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Journal Pre-proof

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Research Article

Information technology and artificial intelligence support in management experiences of the pediatric designated hospital during the COVID-19 2022 epidemic in Shanghai

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Abstract

Objective To describe the information technology and artificial intelligence support in management experiences of the pediatric designated hospital in the wave of COVID-19 in Shanghai.

Methods We retrospectively concluded the management experiences at the largest

pediatric designated hospital from March 1st to May 11th in Shanghai. We summarized the application of Internet hospital, face recognition technology in outpatient department, critical illness warning system and remote consultation system in the ward and the structed electronic medical record in the inpatient system. We illustrated the role of the information system through the number and prognosis of patients treated.

Results The COVID-19 designated hospitals were built particularly for critical patients requiring high-level medical care, responded quickly and scientifically to prevent and control the epidemic situation. From March 1st to May 11th 2022, we received and treated 768 children confirmed by positive RT-PCR and treated at our center. In our management, we use Internet Information on the Internet Hospital, face recognition technology in outpatient department, critical illness warning system and remote consultation system in the ward, structed electronic medical record in the inpatient system. No deaths or nosocomial infections occurred. The number of offline outpatient visits dropped, from March to May 2022, 146,106, 48,379, 57,686 respectively. But the outpatient volume on the internet hospital increased significantly (3,347 in March 2022 *vs*. 372 in March 2021; 4,465 in April 2022 *vs*. 409 in April 2021; 4,677 in May 2022 *vs*. 538 in May 2021).

Conclusions Information technology and artificial intelligence has provided significant supports in the management. The system optimizes the admission screening process, increases the communication inside and outside the ward, achieves early detection and diagnosis, timely isolates patients, and timely treatment of various types of children.

Keywords: Coronavirus disease 2019; Information technology; Artificial intelligence; Closed-loop management; Pediatric designated hospital

1. Introduction

On January 8, 2020, a novel coronavirus was officially announced as the causative

pathogen of coronavirus disease 2019 (COVID-19) by the Chinese Center for Disease Control and Prevention. Since then, the epidemics of COVID-19 become a major challenging public health problem for not only China but also countries around the world [1]. First discovered in Southern Africa in November 2021, the Omicron variant of SARS-CoV-2 has swiftly spread across the world and become the dominant strain globally [2]. In late February, 2022, a wave of SARS-CoV-2 infection rapidly appeared in Shanghai. According to the report from Shanghai Municipal Health Commission, 601,942 cases have been identified until 4th May, 2022, including 547,056 asymptomatic carriers [3]. A batch of cabin hospitals were temporarily constructed to accommodate overwhelming COVID-19 patients. At the same time, more than 12 municipal COVID-19 designated hospitals have been built, particularly for critical patients who require advanced medical care [4].

As the only designated hospital for children in Shanghai, Children's Hospital of Fudan University (CHFU) faced enormous challenges during the pandemic. As one of the first group of "Grade Ⅲ-class A" hospitals, CHFU had also the responsibility to ensure the medical treatment for other children and prevent the occurrence of nosocomial infections in addition to treatment for coronavirus positive children. Through the comprehensive application of information technology, it could cope with remote consultation, high-efficiency medical record writing, rapid nucleic acid detection, hospital flow control, internet hospital administration, and further improve the level of hospital epidermic prevention and control.

2. Methods

This study retrospectively summarized the information improvement measures in our hospital from March to May 2022.

2.1 Application of Internet Information on the Internet Hospital

Our internet hospital was established in May 2020. The organizational structure of the Internet hospital consists of three parts: management platform, business application platform and data center. We used information exchange technology to

connect the information platform of internet hospital with offline hospital. Based on this, we constructed a flowchart between offline hospital and online hospital by summarizing the treatment process of existing internet hospital based on doctor-patient interaction. Various health services are provided in the internet hospital. Patients can consult online before going to the offline hospital to collect relevant professional health information and understand their current situation. If they need to go to a hospital, there can be a more extensive and reliable institution that can assist the hospital in triaging. Doctors provide patients with online services that include general clinics and expert clinics through face-to-face communication or image-text consultation with patients via remote video systems. If there is a drug prescription, it must be reviewed by the pre-review system. When the prescription passed the pre-review system, the drugs are then delivered to the patient's registered address by express delivery in the local hospital based on the choice of patient. During the epidemic, we added the functions of online hospital appointments for inspections and appointment for hospitalization (Figures 1-3).

2.2 Application of face recognition technology in outpatient department

Face recognition technology and risk identification with diversion knowledge basis have been set up at the entrance and exit of the hospital. According to the location of the entrance and exit, the flow of people, the entry and exit of vehicles, ramp-type, column-type and handheld terminals are monitored respectively. The intelligent identification access terminal is connected to the city's big data center and the health cloud. The staff of the hospital can pass through the terminal by face recognition, and patients can scan the QR code through the application code to complete the identification of incoming personnel and epidemic prevention information (the color of the application code, body temperature, nucleic acid detection information, etc.) verification, and the identity information, entry and exit time, etc. of those who have passed the verification are fed back to the hospital through the city's big data center and health cloud platform. The three colors of QR codes (red, yellow and green) correspond to different risk levels [5].

2.3 Critical illness warning system and remote consultation system in the ward

We used the critical illness warning system to distinguish critically ill children in the ward. Our critical illness warning model was based on high-quality medical record data and constructed technologies such as natural language processing and Bayes inference (Figure 4). The real-time monitoring system allows doctors to obtain the monitoring data of critically ill patients in the ward in time.

The COVID-19 isolation ward had a remote consultation system. It allowed the experts to intuitively obtain the complete electronic medical records of patients, including epidemiological history, clinical symptoms, laboratory tests and imaging examination reports, etc; digital radiological images such as chest CT can be accessed in real time, and previous images of patients can be compared. Through the remote consultation system, the ability of clinical treatment experts to conduct unified remote consultation for critically ill patients is formed. The medical department organizes at least one online expert discussion per week, using multi-disciplinary team (MDT). The MDT team consists of experts from the department of infectious diseases, critical care medicine, respiratory medicine, traditional Chinese medicine, etc. The MDT experts can independently contribute to a diagnosis and suggested treatment strategy [6]. It can improve the quality of clinical diagnosis and treatment decisions for sever patients and shorten the time for personalized and precise treatment.

2.4 The inpatient self-examination, structed electronic medical record and the real-time data in the inpatient system

This system was to establish a structured inquiry form for inpatients, and automatically collect patient medical history information. A COVID-19 structured medical record system was also built up and all patients admitted to the new crown will automatically form a structured electronic case.

Based on the structured electronic medical record, the report data of COVID-19 patients was automatically formed. By providing hospital managers with multi-channel display of dynamic data on COVID-19 patients, which can be queried in real time through phone mobile and computer terminals. The indicators mainly include the number of hospitalizations on the day, the number of admissions on the day, the cumulative number of discharged patients on the same day, the average length of

hospitalization, and the cumulative number of cases by type (Figure 5).

2.5 Statistical analysis

We counted the total number of patients, and the continuous variables were expressed as mean ± SD.

3. Results

3.1 Outpatient department and Internet hospital outpatient volume

The number of offline outpatient visits dropped, from March to May 2022, 146,106, 48,379, 57,686 respectively. But the outpatient volume on the internet hospital increased significantly (3,347 in March 2022 *vs*. 372 in March 2021, 4,465 in April 2022 *vs*. 409 in April 2021, 4,677 in May 2022 *vs*. 538 in May 2021) (Figures 6-7).

3.2 Outpatient and emergency screening of patients and hospitalization process

We had established outpatient and emergency screening and admission procedures. Patients with high body temperature would be transferred to the fever clinic through specific routes. Other patients with no fever and yellow/green QR code would be required to do a novel coronavirus antigen test. The test negative patients then were allowed for the entrance into the general clinic, while the test positive patients would transfer to the isolation room to have the nucleic acid test. If the nucleic acid result was negative, then they would be allowed for the general clinic. Patients released from quarantine less than 7 days after COVID-19 infection or with red QR code would be asked to stay in an isolation room for further treatment. The nucleic acid positive children would be directly admitted to the isolation ward. The patients with green QR code would be admitted to the buffer ward, tested for nucleic acid for 3 days before transferred to the official ward (Figure 8).

3.3 The situation of patients admitted to the COVID-19 isolation ward

Since March 2022, a total of 768 confirmed cases of COVID-19 were treated in our designated hospital, including 427 males and 341 females. The average age was (5.45 ±4.74) years. The average hospital stay was (11.4±4.1) days, and 51 patients had underlying diseases. The main underlying diseases are: epilepsy, cerebellar tumor,

leukemia, nephrotic syndrome, Rett syndrome, methylmalonic acidemia, etc. The critical illness warning system alarmed more than 20 times, and all of them were dealt with in a timely manner, achieving zero deaths of coronavirus children.

4. Discussion

During the epidemic, it was difficult for face-to-face medical consultation and treatments. With the development of information and communication technology, children and the family can receive high-quality health care from a distance through tele-health intervention [7]. Internet hospital is a new platform for doctors to conduct diagnosis and treatment activities based on the internet [8].

The main manifestation of COVID-19 includes acute fever, cough and dyspnoea [9], therefore the emergency department (ED) and the fever clinic have become the primary facility that provides initial diagnosis and treatment for patients with potential COVID-19 [10]. Due to the daily large number of patients, the likelihood of cross-infection and the spread of COVID-19 within the hospital is very likely to occur [11-12]. Rapid identification and risk screening of patients entering outpatient clinics was important.

Since we are the only designated hospital for coronavirus positive children in Shanghai, we treated coronavirus positive children and other children at the same time. Nurses used five-level emergency triage systems for quick identification [13]. Children who need rescue are directly taken to the emergency room for first aid. The information system can help medical staff to quickly screen and rescue critically ill patients in a timely manner.

The combined application of new technologies such as Internet hospital, face recognition technology in outpatient department, critical illness warning system and remote consultation system in the ward and the structed electronic medical record in the inpatient system can solve the problems of rapid treatment of COVID-19 children in designated hospitals and to ensure that other children seek medical treatment. This research provided new ideas and methods for the information construction of such hospitals in the future. However, this study was only carried out in one hospital, which has certain limits.

Conflicts of interest statement

The authors declare that there are no conflicts of interest.

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Author contributions

Yu Shi and Jin Fu: Design the research; perform the literature searches; assess the eligibility of studies for inclusion; extract the data from studies; and draft, edit, and revise the manuscript; Mei Zeng, Yanling Ge, Xiangshi Wang, Aimei Xia, Weijie Shen, Jiali Wang, Weiming Chen, Siyuan Jiang: Helped write and edit the manuscript; Xiaowen Zhai: Design the research; assess the eligibility of studies for inclusion; and draft, edit, and revise the manuscript.

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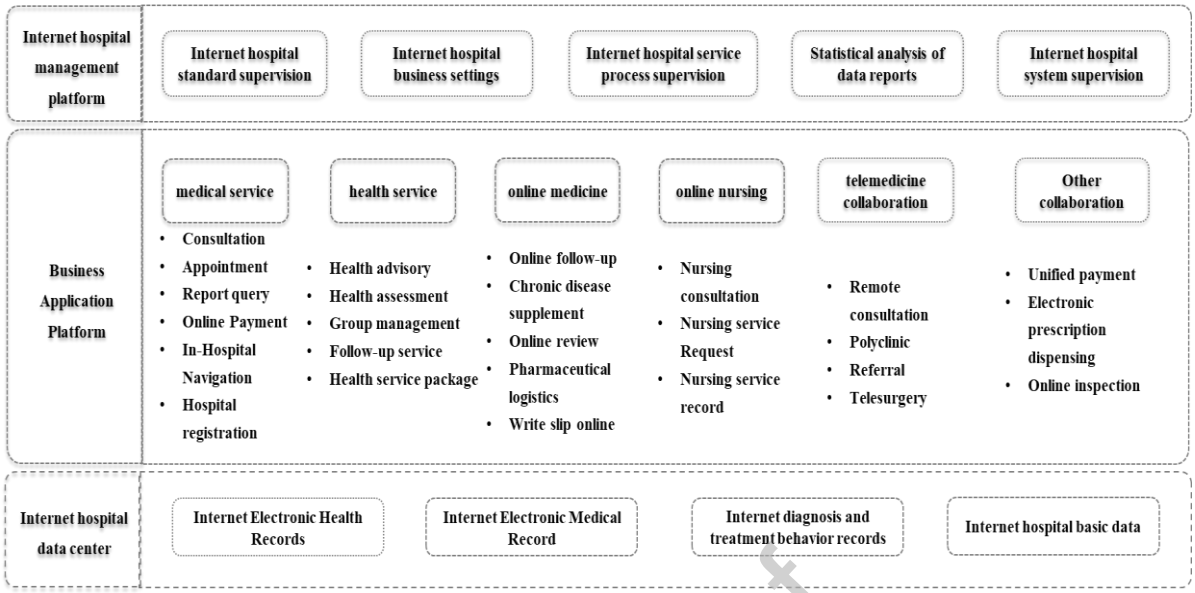

Figure 1. Various medical services provided in the internet hospital.

Figure 2. Example of internet hospital app interface.

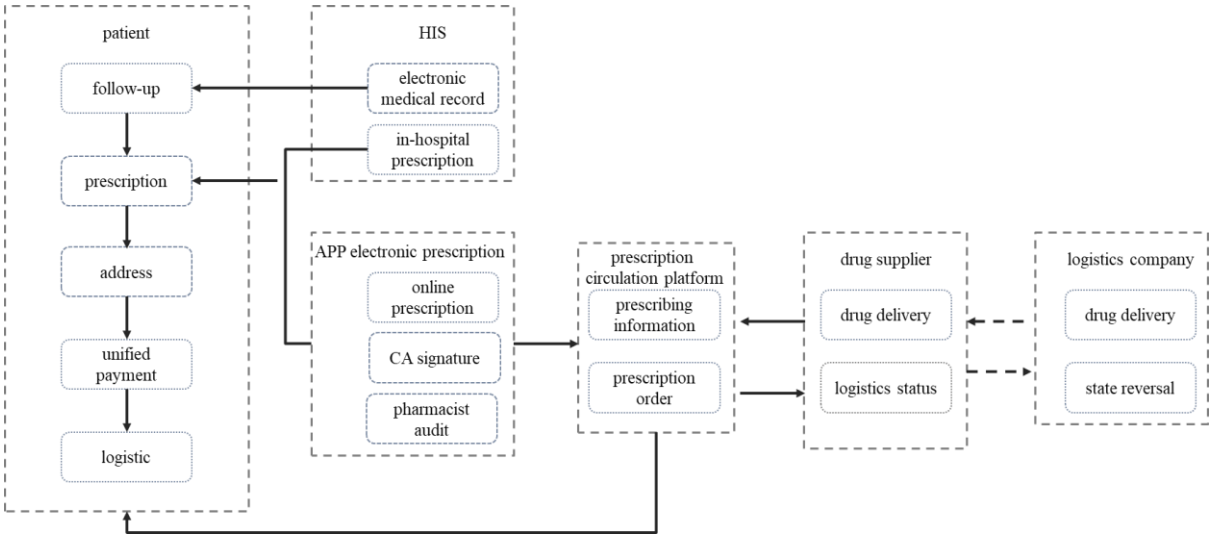

Figure 3. Flowchart of prescription review.

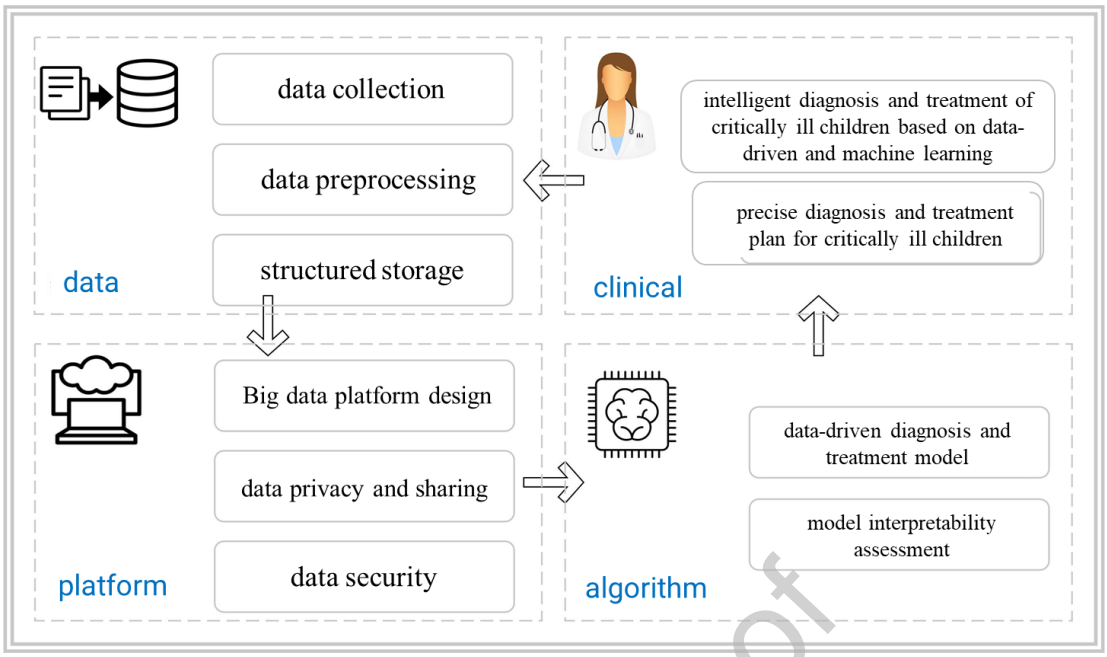

Figure 4. Critical illness warning system and remote consultation system

Fig a: QR for collecting patient information

Fig b: The interface for collecting medical history that appears after scanning the QR code

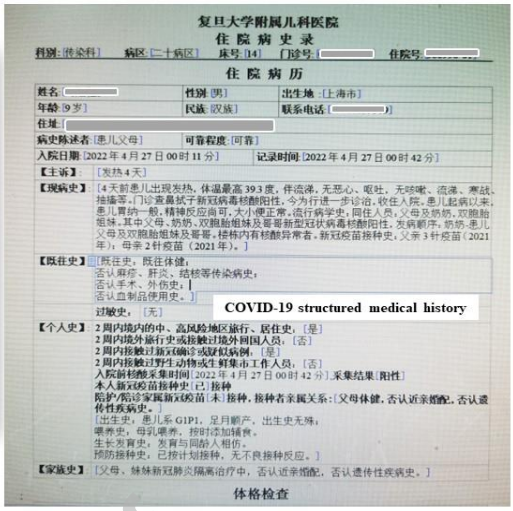

Fig c: COVID-19 structured medical history in the inpatient system

Figure 5. The inpatient self-examination, structed electronic medical record in the inpatient system.

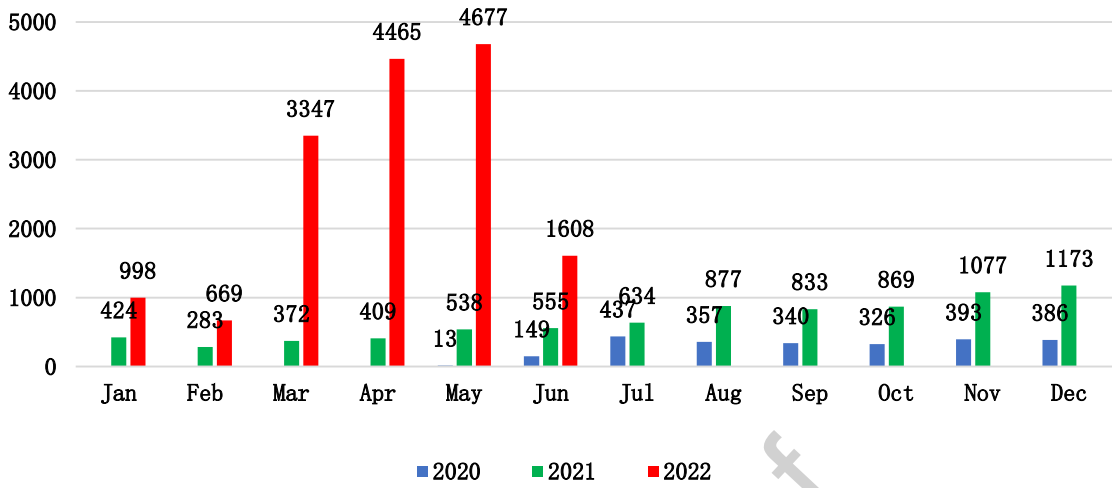

Figure 6. Outpatient volume of Internet hospitals.

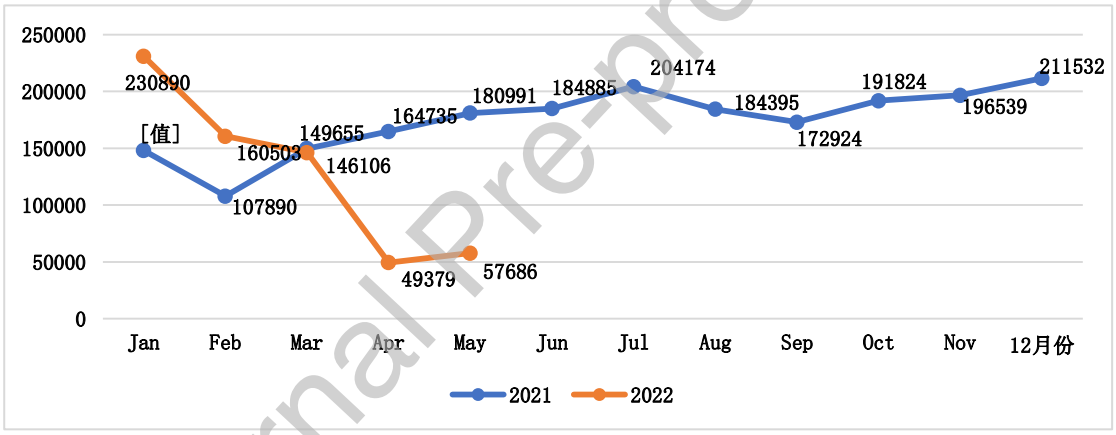

Figure 7. Offline outpatient volume

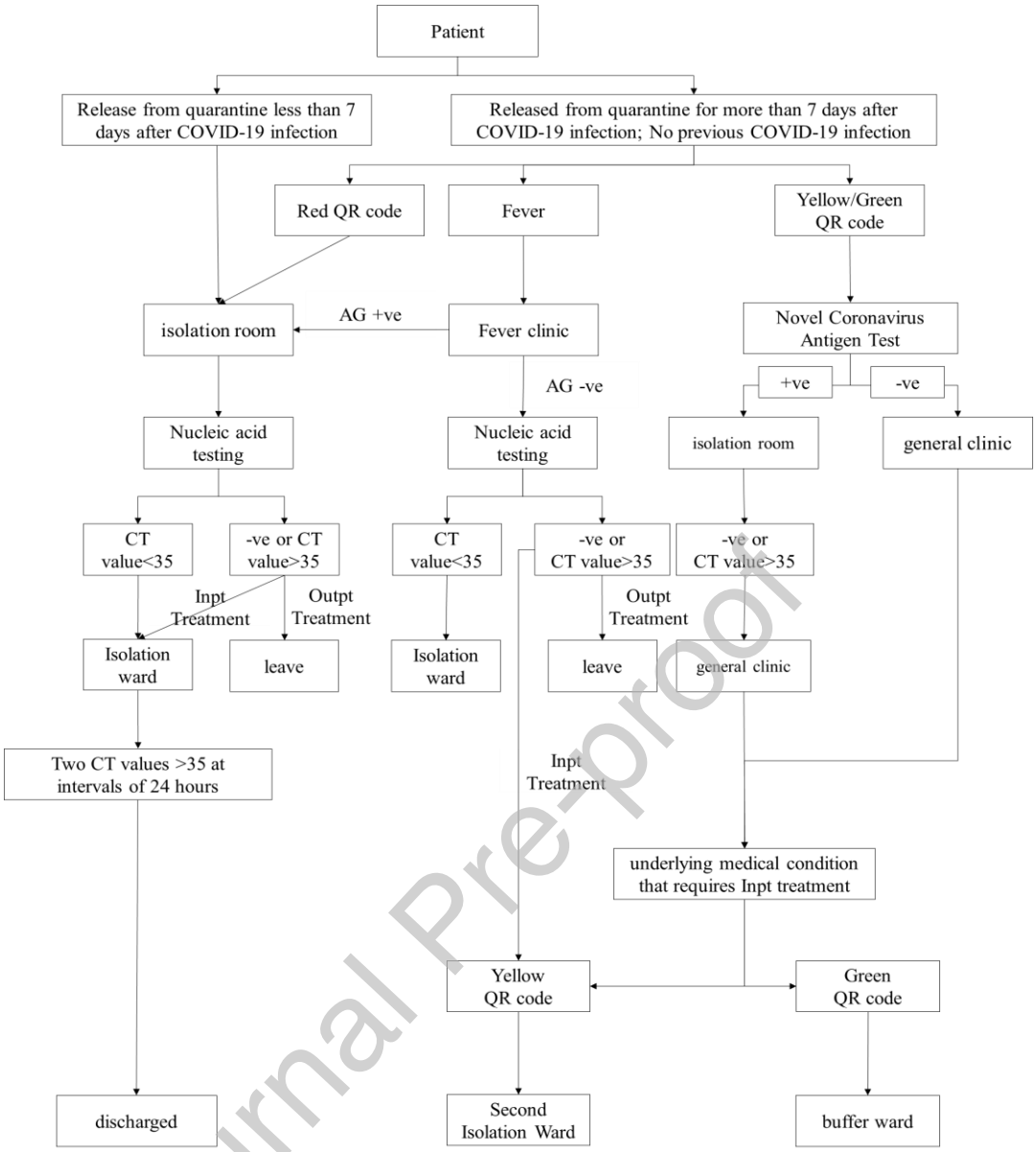

Figure 8. Outpatient and emergency screening of patients and hospitalization process. +ve: positive; -ve: negative; Outpt: outpatient; Inpt: inpatient