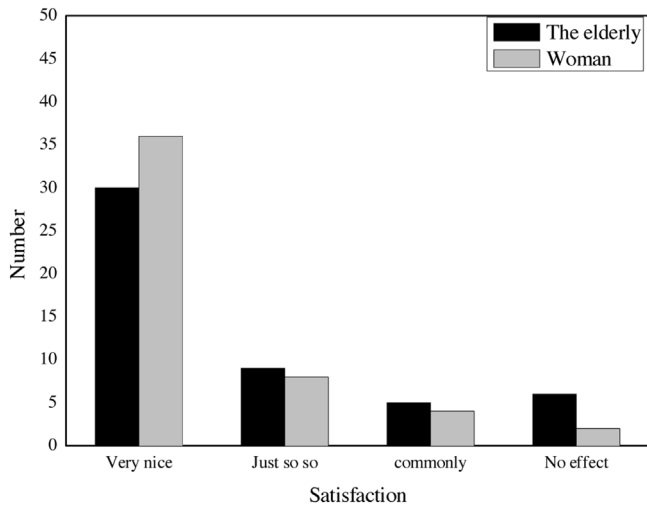


Fig. 3. Analysis of resident satisfaction of public health information management system in primary medical units.

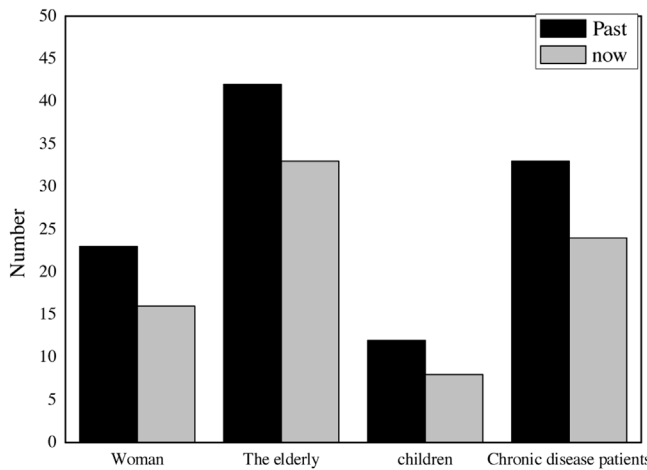


Fig. 4. Analysis of the number of monthly medical treatment before and after the application of the public health information management system.

Results and discussion

Satisfaction study of public health information management system in primary medical units

The analysis of resident satisfaction of public health information management system in primary medical units is shown in Fig. 3. In the figure, the people who are satisfied with the system after the establishment of the information management system in primary medical units mark the majority; they are very satisfied that this account occupies at least 60% of the survey population of their respective groups, and less than 10% of residents have their own views on the role of the system. It can be seen that the information system of the primary medical institutions established in this study has a very positive effect on the health of most residents.

Analysis of the number of medical practitioners before and after the application of public health information management system

The analysis of the number of monthly medical treatments before and after the application of the public health information management system is shown in Fig. 4. As shown in the figure, there is a significant drop in the number of people visiting the medical institutions every month after the establishment of the information

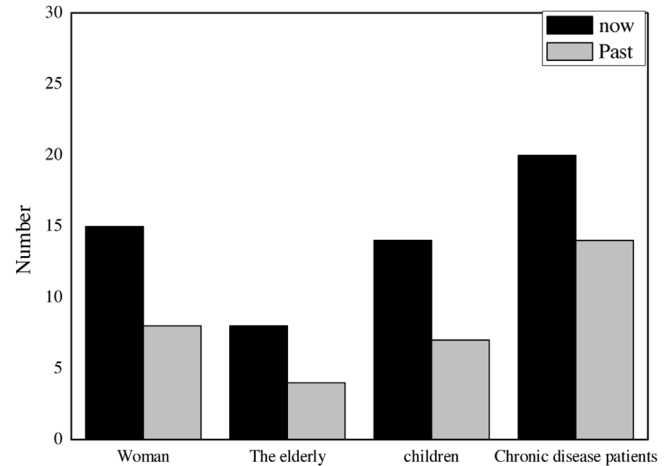


Fig. 5. Analysis of the efficiency of medical units per day before and after the application of the information management system.

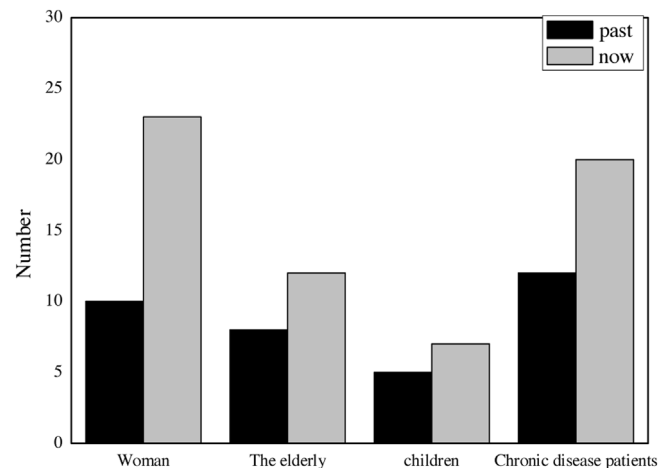


Fig. 6. Analysis of health awareness of residents before and after the application of the information management system.

management system in the primary medical units, whether it is for women, children, the elderly, or the chronically ill patients. It can be seen that the information management system established in this study has a very effective and comprehensive treatment effect on patients' diseases and reduces the number of medical treatments for patients. The public health information management system in the primary health care units of health information has productive work efficiency.

Analysis of the efficiency of medical units per day before and after the application of the information management system

The efficiency analysis of medical units per day before and after the application of the information management system is shown in Fig. 5. As shown in the figure, the efficiency of the primary medical units has significantly been improved before and after the use of the newly built medical information system. The effects of both the children and the elderly are very significant. The diagnosis efficiency of female patients in health care units is improved from 8 cases to 15 cases per day. For the elderly, the daily working capacity is improved from 3 cases to 5 cases, which shows that the new medical information system has significantly improved the efficiency of medical treatments in health care units.

Analysis of health awareness of residents before and after the application of the information management system

The analysis of residents' health awareness before and after the application of the information management system is shown in Fig. 6. As shown in the figure, the health awareness of medical clinics and residents has been dramatically improved after the application of the newly-built medical information system. The knowledge of the aspect for self-protection and many health cares has been dramatically improved, and the improvement of consciousness will reduce the illness. This is to solve the problem fundamentally. It can be seen that the public medical information system established in this study dramatically enhances the residents' health awareness to a large extent.

Conclusion

In this study, the public health information management system is designed, and its application in primary medical units is studied. The EHR and VPN technologies, as well as real-time backup of data storage, are used to design the public health information management system under the premise of economical and straightforward operation. Besides, Xinhua Community Health Service Center Around the Wulong Street, Longsha District, Qiqihar City is selected as the experimental unit of the public health information management system, and the work efficiency of the system in the public health perspective of the primary medical unit is evaluated after 12 months of system operation. The results show that the public health information management system established in this study has excellent management functions, such as management of health record, child health, maternal health, and elderly health. In addition, through a year of application, both patients and the grass-roots level medical institutions are highly satisfied with the system. Besides, as well system has cultivated the awareness of residents for disease prevention and health care and promoted the efficiency of primary care institutions. Therefore, through this study, it is found that the public health information management system plays a very significant role in the primary medical institutions. It is not only reflected in the improvement of work efficiency and the reduction of doctors' work intensity, but also enhances patients' health awareness and reduces the number of hospital treatment, which provides experimental basis for the later development of grass-roots medical public health information management system.

The research in this study is also subject to some restrictions, such as the incomplete data search due to the limitations of time and resource constraints. In addition, the application is only in a primary medical unit for trial operation; the number of experimental samples could have been more extended, as well as the running time. Therefore, the obtained results are slightly lacking in persuasiveness, and subsequent research can conduct more in-depth research to reduce the interferences. The research in this study has significant reference value for later researches.

Funding

No funding sources.

Competing interests

None declared.

Ethical approval

Not required.

Acknowledgements

This work was supported by Basic Research Projects of Basic Scientific Research Business Fees of Provincial Undergraduate Colleges and Universities under the Ministry of Education of Heilongjiang Province (No. 2018-KYWF-0125), General Directive Project of Science and Technology Plan of Qiqihar Science and Technology Bureau (No. RKX-201903) and Social Science Foundation Project of Qiqihar Medical College (No. QYSKL2019-11).

References

- [1] Wu F, Narimatsu H, Li X, Nakamura S, Sho R, Zhao G, et al. Non-communicable diseases control in China and Japan. *Global Health* 2017;13(1):91.
- [2] Prinja S, Nimesh R, Gupta A, Bahuguna P, Thakur JS, Gupta M, et al. Impact assessment and cost-effectiveness of m-health application used by community health workers for maternal, newborn and child health care services in rural Uttar Pradesh, India: a study protocol. *Glob Health Action* 2016;9(1):31473.
- [3] Cortis LJ, Ward PR, Mckinnon RA, Koczwara B. Integrated care in cancer: what is it, how is it used and where are the gaps? A textual narrative literature synthesis. *Eur J Cancer Care* 2017;26(4):e12689.
- [4] Bakibinga P, Kamande E, Omuya M, Ziraba AK, Kyobutungi C. The role of a decision-support smartphone application in enhancing community health volunteers' effectiveness to improve maternal and newborn outcomes in Nairobi, Kenya: quasi-experimental research protocol. *BMJ Open* 2017;7(7):e014896.
- [5] Roger F, Caron A, Morand S, Pedrono M, Garine-Wichatitsky M, Chevalier V. One Health and EcoHealth: the same wine in different bottles? *Infect Ecol Epidemiol* 2016;6(1):30978.
- [6] Quaipe SL, Ruparel M, Beeken RJ, Mcewen A, Isitt J, Nolan G, et al. The Lung Screen Uptake Trial (LSUT): protocol for a randomised controlled demonstration lung cancer screening pilot testing a targeted invitation strategy for high risk and 'hard-to-reach' patients. *BMC Cancer* 2016;16(1):281.
- [7] Deutsch N, Singh P, Singh V, Curtis R, Siddique AR. Legacy of polio—use of India's social mobilization network for strengthening of the universal immunization program in India. *J Infect Dis* 2017;216(Suppl.1):S260–6.
- [8] Deng F, Lv JH, Wang HL, Gao JM, Zhou ZL. Expanding public health in China: an empirical analysis of healthcare inputs and outputs. *Public Health* 2017;142:73–84.
- [9] Canaway R, Bismark M, Dunt D, Kelaher M. Medical directors' perspectives on strengthening hospital quality and safety. *J Health Organ Manag* 2017;31(7/8):696–712.
- [10] Warring CD, Pinkney JR, Delvo-Favre ED, Renner MR, Lyon JA, Jax B, et al. Implementation of a routine health literacy assessment at an academic medical center. *J Healthc Qual* 2018;40(5):247–55.
- [11] Kauremaa J, Tanskanen K. Designing interorganizational information systems for supply chain integration: a framework. *Int J Logist Manag* 2016;27(1):71–94.
- [12] Evans-Lacko S, Hanlon C, Alem A, Ayuso-Mateos JL, Chisholm D, et al. Evaluation of capacity-building strategies for mental health system strengthening in low- and middle-income countries for service users and caregivers, policymakers and planners, and researchers. *BJPsych Open* 2019;5(5):66–77.
- [13] Gopalakrishna-Remani V, Jones RP, Camp KM. Levels of EMR adoption in US hospitals: an empirical examination of absorptive capacity, institutional pressures, top management beliefs, and participation. *Inf Syst Front* 2018:1–20.
- [14] Wankah P, Guillette M, Dumas S, Couturier Y, Breton M. Reorganising health and social care in Québec: a journey towards integrating care through mergers. *London J Prim Care* 2018;10(3):48–53.