
Research and Applications

How hospitals in mainland China responded to the outbreak of COVID-19 using information technology-enabled services: An analysis of hospital news webpages

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ABSTRACT

Objective: Many countries have implemented quarantine rules during the global outbreak of coronavirus disease 2019 (COVID-19). Understanding how hospitals can continue providing services in an effective manner under these circumstances is thus important. In this study, we investigate how information technology (IT) helped hospitals in mainland China better respond to the outbreak of the pandemic.

Materials and Methods: We conducted a content analysis of pages published on the websites of the top 50 hospitals in mainland China between January 22 and February 21, 2020. In total, we analyzed 368 pages that the hospitals published during the initial days of the COVID-19 pandemic. The purpose was to identify common themes related to the utilization of IT by these hospitals in response to the pandemic's outbreak.

Results: We identified 5 focal themes across the webpages published by the hospitals during our study period, including (1) popular medical science education, (2) digitalized hospital processes, (3) knowledge management for medical professionals, (4) telemedicine, and (5) new IT initiatives for healthcare services. Our analysis revealed that Chinese hospitals spent greater effort in promoting popular medical science education in the initial stages of our study period and more on telemedicine in the latter stages.

Discussion: We propose a configurational approach for hospitals to design response strategies to pandemic outbreaks based on their available resources.

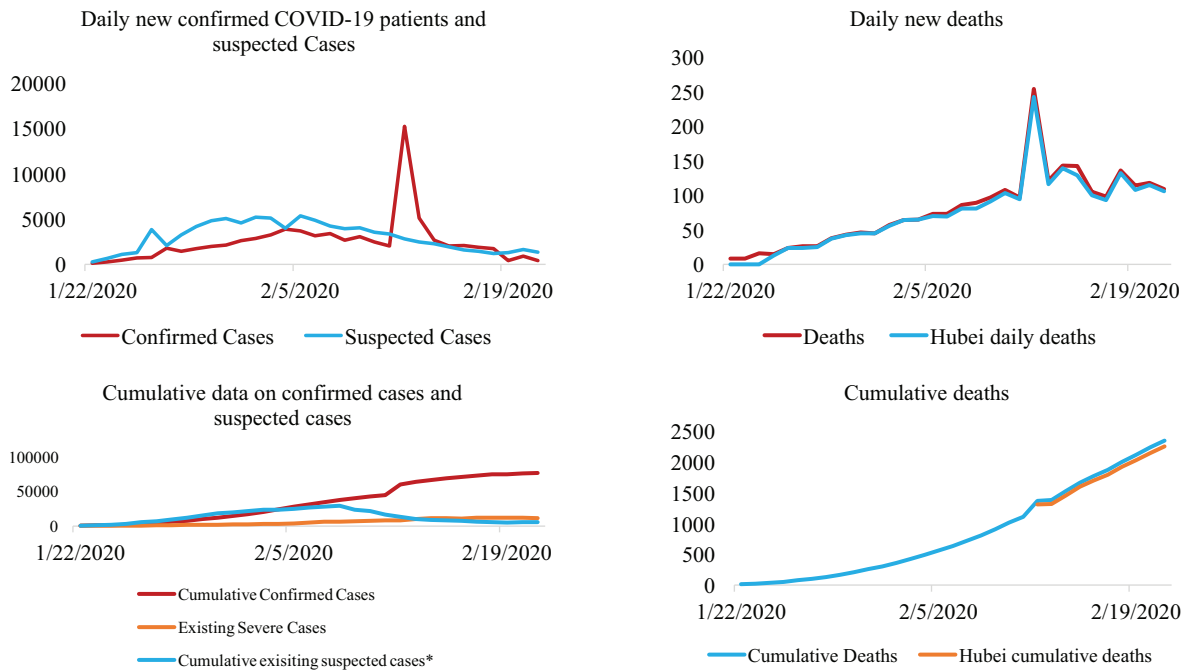
Conclusions: Our study provides rich insights for hospitals to better utilize their IT resources and some recommendations for policymaker to better support hospitals in the future.

Key words: COVID-19 Pandemic, IT-enabled Services, hospital responding strategy, Mainland China

INTRODUCTION

On December 30, 2019, the first case of coronavirus disease 2019 (COVID-19) was confirmed in Wuhan Jinyintan Hospital in Hubei, China.¹ On January 21, 2020, Nanshan Zhong, a well-known respiratory expert in China, announced in the mass media that there was a possibility of limited people-to-people transmission of COVID-

19.² On January 23, 2020, Wuhan was placed in lockdown at 10 AM and residents were told to remain in the city unless they had special reasons for leaving. [Figure 1](#) summarizes the key statistics of COVID-19 confirmed cases, suspected cases, and deaths between January 22 and February 21, 2020, using data from China's National Health Commission.³ As illustrated, around 20% of the



*Cumulative existing suspected cases at time T = cumulative existing suspected case at time (T-1) + daily suspected cases at time T – confirmed cases from suspected cases at time T – removed suspected cases at time T.!

Figure 1. Coronavirus disease 2019 (COVID-19) statistics in China (January 22 to February 21, 2020).

reported cases were critical and severe patients, and around 95% of the mortalities occurred in Hubei province. In response to the pandemic's spread, China's central government launched a national effort aimed at implementing prevention and control mechanisms and cities started to implement quarantines.

Hospitals responded to the outbreak of COVID-19 by creating new rules and procedures for hospital management, redesigning the physical layout of outpatient services, and setting up specific areas for inpatient services for confirmed or suspected cases. They utilized information technology to facilitate these changes. In this article, we seek to answer 2 research questions:

1. How did IT help hospitals respond to the outbreak of the COVID-19 pandemic in mainland China?
2. Were there focal themes in IT-enabled healthcare services offered by hospitals during the outbreak of the pandemic?

To address these 2 questions, we integrated 2 divergent streams of research (ie, IT-enabled healthcare services and pandemic response actions). Extant literature on IT-enabled healthcare services has primarily focused on adoption and usage of electronic health records (EHRs),^{4–7} clinical decision support systems,^{8,9} mobile healthcare apps,^{10,11} web-based platforms such as patient portals,^{12,13} and remote healthcare services such as remote patient monitoring.¹⁴ These empirical studies have investigated multidimensional factors that may influence the adoption and usage of IT-enabled healthcare services. Another stream of research has focused on the prevention or control measures of outbreak of epidemic or pandemic diseases, including the implementation of real-time outbreak and disease surveillance systems,^{15–17} development of algorithms for computerized epidemic early detection systems,^{18,19} and response strategies for the public health system.²⁰ The response strategies include (1) standardized terminologies for patients to ef-

fectively communicate their symptoms and medical histories, (2) threat detection using healthcare data spanning time and location, and (3) response actions such as designing and disseminating guidelines, directing reminders to physicians for worrisome cases, and educating physicians in the application of these guidelines.²⁰

MATERIALS AND METHODS

Content analysis was used to code and categorize news webpages published by hospitals in our study. As recommended by Weber,²¹ content analysis can be used to identify and describe meaningful classifications, reveal patterns, and therefore gain new insights through a systematic analysis of a volume of written communication.²² Our content analysis included 3 phases: preparation, organization, and reporting.^{22,23}

In the preparation phase, we collected all the IT utilization–related news webpages published in the top 50 hospitals in mainland China²⁴ between January 22 and February 21, 2020 (Supplementary Appendix A). Five hospitals did not publish such news webpages during this 1-month time window and were excluded. In total, we retrieved 368 news webpages that identified 360 events. The detailed coding procedure is described in Supplementary Appendix B.

In the organization phase, we adopted an emergent coding approach and followed the steps outlined in Haney et al.²⁵ First, 2 authors (AY and YZ) independently reviewed all the hospital news webpages and came up with a set of codes to form a checklist. Second, they compared notes and reconciled any differences in the initial checklists. Third, a consolidated and mutually agreed-upon checklist was used to independently code the pages. The interrater reliability was excellent using percentage agreement (92.5%) and Cohen's kappa (0.90).²⁶

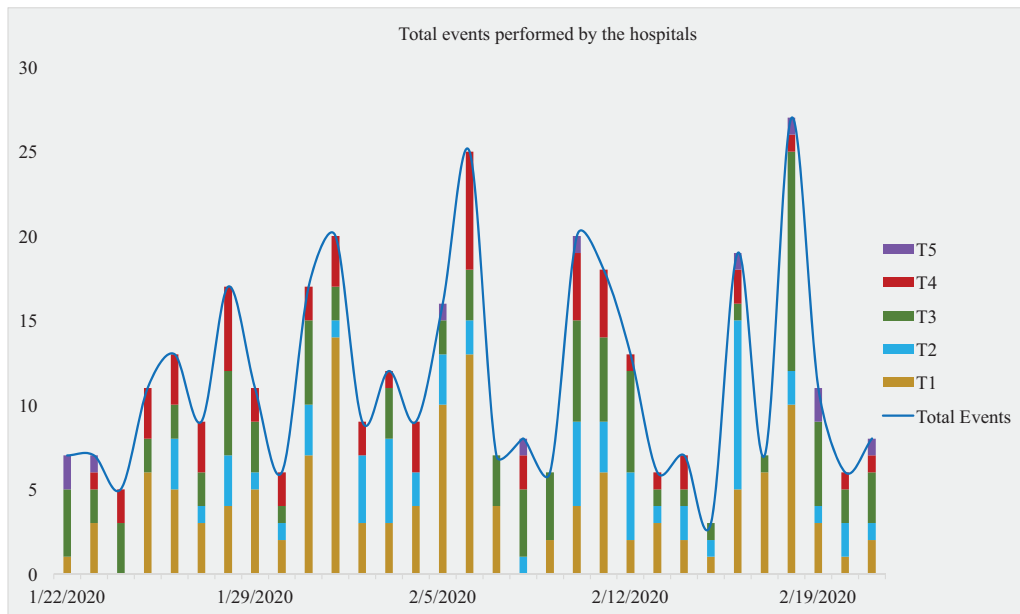


Figure 2. Five themes evolution. T: theme.

In the reporting phase, we used descriptive statistics, tables, and figures to interpret the common themes of how IT helped Chinese hospitals better respond to the pandemic.

RESULTS

Based on the 360 events identified in the published hospital pages, 5 themes emerged on how IT was used to respond to COVID-19, including dissemination of popular medical science education (theme 1), digitalized hospital processes (theme 2), knowledge management for medical professionals (theme 3), telemedicine (theme 4), and new IT initiatives for healthcare services (theme 5). The events in themes 4 and 5 were nonrecurring, but some of the events in themes 1-3 were recurring such as publishing popular science articles. Figure 2 shows the distribution of these 5 themes from January 22 to February 21, 2020. From Figure 2, we can observe the evolutionary patterns among these 5 themes. At the early stage of the study, hospitals focused more on publishing popular medical science articles on their websites (theme 1) and also digitalized hospital processes (theme 2), but in later stages of the study, they focused more on knowledge management for medical professionals (theme 3) and telemedicine (theme 4). Table 1 summarizes the coding underlying 5 themes. We also examined the changing patterns under each theme during this 1-month study period and presented our finding in Figure 3 (for themes 1 and 2) and Figure 4 (for themes 3-5) respectively.

Theme 1: Dissemination of popular science education

More than 37% of events were related to dissemination of popular medical science education. Many hospitals used websites to share popular medical education with the public. We classified these events into 4 types (see Table 1). Some hospitals reprinted articles related to COVID-19 from other sources such as the World Health Organization or China National Health Commission (ie, T1-PEAR). For example, the Peking University People's Hospital (ranked #13) reprinted a series of articles related to COVID-19 prevention such as how to wear a mask, how to wash hands, and how to self-isolate at

home in February 2020. In contrast, some hospitals invited their medical experts from different departments to write original articles about COVID-19 prevention and control measures (T1-PEAO). A good example comes from Tongji Hospital in Wuhan, Hubei (ranked #8). It invited medical experts from infectious disease, respiratory medicine, neurology, and many other areas to write educational articles to the public. Another type of event is popular science article related to special needs people (T1-PESN), such as chronic disease patients, seniors, pregnant women, and children. Because of the quarantine and isolation policies, many patients with special needs were unable to see their doctors for follow-up visits. Therefore, some hospitals used their websites to provide medical guidelines for this group of patients to take care of themselves at home. For instance, Fuwai Hospital (ranked #23) published a series of articles for patients with heart diseases on how to deal with some symptoms during the quarantine period. Last, as people had to stay at home due to the quarantine and isolation policies, some began to exhibit symptoms of anxiety or stress. Hospitals thus rolled out professional advice on how to stay at home healthily and happily. For instance, on January 30, 2020, West China Hospital of Sichuan University (ranked #2) published an online book for reducing the level of anxiety and shared it freely with the public.

Popular medical education raised awareness in the population and reduced the infection risks. Furthermore, quarantine and isolation policy increased the level of stress and anxiety among people and people with special needs were unable to see doctors. The dissemination of medical information by hospitals helped address these issues.

As shown in Figure 3, hospitals published more reprinted articles (T1-PEAR) at the early stage, but later added more originally written articles (T1-PEAO). The number of medical guidelines for special needs patients (T1-PESN) also increased significantly during the middle to later stages. More articles related to psychological issues appeared at the later stage (T1-PEPI). This is quite understandable because people were likely more anxious after being quarantined for a long term and thus psychological issue-related articles were more suitable at that time point.

Table 1. Coding book for the 5 themes

Code	Full name	Description	Events
Theme 1: Popular science education (n = 134 [37%])			
T1-PEAR	Popular medical science article—reprinted	Hospital provided medical popular education to the public about the prevention of COVID-19 from external sources.	49 (37%)
T1-PEAO	Popular medical science article on COVID-19—original	Hospital provided education to the public about the prevention of COVID-19 originally created by the hospital.	46 (34%)
T1-PESN	Popular medical science article related to special needs people	Hospital provided medical guidelines for chronic disease patients or special needs patients (eg, pregnant people, children, seniors) to take care of themselves at home.	30 (22%)
T1-PEPI	Popular medical science article related to psychological issues	Hospital provided professional psychological advices to the public via manual or videos on how to handle stay-at-home pressure or anxiety risen from suspicion of COVID-19 infection or quarantine.	9 (7%)
Theme 2: Digitalized hospital processes (n = 62 [17%])			
T2-OA1	Suggested using online appointment	Hospital suggested that patients use online appointment methods as much as possible.	5 (8%)
T2-OA2	Partially implemented online appointment	A few of the hospital's departments used online methods to make an appointment.	2 (3%)
T2-OA3	Fully implemented online appointment	All of the hospital's outpatient services used online methods to make appointment.	16 (26%)
T2-RPA	Robotic process automation or mobile services	Hospital used robots or mobile devices to support hospital processes (eg, using robots to deliver medicines to coronavirus patients).	4 (6%)
T2-VO	Virtual organization	Hospital used IT-enabled services for hospital administration (eg, online meetings or social media groups).	12 (19%)
T2-DSC	Digitized security controls	Hospital used digitalized administrative processes such as using infrared thermometer to detect temperature without body contact.	18 (29%)
T2-SI	System integration	Hospital integrated information systems to support communications in multiple locations (eg, laboratory information system integration).	5 (8%)
Theme 3: Knowledge management among medical professionals (n = 95 [26%])			
T3-OT	Online training	Hospital provided online training videos for intraorganizational training or for sharing training videos with medical professionals in other hospitals.	32 (34%)
T3-OTG	Online treatment guidelines	Hospital shared online treatment guidelines pertaining to COVID-19 or other diseases with medical professionals.	28 (29%)
T3-OC1	Within-hospital online collaboration	Hospital's medical professionals used online collaboration tools to work with colleagues in different locations of the hospital or with colleagues in Wuhan.	5 (5%)
T3-OC2	Cross-hospital online collaboration in Wuhan	Medical professionals from different hospitals supported the same hospital in Wuhan. They used online collaboration tools to discuss the treatment plan for patients.	3 (3%)
T3-OC3	Cross-hospital distributed online collaboration	There was online collaboration among medical professionals from multiple hospitals in multiple locations.	27 (28%)
Theme 4: Telemedicine (n = 58 [16%])			
T4-OMC	Online medical consultation services for COVID-19 symptoms	Hospital provided online consultation services to patients with fever symptoms.	22 (38%)
T4-OMP	Online medical consultation services for psychological issues	Hospital provided online consultation services to the public related to psychological issues.	7 (12%)
T4-OMF	Online medical consultation services for follow-up consultation and prescription or other disease	Hospital provided online prescriptions, follow-up consultation services, and other disease consultation services to the existing patients.	19 (33%)
T4-PSE	Patient's online self-assessment	Hospital provided online AI-enabled tools to the public for self-assessment.	5 (9%)
T4-MHJ	Multihospital joint online doctor consultation services	Multiple hospitals provide online medical consultation services using external platforms such as Tencent Weibo.	5 (9%)
Theme 5: New IT initiatives (n = 11 [3%])			
T5-ITP	New IT platform initiative	Hospital proposed new IT platform projects to better prepare for future outbreak of viruses/diseases.	7 (64%)
T5-PHI	Promotion of the concept of "Internet plus healthcare services"	Hospital recognized the value of the Chinese government's proposed concept of "Internet plus healthcare services."	4 (36%)

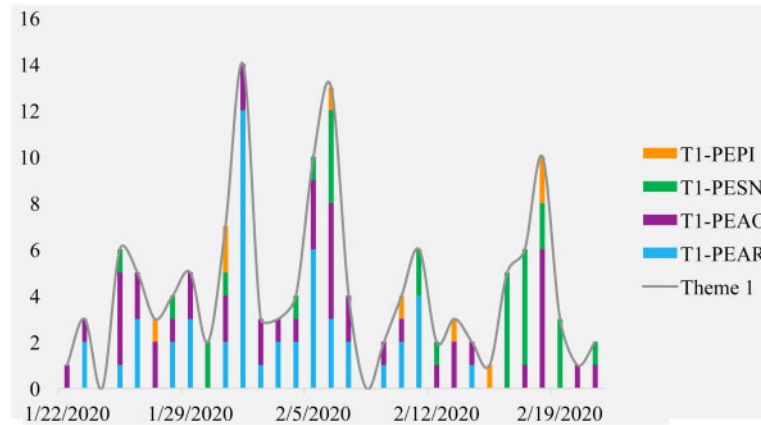
AI: artificial intelligence; COVID-19: coronavirus disease 2019; IT: information technology.

Theme 2: Digitalized hospital processes

The second theme relates to the hospitals' digitalized processes to reduce the COVID-19 infection risk. Our findings indicated that 16 hospitals requested all their outpatients to use online methods (eg, hospital's mobile app, hospital's service account on social media, and official website) to make an appointment (T2-OA3). Three

hospitals used robots or mobile devices to support their medical processes (T2-RPA). A good example is Guangdong Provincial People's Hospital (ranked #27). On January 27, 2020, the hospital welcomed 2 new robotic employees to help deliver medicines from the pharmacy to the nurse workstation, as well as from the nurse workstation to the isolation ward. These robots are able to take the elevator,

Theme 1 evolution



Theme 2 evolution

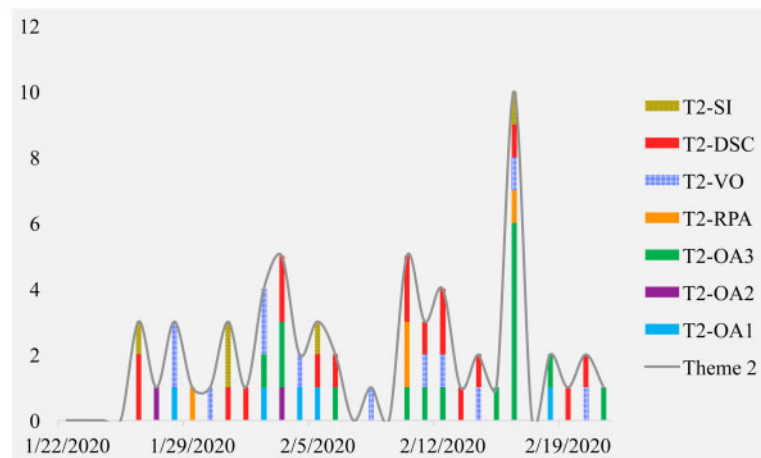


Figure 3. Evolution of events in theme 1 (top) and theme 2 (bottom).

open and close doors, avoid obstacles, and recharge themselves. The utilization of these robots reduced close contact between healthcare workers, as well as between healthcare workers and confirmed COVID-19 patients. Later, on February 10, 2020, Guangdong Provincial People's Hospital added 3 new robots to their medical service team. These 3 new robots were mainly responsible for guiding patients to appropriate departments and answering questions related to COVID-19 prevention.

Hospitals also adopted IT-enabled services for administration (T2-VO). Online meeting tools were used for conferencing and social media apps such as WeChat were used for creating communication groups among healthcare workers and patients. A wide variety of digitized measures were also used for security control in the hospitals (T2-DSC). For instance, almost all the hospitals asked their visitors to report health status. Some hospitals used paper-based forms, but Ruijin Hospital (ranked #4) used QR codes to capture this information. Patients could scan the QR code published on the website to fill in a form on WeChat. Then they could simply present the form to the security staff when they visited the hospital. Many hospitals also used infrared thermometers to detect visitor temperatures without touching the body. Furthermore, in order to save medical protective clothing and reduce the risk of hu-

man contact, only 1 doctor made the rounds of isolation wards and then used WeChat to communicate with other healthcare workers outside the wards. The final event in this theme is systems integration (T2-SI). Hospitals integrated their IT infrastructure or information systems to better support diagnosis and clinical decision making during the outbreak of COVID-19. One example comes from Shanghai Ninth People's Hospital (ranked #29). On January 31, 2020, the hospital integrated its laboratory information systems to support its fever department. After the laboratory information systems integration, all the outpatients with fever symptoms could complete their doctor visits only in the fever department without visiting other departments in the hospital.

From Figure 3, we can also observe that within the 1-month study period, hospitals started with digitalized security controls (T2-DSC), then added more measures in coordinating administrative activities online (T2-VO), followed by emphasizing the usage of online appointments (T2-OA3). Interestingly, we also found that in the initial stages, the majority of hospitals suggested that outpatients use online appointments but not mandatorily (T2-OA1), then they implemented partial online appointments (T2-OA2), and by the end of the study period, they had fully implemented online appointments for all the outpatient services (T2-OA3).

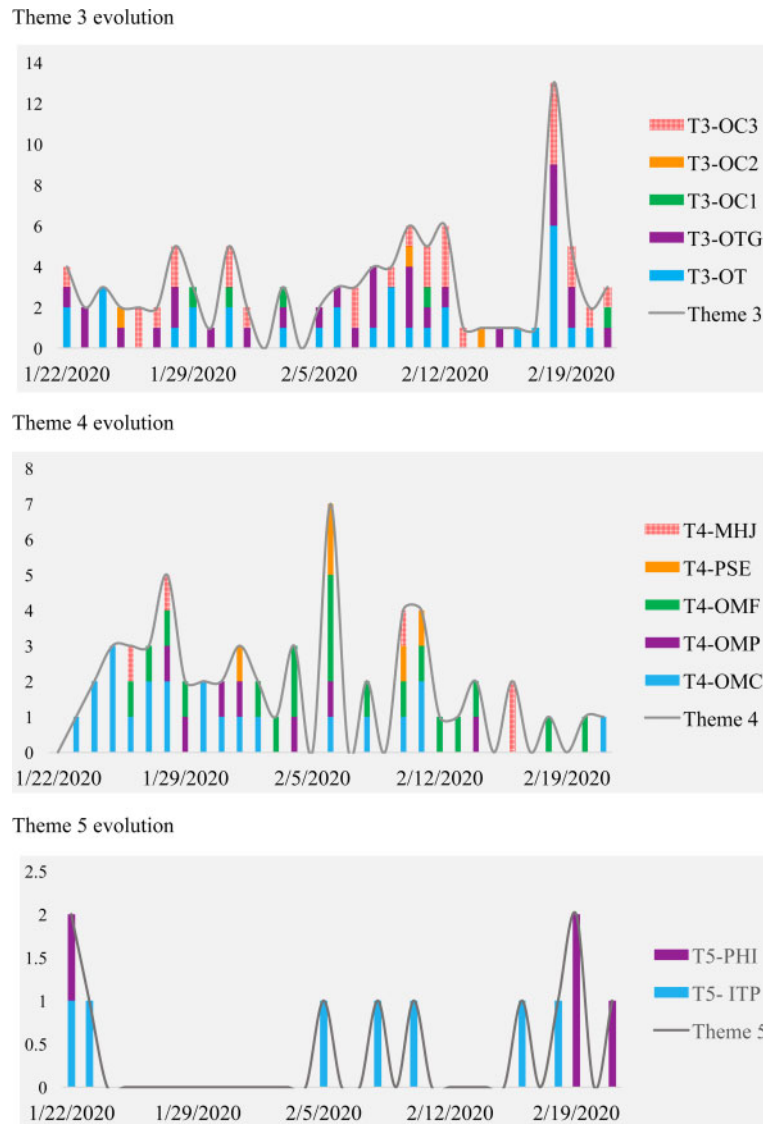


Figure 4. Evolution of events in theme 3 (top), theme 4 (middle), and theme 5 (bottom).

Theme 3: Knowledge management for medical professionals

Our findings also reveal many events related to knowledge management, including knowledge discovery, knowledge capture, knowledge sharing, and knowledge application.²⁷ Medical knowledge is primarily tacit and procedural.²⁸ Thus, the dominant medical education and training method is learning by doing and medical training typically consists of lecture and practice. Medical training is extremely important to reduce the infection risk to healthcare workers. Training topics such as how to wear protective clothing appropriately, how to take care of confirmed or suspected COVID-19 patients, and how to provide professional counselling advices to anxious patients are thus critical. A pattern we observed in our data was that many hospitals recorded training videos and then shared them online internally and externally (T3-OT). By doing so, the duration of onsite training was shorter, reducing the infection risk. Moreover, the onsite training could focus more on the practice of medical skills. Another major event in this theme was that many highly ranked hospitals shared their treatment plans pertaining to

COVID-19 and other diseases online with peers (T3-OTG). For instance, Peking Union Medical College Hospital (ranked #1) and West China Hospital of Sichuan University (ranked #2) both shared their guidelines for COVID-19 treatment online.

Online collaboration on treating COVID-19 critical and severe patients was another trend visible in our results. Online collaboration may take various forms. One form is within-hospital online collaboration (T3-OC1). For example, Ruijin Hospital (ranked #4) implemented an online collaboration platform for doctors to diagnose patients in a distributed mode. If the fever department had a patient that needed assistance from other departments, then doctors from other departments could stay in their own offices and join the consultation meeting via online collaboration tools. The main purpose was to reduce close contact and thus mitigate the risk of infection. Another form of online collaboration was cross-hospital collaboration at the same hospital in Wuhan (T3-OC2). Because there were many medical supporting teams working at the same hospital in Wuhan, they needed a common platform for knowledge sharing, discovery, and application.

The majority of online collaboration events took the form of cross-hospital online collaboration in a distributed mode (T3-OC3), which involved medical professionals from multiple hospitals located in different locations. This type of online collaboration consolidated medical expertise from different areas in various hospitals. For instance, on February 10, 2020, the First Affiliated Hospital of Zhengzhou University (ranked #22) collaborated with 11 hospitals to discuss and share treatment plans and experiences for COVID-19. This meeting was held on the distance healthcare platform constructed by the Henan provincial government.

From Figure 4, we can observe that knowledge sharing (T3-OT, T3-OTG) among medical professionals was dominant in the early stages of the 1-month study window. Nevertheless, the number of online collaboration events increased gradually (T3-OC1, T3-OC2, and T3-OC3) toward the later stage. This implies that medical professionals initially focused more on knowledge sharing and later more on knowledge application and discovery.

Theme 4: Telemedicine

Events in this theme relate to providing online medical services or telemedicine. Five types of events were observed, including (1) online medical consultation services for COVID-19 symptoms (T4-OMC), (2) online medical consultation services for psychological problems (T4-OMP), (3) online medical consultation services for other diseases or follow-up consultation and prescription refill (T4-OMF), (4) artificial intelligence (AI)-enabled tools for the public to conduct self-assessment (T4-PSE), and (5) joint online doctor consultation services by multiple hospitals (T4-MHJ).

In our sample, 22 hospitals, almost 50%, launched their online medical consultation services quickly to respond to the COVID-19 epidemic (T1-OMC), especially the hospitals in Wuhan. For instance, Tongji Hospital in Wuhan (ranked #8) and Union Hospital in Wuhan (ranked #12) are both affiliated to Tongji Medical College of Huazhong University of Science and Technology. They launched their online medical consultation services on January 24, 2020, the day after Wuhan was locked down. This action helped serve people who had fever symptoms. Later, many patients complained that they were unable to see their specialists for follow-up visits and refill their prescriptions. To meet these needs, 19 hospitals introduced new online follow-up medical consultation services and prescription refills (T4-OMF).

Some hospitals even delivered medicine to the homes of patients, such as Xiangya Hospital of Central South University (ranked #18) and the First Affiliated Hospital of Xi'an Jiaotong University (ranked #48). Seven hospitals provided online consultation services for psychological problems (T4-OMP) to the public. One example comes from West China Hospital of Sichuan University (ranked #2). On February 14, 2020, West China Hospital launched an online consultation platform for psychological intervention. The platform integrated videos, hotline, audios, online mini-games, Q&A, and self-assessment to provide recommendations for affected people. Another event in this theme is online self-assessment tools (T4-PSE). Users could use these tools to self-evaluate their probability of having COVID-19. These tools were generally supported by AI technologies. The last type of event in this theme is joint doctor consultation services by multiple hospitals (T4-MHJ). Five hospitals reported doing so. Joint doctor consultation services were typically supported by companies or organizations such as Tencent Holdings Ltd. or China Central Television (CCTV) in order to attract more experts to participate in the medical consultation services.

We can observe some evolutionary patterns in this theme in Figure 4. At the early stage, hospitals paid more attention to launching online consultation services related to COVID-19 (T4-OMC) but then complemented the T4-OMC services with online prescription refills and follow-up consultation services (T4-OMF). Online psychological intervention services appeared in the early to middle stage but became more significant in the later stage (T4-OMP).

Theme 5: New IT initiatives

During the outbreak of COVID-19, 7 hospitals recognized the significance of IT in healthcare services. They began to make large investments in new IT platforms (T5-IPT) and promoted the concept of "Internet plus healthcare services" (T5-PHI). For instance, West China Hospital of Sichuan University (ranked #2) initiated 2 projects related to IT platforms on February 10, 2020. These 2 projects were a platform for precision diagnostics and a big data platform for disease epidemic research. Also, Xiangya Hospital of Central South University (ranked #18) collaborated with a private company to develop a COVID-19 prevention and popular science education system on February 16, 2020. The concept of "Internet plus healthcare services" has been promoted by China's central government since 2018. In our sample, we found that 4 hospitals promoted this concept on their websites. From Figure 4, we can tell that the majority of theme 5 events happened in the later stage of the 1-month study window showing a learning curve.²⁹

DISCUSSION

Implications for research

Our findings revealed 5 themes related to IT utilization in hospitals to better respond to the COVID-19 pandemic. Based on these 5 themes, we have developed an integrated framework for hospitals to better configure their pandemic response strategies using IT-enabled services. As depicted in Figure 5, first, an effective control and prevention strategy highly relies on the IT-infrastructure. This infrastructure may be constructed and maintained at the hospital, provincial, or country level. A hierarchy may exist for these 3 levels of infrastructure. The more robust the IT-infrastructure is, the better will be the delivery of the IT-enabled healthcare services. Second, the response strategy may contain 1 or more of these 4 categories of IT-enabled services (ie, disseminating popular medical science education, knowledge management for healthcare workers, telemedicine, and digitalized hospital processes). Last, the success of the response strategy may be influenced by the hospital's vision and government policy. Government policies such as China's "Internet plus healthcare services" can have a significant impact on the resources that hospitals receive as well as their outlook.

Implications for practitioners

Our study provides some recommendations for policymakers, medical professionals, and hospital managers. First, our study can help policymakers better prepare for similar medical crises. As suggested by our research, IT infrastructure is extremely important for implementing an "Internet plus healthcare services" program in mainland China's hospitals. IT infrastructure at the provincial or divisional level can provide greater benefits compared with isolated hospital IT infrastructures. For instance, Sichuan province and Henan province have implemented provincial-level online collaboration systems among hospitals. As such, online collaboration activities among hospitals in these 2 provinces were more compared with the others. In

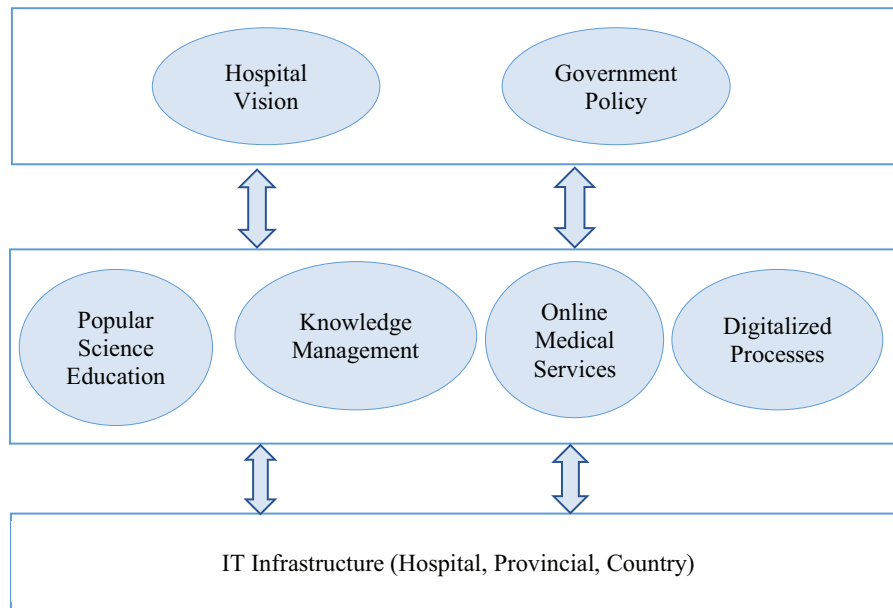


Figure 5. An integrated framework for configuring hospital's responding strategy. IT: information technology.

the future, provincial or divisional policymakers may consider allocating more resources for IT infrastructure development, such as big data platforms or online collaboration systems.

Second, for medical professionals, our study suggests that medical training should place more effort on procedural training and incorporate more IT elements in the training. During the outbreak of COVID-19, medical procedural training has become extremely important.³⁰ Inappropriate medical procedural taken by doctors or nurses can increase the infection rate. Our findings reveal that IT-enabled training such as flipped classrooms were suitable during the outbreak of COVID-19. Because of the rushed schedule, many medical professionals who were supporting Wuhan had to attend the training session right after they arrived. In a flipped-classroom training, the hospitals posted online training videos to a platform like WeChat and then used the in-classroom format for practice training. Under a pandemic outbreak, medical professionals are highly motivated to receive appropriate training. As such, watching training videos online might improve training efficiency.

Third, digitalization of hospital processes is a trend. Our findings confirm that AI technologies can be used for online self-assessment systems, robots can be used in guiding patients and delivering medicines within the hospital, and QR codes can be used for collecting patient and visitor information. All these digitalized processes can also be integrated into daily routines, and not just for preventing and controlling epidemic disease.

Limitations and future directions

First, the study only focused on the news webpages on the hospital websites. However, because of the popularity of social media service accounts (eg, hospitals' WeChat service accounts), hospitals may update their news more frequently on the social media platforms than their official websites. Future research can extract the news from the social media platforms and examine whether there are any differences compared with the present study. Second, we did not analyze the sequence of events in this study. Event sequence analysis is an approach to study the unfolding process of response events.³¹ It can be

used to identify emerging response strategies. Future research can thus investigate common patterns of event sequences in hospitals.

CONCLUSION

This study aimed to investigate the role of IT in helping hospitals respond to the outbreak of COVID-19. Based on a content analysis of 368 news webpages from 45 top hospitals in mainland China, we identified 5 common themes in which IT was utilized by the hospitals between January 22 and February 21, 2020. These 5 themes were (1) dissemination of popular medical science education, (2) digitalized hospital processes, (3) knowledge management for medical professionals, (4) telemedicine, and (5) new IT initiatives. We also developed an integrated framework for hospitals to configure their response strategies to disease outbreaks using IT-enabled services. Our study offers some rich insights for policymakers, medical professionals, and hospital managers to better prepare for other medical crisis in the future.

AUTHOR CONTRIBUTIONS

AY conceived of and designed the project and was responsible for data acquisition, analysis, interpretation, and writing. YZ contributed to the data acquisition, analysis, and interpretation, and editing. DAM made substantial contributions to the data interpretation, writing, and editing. All authors made substantial contributions to the revision and gave approval for the final version of manuscript to be published and agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

CONFLICT OF INTEREST STATEMENT

None declared.

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