Strategies, challenges and opportunities in the implementation of COVID-19 field hospitals: a scoping review

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ABSTRACT

Objectives COVID-19 has strained healthcare systems, requiring the redesign of their structure, human resource management and clinical approach. Countries have adopted implementation strategies and maximise field hospital functionality to address the issue of overflow of patients with COVID-19. This scoping review was based on the main research question, ‘What are the implementation strategies, challenges and opportunities in managing the field hospital during the COVID-19 pandemic?’, and aimed to consolidate all recent evidence on COVID-19 field hospital implementation approaches, challenges and potentialities.

Design Scoping review, following the Arksey and O’Malley’s framework, and Preferred Reporting Items for Systematic Reviews and Meta-Analyses extension for Scoping Reviews guidelines.

Data sources PubMed, Web of Science and Scopus were searched from 1 January 2020 through 31 December 2021.

Eligibility criteria Original articles, reviews, case studies and reports written in English were included. Works without full article and articles that did not answer the research questions were excluded.

Data extraction and synthesis Data were extracted using a standardised data extraction form in Microsoft Excel. The findings of all included articles were synthesised narratively.

Results Eighty-five records were reviewed and 25 studies were included. For the field hospital implementation strategies, ‘surge capacity’, namely space, human resource, supply and system, was discussed in addition to the preparation and workflow of other services such as pharmacy, rehabilitation, food and nutrition. The management of COVID-19 field hospitals is challenging with respect to staff and resource shortages, inability to anticipate patient load and poor communication. The opportunities and recommendations for improvement of management were also highlighted.

Conclusions The compilation of lessons learnt may help improve the future management of field hospitals, administratively and clinically.

INTRODUCTION

The COVID-19 pandemic has strained the global healthcare system, necessitating the structure’s reorganisation, human resource reconstruction and clinical management reorganisation.1 2 Due to the surge in demand, countries have been forced to adopt implementation strategies and maximise field hospital functionality in order to optimally cope with the patient loading.3 In the USA, the COVID-19 field hospital resources have been mobilised in various ways, where the number of patients ranged from the lowest possible count to well over a thousand in several locations. While most US field hospitals did not treat patients in the early phase of the pandemic,4 this situation changed as the increased cases of COVID-19 transmission and hospitalisation have resulted in the reintroduction of field hospitals as one of the emergency response strategies, particularly in the most affected localities such as New York, Boston, Philadelphia and Baltimore.5 6

The WHO defined a field hospital as a self-contained, mobile healthcare facility that can be quickly built and expanded, or outsourced to meet immediate emergency needs for a specified period.6 The use of field hospitals in the after-effects of sudden-impact catastrophic events complements existing medical systems for these purposes: provide prompt emergency medical attention including advanced trauma life support, follow-up care...
for trauma and emergency cases and routine check-up, or operate as an interim facility to replace damaged facilities while waiting for restoration. Additionally, the WHO also recommended using community facilities for the isolation of the mild and moderate cases, as part of COVID-19 surge plans.

Nations from all over the world developed a variety of designs and strategies for the construction and placement of field hospitals, whether using an existing structure or adapting an open area. For example, a temporary health facility was constructed in Spain with the installation of environmental monitoring system, which tracks the humidity, temperature and carbon dioxide level. Nevertheless, the facility was not immune to difficulties as the project’s progress was hampered by issues of structural design feasibility, patient and staff comfort and safety, the competitiveness of oxygen therapy on the market and the lack of access to electronic medical devices. The field hospital architectural design planning should consider important factors like venue feasibility and work ability.

Notwithstanding the difficulties in providing care through field hospitals, one benefit is the simplicity with which patients with minor symptoms can be centrally handled. This has greatly aided the control of the outbreak as patients with mild symptoms have the potential to rapidly spread the infection throughout the community. Additionally, COVID-19 particles spread faster indoors than outdoors due to the higher indoor viral particle concentrations hence the implementation of a field hospital to facilitate disease control more effectively. In Malaysia, the Low-Risk COVID-19 Quarantine and Treatment Centre was established in response to National Disaster Management Agency and Ministry of Health directives for the development and operation of a quarantine centre located in the Malaysia Agriculture Expo Park Serdang (MAEPS). The MAEPS was transformed into a hospital-like facility equipped with COVID-19 wards, X-ray rooms, resuscitation rooms and pathological laboratory. However, as the number of cases peaked, patients’ comfort, inadequate food supply, poor sanitation and ineffective system management have become the primary challenges.

The aim of this study was to review the relevant literature on COVID-19 field hospital implementation strategies, challenges and opportunities. This is the first scoping review to our knowledge that specifically addressed field hospital management and challenges during the COVID-19 pandemic hence may contribute to the body of knowledge and help in future pandemic responses.

METHODS
This scoping review was conducted in accordance with the Arksey and O’Malley’s scoping review framework, adhering to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR) guidelines. All fundamental elements as required by the PRISMA-ScR are shown in online supplemental appendix 1.

Research question formulation
The review question was developed based on the PICo (phenomena of interest, context) concept. The population, intervention, comparator/s, outcomes framework has been widely used for evaluating the effectiveness of treatments in terms of their impact on outcomes, while the PICo concept is recommended for reviewing or synthesising expert opinion, text or policy regarding a phenomenon. The phenomena of interest refers to field hospital implementation strategies, while context refers to the setting during the COVID-19 pandemic. The main research questions are: (1) What are the field hospital implementation strategies during the COVID-19 pandemic?; (2) What are the field hospital management challenges during the COVID-19 pandemic? and (3) What are the field hospital management opportunities during the COVID-19 pandemic?

Data source and search strategy
The Scopus, PubMed and Web of Science databases were searched from 1 January 2020 to 31 December 2021. Table 1 lists the keywords used to search for relevant articles.

Study selection
The inclusion criteria were: (1) studies published in 2020–2021; (2) original articles, reviews, case studies and reports. The exclusion criteria were: (1) no full article; (2) articles in language other than English; (3) unrelated to COVID-19 field hospital implementation or management. During the article selection, each of the eight authors screened the titles and abstracts of all potentially eligible articles. The screened articles were divided randomly among all authors. Two authors reviewed each article independently and interchangeably. Disagreements were resolved through discussion and consensus between the two authors and/or input from a research team leader.

Data extraction and synthesis
Data were extracted from the 25 included articles using a standardised data extraction form and organised using Microsoft Excel. The information collected in the form included: (1) author/publication year, (2) references, (3) country, (4) study design, (5) statistical analysis and (6) results/findings. The findings of all included articles were synthesised using a narrative synthesis. Study quality was not appraised due to the nature of the scoping review.

Patient and public involvement
None.

RESULTS
A total of 553 articles were identified from three electronic databases. After the search results were limited
to publication year (2020–2021), English language and publication type (original articles, reviews, case studies and reports), 366 ineligible articles were excluded. A total of 102 duplicate records were removed, leaving 85 records for title screening (figure 1). Fifty-three articles were removed during the screening, leaving 32 articles for full-text screening. Disagreements among the researchers were resolved through discussion to reach a consensus. Of the 32 articles, 1 was excluded due to inability to obtain the full-text article, another was excluded as it was not in English and 5 were excluded as they did not answer any research questions (figure 1). Only 25 articles were included in the full-text assessment following the rigorous selection screening as shown in figure 1. Table 2 depicts the descriptive summary of the study locations and study designs of the 25 studies. Table 3 summarises the points on COVID-19 field hospital implementation strategies, challenges, and opportunities. Online supplemental appendix 2 presents the detailed findings from the 25 studies included in this scoping review. The 25 studies were from the USA, China, Spain, Italy, Brazil, Columbia, Egypt, South Africa and Romania. There were 14 case studies, 7 narrative reviews, 3 reports and 1 cross-sectional study.

### COVID-19 field hospital implementation strategies

Twenty-three of the 25 articles answered research question 1. Six articles discussed ‘surge capacity’, namely space, human resources, supplies and systems. The first steps in establishing a field hospital were site location identification, layout and construction, and design.\(^{16-18}\) The main work area was defined and divided into sections according to functions.\(^{2,8,19-22}\) Human resource management involves the development of a core leadership team,\(^{19}\) a multidisciplinary subteam,\(^{18,21,22}\) and shift rotations for all workers including doctors and nurses.\(^{20}\) Rapid National Guard deployment to the field hospital allowed personnel to use their military skills to quickly organise and reduce transmission risk.\(^{23}\) Field hospitals

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**Table 1** Keywords used in the screening process

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<th>Databases</th>
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<td>Scopus</td>
<td>1. TITLE-ABS-KEY (“field hospital” OR “mobile hospital”) AND (“organization” OR “management” OR “administration”) AND (“COVID-19 pandemic” OR “COVID-19” OR “coronavirus”))</td>
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<tr>
<td></td>
<td>2. TITLE-ABS-KEY (“field hospital” OR “mobile hospital”) AND (“challenge” OR “limitation” OR “barrier” OR “issue” OR “difficulty”) AND (“COVID-19 pandemic” OR “COVID-19” OR “coronavirus”))</td>
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<tr>
<td></td>
<td>3. TITLE-ABS-KEY (“field hospital” OR “mobile hospital”) AND (“opportunity” OR “chance” OR “recommendation” OR “solution”) AND (“COVID-19 pandemic” OR “COVID-19” OR “coronavirus”))</td>
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<tr>
<td></td>
<td>2. ALL= (“COVID-19 pandemic” OR “COVID-19” OR “coronavirus”) AND ALL= (“field hospital” OR “mobile hospital”) AND ALL= (“challenge” OR “issue” OR “barrier” OR “limitation” OR “difficulty”)</td>
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<td>3. ALL= (“COVID-19 pandemic” OR “COVID-19” OR “coronavirus”) AND ALL= (“chance” OR “recommendation” OR “solution” OR “opportunity”) AND ALL= (“field hospital” OR “mobile hospital”)</td>
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**Figure 1** Preferred Reporting Items for Systematic Reviews and Meta-Analyses flow chart.
Table 2  Summary of study locations and study designs

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<th>Study location</th>
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<td>USA</td>
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Study design

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<td>Case study (n=14)</td>
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<td>Narrative review (n=7)</td>
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Table 3  Summary of points on implementation strategies, challenges and opportunities of COVID-19 field hospitals

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<td>Workflows, procedure and criteria</td>
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<td>Management of supplies and system</td>
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<td>Space and working area demarcation</td>
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<td>Shortage of supplies (PPE, medications, equipment, EMR)</td>
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<td>Lack of clear procedures and criteria</td>
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<td>Difficulty to predict the number of admissions</td>
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<td>Increased use of technology</td>
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EMR, electronic medical record; PPE, personal protective equipment.
also provide basic medical equipment for patient monitoring, mobile CT scan and laboratory equipment.\textsuperscript{18, 20} Some field hospitals employed electronic health records (EHRs), building information modelling, internet of things, cloud computing and intelligent robots, creating a contactless medical environment with the main purpose to reduce healthcare personnel exposure.\textsuperscript{19, 24}

Three articles discussed the triaging process, patient management regulation, and principles for admission and referral.\textsuperscript{2, 8, 20} The approach used in managing decompensating patients was also mentioned and divided into four phases: identification, assessment, resuscitation and transport.\textsuperscript{2} The establishment of rapid response capabilities to improve workflow efficiency in responding to the deteriorating patients was also described.\textsuperscript{20} To prevent COVID-19 transmission, twice daily routine disinfection was done.\textsuperscript{20} In Italy, personnel could remain in dirty areas for major mobility limitations.\textsuperscript{32} One article described the use of a reliable and valid short questionnaire to screen patients for malnutrition risk.\textsuperscript{33} The absence of EMR and referral.\textsuperscript{2} The approach used in managing decompensating patients was also described.\textsuperscript{20} To prevent COVID-19 transmission, twice daily routine disinfection was done.\textsuperscript{20} In Italy, personnel could remain in dirty areas for major mobility limitations.\textsuperscript{32} One article described the use of a reliable and valid short questionnaire to screen patients for malnutrition risk.\textsuperscript{33}

COVID-19 field hospital management challenges

Of the 25 articles, 22 discussed COVID-19 field hospital management opportunities. An article from China shared its success in designing and constructing a field hospital in only 10 days, which may serve as a model for other countries that need to establish field hospitals to battle the COVID-19 pandemic.\textsuperscript{17} An implementation framework for the field hospital critical care amid the issue of resource constraints may guide future planning of field hospital operations.\textsuperscript{25} Additionally, one study described the use of a location model in determining the optimum location of COVID-19 field hospitals.\textsuperscript{36}

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Nurses’ vital contribution throughout the pandemic earned them social acclaim and improved their public image.\textsuperscript{35} Field hospital implementation requires enough people, tight coordination, frequent communication, leadership and planning.\textsuperscript{21, 22} Bell et al developed a standard staff mobilisation process to address personnel shortages. According to other studies,\textsuperscript{5, 32} staff training ensures quality patient care, while rehearsals can reduce human error.\textsuperscript{19} Several methods addressed supply and resource shortages. PPE was reused with limitation up to four times and cleansed with alcohol-based disinfectants instead of using hypochlorite solutions.\textsuperscript{26} Logistics and medical support demanded partnerships with local government, the military and large hospital organisations.\textsuperscript{16}

Given limited resources and time, public health authorities and local hospital systems needed to cooperate and communicate with alternate care site leadership to provide pharmacy services.\textsuperscript{3} The absence of EMR and increased food delivery time in field hospitals could be rectified by implementing a standardised data collection form and a computerised diet order tracker. Due to reduced patient exposure time, validated questionnaires could not be used to diagnose malnutrition. New screening instruments with fewer items and simplified language were needed.\textsuperscript{32}

Generally, the provision of healthcare services by COVID-19 field hospitals required further improvement. High-quality clinical equipment, technology, suitable furniture and attention to structural elements might alleviate patient concerns regarding non-conventional hospital.\textsuperscript{18} The treatment and care plans should also address vulnerable populations, prioritise mental health,
as well as improve the operations for future surges with the aid of intelligent robotics.34

DISCUSSION

Before the COVID-19 pandemic, the literature recorded responses to numerous previous disasters and emergencies. Such experience can be evolved and modified for the current COVID-19 response. Local contingency plans for communicable diseases were often initiated by strengthening epidemic control strategies, which was then expanded to pandemic preparedness to prepare for the potential emergence of an infective strain worldwide.37 Systematic framework organisations at each level (central, country and township government) and ongoing analysis and evaluation of lessons learnt from past experiences will guarantee the best possible response to upcoming disasters.38

COVID-19 field hospital implementation strategies

The COVID-19 pandemic has stressed the health system such that it has been necessary to implement new strategies that consider the structure, human resources and clinical approach in line with the surge capacity, which refers to expanding the response capacity to meet needs that exceed normal demand.1 Many out-of-hospital structures were built to support the overwhelming demands on the health system while adhering to WHO field hospital guides.2 The temporary field hospitals were aimed to accommodate patients with mild-to-moderate COVID-19 symptoms to contain equipment and manpower costs, while ICU zones were implemented only to stabilise patients while awaiting referral to tertiary hospitals.18 The literature following the emergence of the pandemic documented how high-burden countries such as China20,39 and Italy18 suggested converting public localities such as exhibition halls or basketball courts into temporary field hospitals to provide an immediate response to requests for new beds from stressed hospitals with reduced time and cost compared with building new conventional hospitals. The principle of mobile field hospital operation incorporated admission criteria based on national guidelines on clinical diagnosis and management of COVID-19, and discharge criteria that included improvement clinically and based on laboratory and/or radiological findings.20

Strategic implementation considered a multidisciplinary team of medicine, nursing, hospital engineering and hospital architecture. Work areas must be carefully demarcated into an anticipated contaminated patient care area, a staff area without contamination risk and a logistic bay consisting of a warehouse, food preparation site, health material store, pharmacy and management area. Several health points of view are parallel with field hospital development, such as the healthcare objectives (criteria for admission, triage, case definition), humanisation plan (information centre for patients and family), task flow definition, designated ‘clean path’ and ‘dirty path’ route, and PPE decontamination.20 For example, the Bergamo Field Hospital in Italy used the technical zone partition of the emergency team as the core in hospital layout planning, which highlighted the mandatory pathways for healthcare workers and optimised PPE usage to minimise staff exposure.11 Furthermore, waste management plans, human resource organisation, training programmes,42 and coordination with other structures such as rehabilitation, pharmacies and social work services5 were equally important measures. The utilisation of advanced technology has minimised the exposure risk among healthcare staff as well as relieved work pressures among staff, given the obvious unpredicted enormous demand for material and medical care management throughout the pandemic.43 Environmental management was also achieved by optimising building space zoning, implementing negative-pressure ventilation environments and maintaining high hygiene standards.44 45

One department to be prioritised is pharmacy services, which need to promptly react in the continuous provision of safe and efficient medicines when patient numbers increase.31 Internal reorganisation of the pharmacy department may include the establishment of a telepharmacy and special shifts. Wallis et al40 reported the successful integration of on-site satellite pharmacy services into field hospital operations during a surge in COVID-19 cases in Massachusetts, USA, where an appropriate staffing model, policies and workflow procedures were applied. On-site pharmacy services in field hospitals ensured continuity of care, smooth operational logistics and thorough interprofessional collaboration, which led to optimal care to all admitted patients in a safe, caring and healing environment.3 30 COVID-19 field hospitals could not be implemented without interagency collaboration. The USA,16 Italy26 and France46,47 reported successful collaboration between the government and military for the provision of infrastructure, equipment, materials, physical space and security. Other local healthcare organisations provided technical aid in administration, clinical staffing, EHR, laboratories and medical supplies.48 The excellent mutual support during the pandemic ensured positive clinical outcomes such as low hospital readmission and mortality rate.16 49

COVID-19 field hospital management challenges

One of the most frequently reported issues was the difficulty in acquiring and maintaining personnel supplies. Typically, only a limited number of medical staff could be redeployed to field hospitals.19 20 This process was complicated by ever-changing patient loads and difficulties in predicting local increases in the number of infected patients, as it is important for management to ensure adequate staff-to-patient ratios while avoiding needless expenditure.32 The staff might also have experienced stress when the total number of patients cared for increased, resulting in added demand to optimise system efficiency.30 Moreover, acquiring adequate supplies was challenging as there were shortages in certain necessary items across the country. The need for scrubs and
constant PPE use, medication shortages, poor medical equipment and limited medical supplies were among the concerns during field hospital operations and might have affected care services delivery.

Providing appropriate facilities is an important challenge as part of preparation to establish a field hospital. The building and site selection are crucial, with several countries deciding to use existing buildings as makeshift field hospitals as they were more likely to have established water and electrical supplies. Such buildings included stadiums, exhibition centres and conference centres. However, the challenge of implementing infection control measures has been associated with the utilisation of existing buildings as makeshift field hospitals. COVID-19 particles spread faster between people indoors than outdoors, with indoor viral particle concentrations frequently being higher than that outdoors. Given that the healthcare workers have the highest exposure risk, a suitable field hospital layout with appropriate modifications is therefore important to protect healthcare workers’ safety while they provide care to patients.

Field hospitals often face challenges related to the workflow and procedures practised in the hospital. Field hospitals often admit patients with mild and moderate diseases to relieve the pressure faced by specialised hospitals. For example, the admission criteria of field hospitals in China included mildly symptomatic patients, stable vital signs, age >18 years and <65 years, with no severe underlying cardiopulmonary, neurological, renal conditions or history of mental disorder, and capable of independent living. While the admission criteria were important to present a clear picture to the healthcare workers, the progression of the pandemic resulted in a high number of patients meeting the criteria, leading to inability of the field hospital to cope with admission numbers. Consequently, this led to a lack of equipment and resources, and stressed healthcare workers, which ultimately resulted in patients receiving suboptimal treatment and affecting their prognosis.

Baughman et al mentioned the issue of mental health among field hospital occupants in Boston, USA. A study of a Chinese shelter hospital reported 18.6% and 13.4% prevalence of anxiety and depression, respectively, with higher anxiety in those with poor sleep quality and two or more current physical symptoms, while the depression risk factors were being female, having a family member with COVID-19 and having ≥2 current physical symptoms. It is also crucial to address burnout among field hospital frontliners. Nurses were among those with high prevalence of burnout, with a prevalence of 35%–45%.

The interviewed nurses revealed their concerns and expressed anxiety, fear and uncertainty about the epidemic. As a result, healthcare workers require managerial and psychological support to reduce worry and increase well-being and resilience when dealing with a health crisis. There was also an urgent need for mental health assessment and intervention to be available and accessible for all healthcare personnel.

Effective teamwork and sufficient communication are critical components in managing patients in field hospitals. Teamwork quality is associated with care delivery system quality and safety, with communication failures identified as an independent cause of preventable patient harm. An estimated 27% of medical malpractice cases resulted from communication barriers, where better communication could reduce medical errors and patient injury. Field hospital human resources often comprise healthcare workers from one or more hospitals and involve other agencies such as the army, academic medical centres, and governmental and non-governmental organisations. The unfamiliarity between the healthcare workers working in the makeshift field hospitals and the new system and workflow might be the risk factors for miscommunication.

**COVID-19 field hospital management opportunities**

Innovative science and technology have been widely used in general COVID-19 management worldwide. Similar observations were made in the field hospital setting, with hospital operations assisted by various advanced technological devices and systems. However, one aspect that should be considered during the application of these devices is the availability of high-security data transmission and high networks. This is important as field hospitals deal with patients’ data and information which are confidential. The cost of providing these technologies should also be examined during the field hospital planning phase.

Regarding field hospital management, a pragmatic stepwise approach involving quality improvement methods (process mapping, failure modes and effect analysis, on-site walk-through) was used to improve medical care efficiency in the unfamiliar setting posed by the pandemic. A similar approach might also be used in different settings as a part of activities by other relevant field hospital departments. Health personnel competency is important to deliver patient care in a field hospital, where the staff must be trained rapidly and efficiently. On the other hand, a standard admission and discharge criterion that is compatible with national recommendations should be modified as the epidemic evolves to prevent readmission and infection spread. Due to the dynamic nature of the pandemic, the procedure and criteria should be made clear yet flexible to adapt to any changes in disease trend, and regular input from local epidemiology experts should be considered.

Clinical pharmacists are critical to the team delivering care to patients with COVID-19. Clinical pharmacists adapted and devised a limited formulary by assessing drug distribution workflow and current prescribing trends, which resulted in the establishment of efficient and effective medication distribution services in the field hospital. Tracking and remote follow-up systems for patients with COVID-19 must be developed and adapted to ensure that patients will continue to receive rehabilitative care and follow-up management practices.
Sanchez et al highlighted the essential role of dietitians in improving COVID-19 field hospital efficiency. The importance of nutritional screening and monitoring was supported by the findings from Wuhan, China, as the prevalence of malnutrition among elderly patients with COVID-19 was 52.7%. Nutrition screening and assessment of patients with suspected or confirmed COVID-19 should be continued to identify individuals with reduced appetite, food insecurity, social isolation or other nutrition risk factors, as it will aid healthcare providers in recognising whether a dietitian referral or community service assistance is required.

**Study limitations**

Several limitations were encountered in this scoping review. First, nearly all studies were case studies, case reports or narrative reviews. As such, there were no data suitable for quantitative pooling (eg, in meta-analyses). Globally, the literature exploring the execution of COVID-19 field hospitals during the pandemic remains scarce. Despite these limitations, this is the first comprehensive scoping review to the best of our knowledge that synthesised research evidence on the field hospital during the COVID-19 pandemic, highlighting all three main research questions (implementation strategies, challenges and opportunities), which might serve as future guidance for healthcare facilities with the potential to be transformed into field hospitals in the future.

**CONCLUSION**

The COVID-19 pandemic continues to present complex challenges for hospital administrators and staff. This scoping review identified several implementation strategies, challenges and opportunities that should be considered when deploying a field hospital. The topics discussed in this scoping review were pharmacy, rehabilitation, nutrition, surge capacity, multicollaboration and integration efforts, the technical aspects of isolation set-up and airborne infection control strategies. Hospital administrators, clinicians, emergency response personnel and public health professionals may benefit from understanding the lessons learnt from other countries, in order to improve the management of field hospitals in the near future.

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