Original Article

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Clinical Characteristics and Factors Associated with Mortality of Patients with COVID-19 at Bussarakham Field Hospital: Thailand

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Abstract

Objective: During the third and fourth wave of the coronavirus disease 2019 (COVID-19); from April to September 2021 all hospitals in Bangkok Metropolitan Region reached surge capacity. Hence, Bussarakham Field Hospital (BH) was established to address this crisis. This study aimed to identify factors associated with in-hospital mortality in BH, Thailand's largest field hospital for COVID-19.

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Material and Methods: This was a retrospective study among all adult COVID-19 patients, confirmed by Reverse transcription-polymerase chain reaction (RT-PCR), admitted to BH from May to September 2021. The data on potential factors associated with treatment outcome (survived or deceased) were retrieved from the standard admission records for COVID-19 and discharge summaries. A multivariable logistic regression model was performed to explore factors associated with in-hospital mortality.

Results: A total of 18,173 patients were enrolled with death occurring in 224 patients during hospitalization. The mortality rate was 1.23%. The adjusted odds ratios (95% CIs) of male gender, aged >65 years, having diabetes mellitus, pregnancy, lower respiratory tract (LRT) symptoms at initial presentation, pneumonia with hypoxemia at initial presentation were: 1.91 (1.35, 2.70), 5.37 (3.75, 7.69), 2.55 (1.75, 3.71), 6.40 (2.15, 19.08), 2.81 (1.88, 4.19) and 3.11 (1.35, 7.15) respectively.

Conclusion: The pre-existing factors that increased mortality risk consisted of elderly age, diabetes mellitus and pregnancy. In addition, patients who presented with LRT symptoms or pneumonia with hypoxemia also had a higher mortality risk. Therefore, clinical triage should be carefully performed in field hospitals during any pandemic.

Keywords: COVID-19, factors, field hospital, mortality, Thailand

Introduction

The global pandemic of the coronavirus disease 2019 (COVID-19) caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) has been a significant problem worldwide as of December 2019[1]. The World Health Organization (WHO) declared COVID-19 as a pandemic disease on March 11 2020[2], which simultaneously started with the first wave of the outbreak in Thailand. The second wave began in December 2020[3].

Then thirteen months after the first wave a third wave in Thailand occurred in April 2021 upon which the fourth wave surged in June 2021. During this time, the 'Delta COVID-19 variant' which is more contagious and causes more severe illness than the previous variants occurred, until the Alpha and Beta, then became the dominant strain in Thailand[4]. (Figures for the COVID-19 pandemic timeline is shown in the appendix[5].) The Bangkok Metropolitan Region was the center of COVID-19 however, eventually all hospitals reached surge capacity due to the rising number of patients with COVID-19 infection. As a result, the Ministry of Public Health (MoPH) of Thailand adjoinded with the private sector collaborated to establish the Bussarakham Field Hospital to address this critical shortage. This field hospital in Nonthaburi, Thailand became the largest temporary field hospital for COVID-19 patients. The objective of the Bussarakham Field Hospital was to treat patients with intermediate severity (yellow code) based on triage criteria. The yellow-coded patients were non-critically ill and symptomatic including those with pneumonia (non-severe), lower respiratory tract symptoms (chest tightness, difficulty breathing, cough), fatigue or complications from underlying diseases. Therefore, the yellow-coded group had stable hemodynamic parameters: not requiring ventilator support.

According to data from the World Health Organization, the global mortality rate of COVID-19, when the pandemic was in its early stages, was as high as 7.23% in April 2020 with this declining to 2.2% as of December 2020[6]. There are several well-known risk factors associated with in-hospital mortality of COVID-19 patients which include: advanced age[7-13], male gender[7,9,10,13], obesity[10,14,15], hypertension (HT)[9,10,15], diabetes mellitus (DM)[9,10,15], cardiovascular disease (CVD)[9,10], chronic obstructive pulmonary disease (COPD)[9,10,15], chronic kidney disease (CKD)[15], cancer[9-11], smoking status[10], immunosuppression[15], dyspnea[11], low oxygen saturation[7,12], C-reative protein (CRP)[7,8,12,16], D-dimer[8,10], lactate dehydrogenase (LDH)[11,16], lymphopenia[8,16], blood urea nitrogen (BUN)[12] and serum creatinine (SCr)[7,10,12].

To the best of our knowledge, this is the largest retrospective cohort study in a field hospital for COVID-19 therefore, this study aimed to determine the clinical characteristics, treatment in addition to factors associated with the mortality of COVID-19 patients at Bussarakham Field Hospital.

Material and Methods

Setting

Bussarakham Field Hospital was located in the Challenger Hall of the IMPACT exhibition center, northwest of Bangkok. Three main interconnected halls (60,000 m^2) were transformed into wards with 3,716 beds for mild to moderate-severity patients. In addition, during the last month of operation, the top floor of the car parking area was turned into a temporary 17-bed intensive care unit (ICU) and 32-bed semi-ICU. Seven-hundred oxygen pipelines were installed to support low-and high-flow oxygen therapies and invasive mechanical ventilators. The healthcare workers were recruited from provincial, regional, and university hospitals countrywide to participate in a two-week rotation. Each rotation included approximately 60 doctors and 120 nurses.

Design and participants

We conducted a retrospective cohort study to identify the clinical characteristics, treatment outcomes and factors associated with in-hospital mortality of COVID-19 patients. The COVID-19 patients included in this study were confirmed by reverse transcription-polymerase chain reaction (RT-PCR) before admission to Bussarakham Field Hospital from May 14 to September 20 2021. The exclusion criteria were: (1) age <15 years, (2) transfered to another hospital and (3) previous history of COVID-19 infection within three months before admission.

Data collection

Trained data collectors retrieved patient information from the medical records (standard admission records for COVID-19 patients, progress notes and discharge summaries). Study data were collected and managed using REDCap® electronic data capture tools, hosted at Suratthani hospital medical education center[17]. Treatment outcome (survived/deceased: outcome) and length of stay were collected from discharge summaries. The potential factors (exposure) associated with mortality included: demographics, age, body weight, smoking status, comorbidities, pregnancy and clinical presentation (i.e. symptoms and admission parameters) which were collected from the admission records. The laboratory data were collected from electronic laboratory reports by matching with patients' hospital numbers. The management data and chest radiography results were collected from progress notes. Data sources and roles of variables are demonstrated in Supplementary Table 1. All COVID-19 vaccinations in Thailand were registered in the database of the MoPH. Additionally, vaccination data was matched and retrieved, (type of vaccine and date of injection) using the patient national identification (ID) numbers. During the study period, three different vaccines were available in Thailand that included: CoronaVac® (Sinovac), ChAdOx1 nCoV-19 (Vaxzevria®, Oxford/AstraZeneca) and BBIBP-CorV (Covilo®, Sinopharm [Beijing]).

Definitions

Diagnosis of COVID-19 infection was based on laboratory-confirmed SARS-CoV-2 genes detected by RT-PCR in respiratory tract samples. COVID-19 severity was classified according to the clinical practice guidelines of Thailand as[18]: (1) asymptomatic, (2) mild symptoms without pneumonia or risk factors for developing severe disease (i.e. age >60 years, COPD, CKD, CVD, cerebrovascular disease [CVA], DM, obesity [body weight >90 kg or BMI ≥30 kg/m^2], cirrhosis, immunocompromised), (3) mild symptoms with risk factors or mild-moderate pneumonia not requiring oxygen support and (4) severe pneumonia with hypoxemia (resting oxygen saturation at room air ≤96%). The diagnosis of pneumonia and radiographic infiltration were based on documentation by a physician in the medical records at initial admission.

Prognostic factor thresholds

The candidate continuous variables were potential factors associated with in-hospital mortality. Their cut-off values were chosen according to previous studies: (1) age >65 years[7], (2) obese (BMI >30 kg/m^2)[7] and extremely obese (BMI ≥40 kg/m^2)[14], (3) body temperature ≥38.0°C representing fever[19] and (4) age-adjusted low oxygen saturation ≤90% (age >50 years) and ≤93% (age ≤50 years)[7].

Statistical analysis

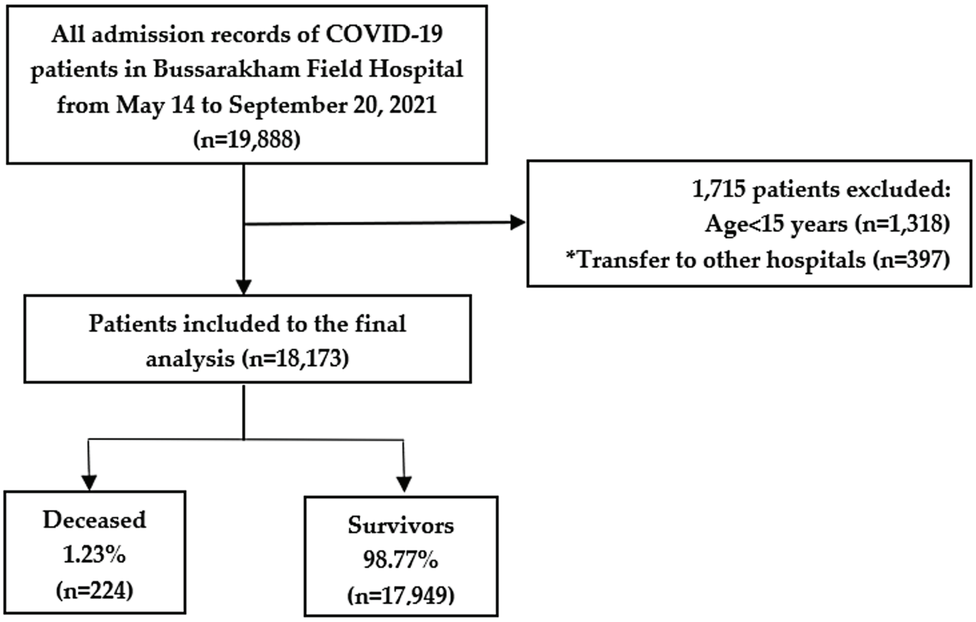
Demographic data were summarized using descriptive statistics and Logistic regression analysis was used to determine factors associated with in-hospital mortality. Variables with a p-value<0.1 from the univariable model were included in the final multivariable regression model. Variance inflation factors (VIFs) were used to detect collinearity among the predictors included in the multivariable models. VIFs of 2.5 or greater were generally considered indicative of considerable collinearity[20]. The odds ratio (OR) as well as its 95% confidence interval (CI) were estimated. Variables with more than 20% missing data were be excluded from the final analysis performed complete case analysis was used for the remaining variables. Furthermore, subgroup analysis via COVID-19 severity was performed to evaluate the factors associated with mortality among different subgroups. p-value<0.05 were considered to be statistically significant for all analyses. All statistical analyses were performed using Stata Statistical Software Release 16 (StataCorp LLC, College Station, TX, USA).

Ethics approval and informed consent

The Institutional Review Board and the Ethics Committee of Pranangklao Hospital approved the study protocol (Approval ID: EC36/2564). Patient informed consent was not required as there was no direct patient contact or primary collection of individual patient data. All personally identifiable information including patient's name and national identification numbers were encrypted for storage and de-identification after completing the data collection.

Results

From a total of 19,888 patient records, screened during the study period, 1,318 and 397 patients were excluded due to age <15 years and transferred to other hospitals respectively. Finally, 18,173 patients were included in the final analysis (Figure 1). From this two hundred and twenty-four patients died with the mortality rate being 1.23% (224/18,173). The mean±S.D. age was 43.4±16.1 years. Thirty percent of all patients had one or more underlying diseases with the two most common comorbidities being hypertension (18.2%) and diabetes mellitus (9.9%). One hundred and fifty-six patients (0.9%) were pregnant. About seventeen percent of all patients were foreigners without ID



Note: *Most patients were transferred to a regular hospital with more advanced facilities; because they developed worsening symptoms after admission.

Figure 1 Study flow chart of COVID-19 patients admitted to Bussarakham Field Hospital

numbers thus, vaccination information was missing data. Eight hundred and ninety patients (5.9%) had received two doses of the COVID-19 vaccine: CoronaVac® (Sinovac) which was the most frequently used vaccine (88%).

Eighty-five percent of patients had symptoms before admission, with the median (IQR) duration of illness being 6 (3, 9) days. The presenting symptoms included: upper respiratory tract (URT) symptoms (43%) (i.e. sneezing, runny nose, anosmia or dysgeusia), cough (58%) and lower respiratory tract (LRT) symptoms (33%) (i.e. dyspnea or tachypnea). The mean±S.D. length of stay was 10.9 days±3.5. Although 54% of all patients had radiographic infiltration 27% were diagnosed with pneumonia at initial admission. Most of the laboratory parameters had more than 20% missing data hence, they were excluded from the final analysis. However, the remaining clinical parameters had few missing data and were designated for analysis on a complete case basis.

Comparisons between clinical characteristics, initial admission parameters and management among the deceased and survivors are shown in Table 1, Table 2 and Table 3 respectively. In comparison with the survivors, the deceased cases were significantly of male gender (57.6 vs 45.0%), older (65.6 vs 43.1 years) had higher body weight (68.6 vs 66.0 kg) had one or more underlying diseases including HT (52.5 vs 17.7%), DM (45.7 vs 9.5%), CVD (7.0 vs 1.5%), CKD (2.3 vs 0.4%), CVA (1.9 vs 0.4%) and were more likely to be pregnant (2.7 vs 0.8%). The deceased had more LRT symptoms (79.1 vs 32.1%) and more pneumonia (70.5 vs 26.1%). In addition, the survivors were more likely to have received two doses of CoronaVac® (Sinovac) vaccine. At initial admission, the deceased had

Table 1 Comparison between clinical characteristics of the deceased and survivors of COVID-19 patients in Bussarakham Field Hospital (N=18,173)

Characteristics	Missing, n (%)	Deceased, n (%) 224 (1.23)	Survivors, n (%) 17,949 (98.77)	p-value
Male gender	16 (0.1)	129 (57.6)	8,075 (45.0)	<0.001
Age,	17 (0.1)			
Years, mean±S.D.		65.6±15.7	43.1±15.9	<0.001
>65 years		127 (56.7)	1,659 (9.3)	<0.001
Body weight, kg, mean±S.D.	513 (2.8)	68.6±17.6	66.0±16.6	0.031
BMI, kg/m^2, mean±S.D.	1,186 (6.5)	25.7±5.5	25.2±5.7	0.310
Underlying diseases				
Hypertension	119 (0.7)	114 (52.5)	3,164 (17.7)	<0.001
Diabetes mellitus	138 (0.8)	100 (45.7)	1,685 (9.5)	<0.001
Cirrhosis	162 (0.9)	1 (0.5)	35 (0.2)	0.350
Cardiovascular disease	158 (0.9)	15 (7.0)	267 (1.5)	<0.001
Chronic kidney disease	164 (0.9)	5 (2.3)	73 (0.4)	0.002
COPD	170 (0.9)	1 (0.5)	57 (0.3)	0.500
Cerebrovascular disease	161 (0.9)	4 (1.9)	71 (0.4)	0.012
Immunocompromised	171 (0.9)	1 (0.5)	69 (0.4)	0.570
Obesity	1,186 (6.5)			
BMI >30 kg/m^2		22 (16.3)	2,839 (16.8)	0.860
BMI ≥40 kg/m^2		3 (2.2)	336 (2.0)	0.750
Pregnancy	145 (0.8)	6 (2.7)	150 (0.8)	0.013
Current smoker	1,274 (7.0)	13 (6.7)	1,889 (11.3)	0.051
COVID-19 vaccination (dose 1/dose 2)				
SV/SV	3,077 (16.9)	4 (1.8)	780 (5.2)	0.020
AZ/AZ	3,077 (16.9)	0 (0.0)	50 (0.3)	1.000
SNP/SNP	3,077 (16.9)	0 (0.0)	14 (0.1)	1.000
SV/AZ	3,077 (16.9)	0 (0.0)	14 (0.1)	0.460
Day of illness at presentation, median (IQR)	684 (3.8)	5.0 (4.0, 8.0)	6.0 (3.0, 9.0)	0.510
Initial Symptoms				
Any symptom	184 (1.0)	184 (89.3)	15,075 (84.8)	0.078
Constitutional symptom	0 (0.0)	117 (52.2)	9,572 (53.3)	0.79
Fever	244 (1.3)	95 (46.6)	6,580 (37.1)	0.007
Headache	250 (1.4)	39 (18.9)	4,605 (26.0)	0.020
Myalgia	262 (1.4)	40 (19.4)	3,970 (22.4)	0.350
URT symptom	0 (0.0)	51 (22.8)	7,727 (43.0)	<0.001
Sneezing	269 (1.5)	13 (6.3)	2,499 (14.1)	<0.001
Running nose	264 (1.5)	23 (11.2)	3,057 (17.3)	0.020
Anosmia	248 (1.4)	24 (11.8)	4,833 (27.3)	<0.001
Dysgeusia	248 (1.4)	24 (11.7)	3,036 (17.1)	0.040

Table 1 (continued)

Characteristics	Missing, n (%)	Deceased, n (%) 224 (1.23)	Survivors, n (%) 17,949 (98.77)	p-value
LRT symptom	0 (0.0)	174 (79.1)	5,706 (32.1)	<0.001
Dyspnea	253 (1.4)	113 (55.1)	4,236 (23.9)	<0.001
Tachypnea	165 (0.9)	138 (61.6)	2,410 (13.4)	<0.001
Dry cough	247 (1.4)	77 (37.4)	5,864 (33.1)	0.210
Productive cough	248 (1.4)	54 (26.3)	4,953 (28.0)	0.640
Rash	292 (1.6)	1 (0.5)	319 (1.8)	0.280
Diarrhea	259 (1.4)	26 (12.7)	2,372 (13.4)	0.840
Pneumonia at presentation	304 (1.7)	158 (70.5)	4,602 (26.1)	<0.001
COVID-19 severity by categories	0 (0.0)			<0.001
1: Asymptomatic		18 (8.0)	2,753 (15.3)	
2: Mild symptoms without pneumonia or risk factors		6 (2.7)	7,138 (39.8)	
3: Mild symptoms with risk factors or non-severe pneumonia		105 (46.9)	7,109 (39.6)	
4: Severe pneumonia with hypoxemia		95 (42.4)	949 (5.3)	

S.D.=standard deviation, BMI=body mass index, COPD=chronic obstructive pulmonary disease, SV=CoronaVac® (Sinovac), AZ=Vaxzevria® (Oxford/AstraZeneca), SNP=Covilo® (Sinopharm [Beijing]), IQR=interquartile range, URT=upper respiratory tract, LRT=lower respiratory tract
All proportions (%) were calculated among non-missing data.

a higher mean respiratory rate (24 vs 20 breaths/minute had a lower mean oxygen saturation at room air (92.1 vs 97.4%) and were more likely to require respiratory support on admission (90.2 vs 13.8%) compared to survivors. Furthermore, there were significant differences in the following laboratory investigations: lower median absolute lymphocyte count (627/mm^3 vs 1,665/mm^3) and lower mean serum bicarbonate (18.0 vs 24.6 mmol/L) but higher median BUN (22.8 vs 12.6 mg/dL), higher median SCr (0.97 vs 0.71 mg/dL) and higher median CRP level (63 vs 13 mg/dL). There were some significant differences in management between the deceased and survivor groups. The deceased patients were more likely to receive favipiravir (94.6 vs 69.3%), dexamethasone (87.2 vs 34.1%) and enoxaparin (39.6 vs 1.5%). Since a shortage of ICU beds occurred during the rapidly increasing number of severe COVID-19 patients, the number of patients admitted to the ICU might not represent the actual number of patients requiring ICU admission: it was therefore decided to exclude this variable from the final analysis.

Finally, 18 potential variables were included in the multivariable model including: gender, age, smoking status, DM, HT, CVD, CVA, CKD, pregnancy, COVID vaccination, presenting symptoms, body temperature, pneumonia on admission, low age-adjusted oxygen saturation at room air and COVID-19 severity. The univariable and multivariable analyses are demonstrated in Table 4. The following factors were independently found to increase the risk of in-hospital mortality significantly (Figure 2): male gender (adjusted OR [aOR] 1.91, 95%CI 1.35-2.70), age >65 years (aOR 5.37, 95%CI 3.75-7.69), DM (aOR 2.55, 95% CI 1.75-3.71), pregnancy (aOR 6.40, 95% 2.15-19.08), LRT symptoms

Table 2 Comparison between the initial admission parameters and investigations of the deceased and survivors of COVID-19 patients in Bussarakham Field Hospital (N=18,173)

Parameter	Missing, n (%)	Deceased, n (%)	Survivors, n (%)	p-value
Admission parameters, mean±S.D.				
BT, °C	128 (0.7)	36.6±0.8	36.4 (0.5)	<0.001
HR, per minute	153 (0.8)	93.8±16.9	92.4 (15.1)	0.190
SBP, mmHg	137 (0.8)	128.5±23.3	123.9 (18.5)	<0.001
DBP, mmHg	142 (0.8)	74.8±14.5	75.6 (12.3)	0.370
RR, breaths per minute	165 (0.9)	24.0±5.6	20.3±1.8	<0.001
Oxygen saturation at RA, %	116 (0.6)	92.1±9.6	97.3±2.5	<0.001
Low age-adjusted oxygen saturation at RA*	116 (0.6)	53 (23.7)	497 (2.8)	<0.001
Laboratory investigations, mean±S.D.				
Complete blood count				
Hemoglobin, g/dL	14,960 (0.8)	12.9±2.0	12.8±1.8	0.690
White blood cell count, /mm^3, median (IQR)	14,500 (79.8)	6,200 (4,200, 9,500)	6,400 (5,000, 8,200)	0.790
Neutrophil, %	14,711 (81.0)	74.5±19.1	61.6±14.6	<0.001
Lymphocyte, %, median (IQR)	14,738 (81.1)	13.4 (8.0, 20.0)	28.0 (18.4, 36.0)	<0.001
Absolute lymphocyte count, /mm^3, median (IQR)	14,738 (81.1)	627 (487, 1,420)	1,665 (1,120, 2,303)	<0.001
Platelet count, x10^3/m^{m}3	14,512 (79.9)	232±91	277±122	0.033
Electrolyte, mmol/L				
Sodium	17,345 (95.4)	140.3±3.4	140.3±3.0	0.950
Potassium	17,346 (95.4)	3.8±0.7	3.9±0.5	0.720
Chloride	17,348 (95.5)	99.8±5.7	102.4±3.8	0.170
Bicarbonate	17,717 (97.5)	18.0±8.5	24.6±2.9	<0.001
BUN, mg/dl, median (IQR)	16,287 (89.6)	22.8 (16.0, 40.1)	12.7 (10.1, 15.9)	<0.001
SCr, mg/dL	15,653 (86.1)	1.1±0.5	0.8±0.6	0.018
Serum albumin, g/dL	17,593 (96.8)	3.4±0.1	4.1±0.5	0.150
Serum glucose, g/dL, median (IQR)	17,738 (97.6)	193.5 (101.0, 286.0)	140.0 (101.0, 198.0)	0.800
CRP, mg/dL, median (IQR)	12,432 (68.4)	62.6 (26.2, 117.5)	13.7 (4.4, 45.3)	<0.001

S.D.=standard deviation, BT=body temperature, HR=heart rate, SBP=systolic blood pressure, DBP=diastolic blood pressure, RR=respiratory rate, RA=room air, IQR=interquartile range, BUN=blood urea nitrogen, SCr=serum creatinine, CRP=C-reactive protein

*Low age-adjusted low oxygen saturation: ≤90% (age >50 years) and ≤93% (age ≤50 years)

All proportions (%) were calculated among non-missing data.

Table 3 Comparison between management and outcomes of the deceased and survivors of COVID-19 patients in Bussarakham Field Hospital (N=18,173)

Variables	Missing, n (%)	Deceased, n (%)	Survivors, n (%)	p-value
Medications				
Antiviral				
Favipiravir	462 (2.5)	191 (94.6)	12,140 (69.3)	<0.001
Day of illness when prescribing, median (IQR)	7,763 (42.7)	5.0 (3.0, 7.0)	6.0 (4.0, 9.0)	0.083
Duration, days, mean±S.D.	7,078 (39.0)	4.5±0.7	4.7±1.4	0.850
Remdesivir	622 (3.4)	1 (0.6)	27 (0.2)	0.250
Andrographolide (Fah-Talai-Jone)	1618 (8.9)	2 (1.1)	1,022 (6.2)	0.002
Systemic steroid				
Dexamethasone	492 (2.7)	177 (87.2)	5,960 (34.1)	<0.001
Methylprednisolone	600 (3.3)	28 (15.1)	57 (0.3)	<0.001
Prednisolone	617 (3.4)	0 (0.0)	16 (0.1)	1.000
Enoxaparin	602 (3.3)	76 (39.6)	265 (1.5)	<0.001
Initial respiratory support	0 (0)	202 (90.2)	2,474 (13.8)	<0.001
Oxygen canular	0 (0)	104 (46.4)	1,983 (11.0)	<0.001
Mask with bag	0 (0)	27 (12.1)	132 (0.7)	<0.001
High-flow nasal canular	0 (0)	67 (29.9)	356 (2.0)	<0.001
Mechanical ventilator	0 (0)	4 (1.8)	3 (0.02)	<0.001
Intensive Care Unit admission	56 (0.3)	32 (14.9)	33 (0.2)	<0.001
Length of stays, days, mean±S.D.	20 (0.11)	9.1±5.1	10.9±3.4	<0.001

IQR=interquartile range, S.D.=standard deviation
All proportions (%) were calculated among non-missing data.

at presentation (aOR 2.81, 95%CI 1.88-4.19) and severe pneumonia with hypoxemia (aOR 3.11, 95%CI 1.35-7.15). Conversely, initial presentation with URT symptoms decreased mortality risk (aOR 0.63, 95%CI 0.13-1.00). Subgroup analysis via COVID-19 severity are shown in Figure 3. All the above factors (male gender, age >65 years, DM, pregnancy and LRT symptom) were more likely to be associated with increased mortality risk. However, only severity categories 3 and 4 had a statistical significance level for all these factors. It Sensitivity analyses was also conducted to address the issue of selection bias due to referred patients assuming that all transferred out patients survived or died: the mortality rates were 1.21% and 3.29% respectively. Most of the conclusions were similar to the analysis of the original cohort (Supplementary Table 2).

Discussion

During the third and fourth waves of the COVID-19 outbreak in Thailand, between April to September 2021, a surge capacity of hospitals occurred. As a result, Bussarakham Field Hospital was rapidly set up along with other field hospitals to address this crisis. These were closed down after 130 days of operation. The in-hospital mortality rate was 1.23%, which was slightly higher than

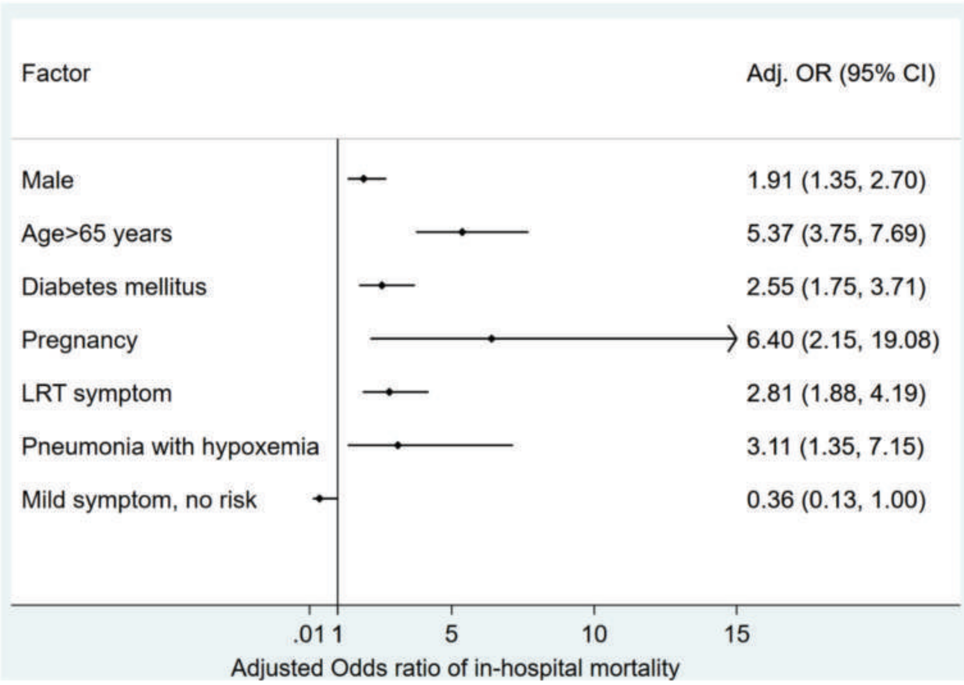
Table 4 Factors associated with in-hospital mortality among COVID-19 patients in Bussarakham Field Hospital based on univariable and multivariable logistic regression analysis

Factors	Univariable analysis		Multivariable analysis	
	Crude OR (95% CI)	p-value	Adjusted OR (95% CI)	p-value
Gender				
Female	1		1	
Male	1.65 (1.26, 2.17)	<0.001	1.91 (1.35, 2.70)	<0.001
Age, years				
≤65	1		1	
>65	13.03 (9.92, 17.11)	<0.001	5.37 (3.75, 7.69)	<0.001
Smoking status				
Non-smoker	1		1	
Current smoker	0.53 (0.29, 0.95)	0.033	0.68 (0.34, 1.36)	0.281
Had the following comorbidity				
No	1		1	
Hypertension	5.29 (4.03, 6.95)	<0.001	1.03 (0.71, 1.50)	0.872
Diabetes mellitus	8.08 (6.15, 10.62)	<0.001	2.55 (1.75, 3.71)	<0.001
Cardiovascular disease	4.70 (2.70, 8.19)	<0.001	1.29 (0.66, 2.53)	0.452
Cerebrovascular disease	4.87 (1.76, 13.47)	0.002	1.14 (0.32, 4.06)	0.838
Chronic kidney disease	5.95 (2.38, 14.88)	<0.001	0.82 (0.24, 2.87)	0.763
BMI				
≤30 kg/m^2	1			
Obese (BMI>30 kg/m^2)	0.98 (0.62, 1.55)	0.926	-	-
<40 kg/m^2	1			
Extremely obese (BMI ≥40 kg/m^2)	1.13 (0.36, 3.58)	0.830	-	-
Pregnancy				
No	1		1	
Yes	3.35 (1.46, 7.66)	0.004	6.40 (2.15, 19.08)	0.001
COVID-19 vaccination: SV/SV				
No	1		1	
Yes	0.34 (0.13, 0.92)	0.034	0.78 (0.24, 2.52)	0.675
Had the following symptom				
No	1		1	
Fever	1.49 (1.12, 1.97)	0.006	1.09 (0.76, 1.55)	0.637
Headache	0.69 (0.48, 0.97)	0.035	1.05 (0.69, 1.60)	0.828
Upper respiratory tract	0.39 (0.29, 0.54)	<0.001	0.63 (0.42, 0.94)	0.023
Lower respiratory tract	7.76 (5.59, 10.76)	<0.001	2.81 (1.88, 4.19)	<0.001
Body temperature, °C				
<38	1		1	
≥38	3.69 (1.80, 7.60)	<0.001	1.42 (0.57, 3.53)	0.450

Table 4 (continued)

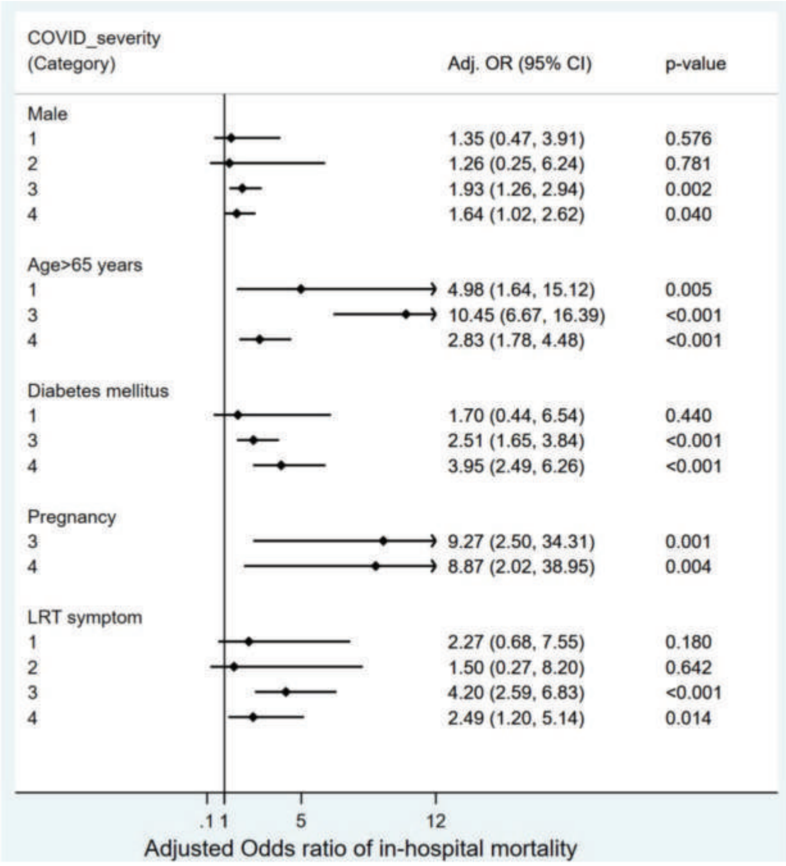
Factors	Univariable analysis		Multivariable analysis	
	Crude OR (95% CI)	p-value	Adjusted OR (95% CI)	p-value
Pneumonia on admission				
No	1		1	
Yes	6.56 (4.91, 8.78)	<0.001	1.13 (0.74, 1.75)	0.571
Low age-adjusted oxygen saturation at RA*				
No	1		1	
Yes	10.91 (7.90, 15.09)	<0.001	1.30 (0.74, 2.27)	0.358
COVID-19 severity				
Category 1	1		1	
Category 2	0.13 (0.05, 0.32)	<0.001	0.36 (0.13, 1.00)	0.050
Category 3	2.19 (1.33, 3.63)	0.002	1.07 (0.54, 2.12)	0.845
Category 4	14.96 (8.98, 24.91)	<0.001	3.11 (1.35, 7.15)	0.008

BMI=body mass index, OR=odds ratio, RA=room air, SV=CoronaVac® (Sinovac)



Adj. OR=adjusted odds ratio, CI=confidence interval

Figure 2 Adjusted odds ratio of independent factors associated with in-hospital mortality of COVID-19 patients in Bussarakham Field Hospital



Adj. OR=adjusted odds ratio, CI=confidence interval, LRT=lower respiratory tract

Note: Because of collinearity issues, the values in some COVID-19 severity categories were omitted from the analysis.

Figure 3 Subgroup analysis by COVID-19 severity (category) for factors associated with in-hospital mortality

Thailand's nationwide mortality rate of 1.05%, but lower than the global mortality rate of 2.05% within the same period.[21] The possible explanation for the slightly higher mortality of Bussarakham Field Hospital compared to the average mortality among the other regular hospitals in Thailand was higher patient volume and being more overwhelmed causing difficulty in providing adequate patient care. This was especially when the ICU beds of the regular hospitals were fully occupied and many patients who were initially identified as having a moderately severe illness (yellow code) later progressed to critically ill status (red code) and could not be transferred out. Therefore, the ICU of Bussarakham Field Hospital was set up in the last operating month.

A large meta-analysis of hospitalized COVID-19 patients from several countries until August 2020, reported a pooled mortality rate of 17.62%[10]. However, mortality of COVID-19 patients varied from zero in the shelter (cabin) hospitals which served as isolation hospitals and treated non-severe diseases to transferred patients to designated hospitals when severe symptoms developed[22] from 0.5% in a university field hospital[23] and to as high as 24.6% in referral centers in Italy during surge capacity[24]. In addition, a study in Israel which used a computational model demonstrated that an overwhelming patient load beyond the capacity of health systems due to a rapid increase of new cases within a short period significantly increased mortality[25]. This study demonstrated data in the center of the third and fourth pandemic waves in Thailand, in which mortality was lower than in the previous waves. This finding was supported by an earlier study in Italy that reported an approximately threefold higher risk of death during the first pandemic wave than in the next wave[13].

This study found that male gender, advanced age, DM, pregnancy, LRT symptoms and pneumonia with hypoxemia at initial presentation independently increased the risk of in-hospital mortality by about 2 to 6 fold. These results are in line with a previous meta-analysis reporting that the elderly (pooled odds ratio [pOR] 2.61), male gender (pOR 1.45), and DM (pOR 1.52) patients were associated with in-hospital mortality[10]. Although this study did not support COPD, obesity and cancer as risks for mortality this finding was possibly due to the low prevalence of COPD (<1%) and obese (17%) patients in this study. Although the univariable analysis found that HT and CVD were associated with in-hospital mortality no significant association was found after adjusting with the other factors in the multivariable analysis. In another meta-analysis, DM was the best mortality predictor compared to other underlying diseases: this could explain the above issue[26]. A previous study proposed that the SARS coronavirus causes the development of DM and diabetic ketoacidosis (DKA) via binding to ACE receptors of pancreatic beta-cells leading to pancreatic cell destruction and glucose metabolism abnormalities[27]. Furthermore, increased systemic steroid use in a randomized controlled trial reported the benefit of lower mortality among patients receiving respiratory support[28]. However, since DKA is a frequent complication among COVID-19 patients that results in higher mortality systemic steroids should be cautiously administered[29]. In this field hospital cohort pregnancy increased the mortality risk of COVID-19 infection by more than six-fold compared to non-pregnant women. These results were consistent with a CDC study that reported severe illness and death among COVID-19 pregnant women[30]. These findings supported risk communication and triage of pregnant patients with COVID-19 to regular hospitals having maternal and fetal monitoring capabilities rather than to a field hospital. Although the CoronaVac® vaccine did not significantly reduce mortality in this study's final multivariable model, the proportion of vaccinated patients (about 5%) having received two doses in this study was too small to draw this mortality conclusion.

Interestingly, the presentation of LRT symptoms (dyspnea and tachypnea), rather than a physician's diagnosis of pneumonia was the independent factor associated with in-hospital mortality within this study's cohort. However, the LRT symptoms could represent either pneumonia or COVID-19 sepsis itself[31]. In this study, COVID-19 patients with severe pneumonia and hypoxemia had about a three times higher mortality rate than those without symptoms. A previous large retrospective cohort study in Spain showed that signs and symptoms; including dyspnea, confusion, and low age-adjusted oxygen saturation in room air were independent predictors of death[7]. Additionally, the viral load in the LRT was associated with 6-week mortality[32]. Compared with similar settings from previous large-scale field hospitals. Fangcang shelter hospitals in Wuhan, China during the outbreak between February and March 2020[33]. They have published many interesting triage strategies to reduce in-hospital mortality. Fangcang hospitals primarily cared for COVID-19 patients with mild to moderate signs or symptoms. Meanwhile, patients who did not meet the admission criteria were referred to higher-level hospitals. The admission criteria of Fangcang hospitals were mild to moderate COVID-19 symptoms and signs, age <65 years, ability to walk and live independently, absence of severe chronic diseases (HT, DM, CAD, malignancy, structural lung disease, pulmonary heart disease and immunosuppression), no history of mental health problem, SpO_2 >93% at room air or respiratory rate <30/min at resting[34]. Thus, it is recommended that there is a strict adherence to the admission triage criteria as best as possible. Additionally, patients presenting with LRT symptoms or hypoxemia at field hospitals should receive close monitoring and priority for referral to the intensive care unit at a tertiary hospital.

Several laboratory parameters were reported as prognostic factors for COVID-19 patients. Unfortunately, this issue could not be evaluated in this current study due to too much missing laboratory data. A prediction model using only three biomarkers (LDH, lymphocyte count, high-sensitivity CRP) selected by machine learning[16] showed unsatisfactory mortality prediction for external validation in the ED[35] and ICU[36].

This study had some limitations. First, the data collection was based on a retrospective chart review. Second, a large amount of laboratory data considered potential risk factors associated with mortality were unavailable. Finally, these study results might limit generalizability, due to being based on a single field hospital during a surge capacity situation of the third and fourth waves of the pandemic, the periods might be dominated by alpha and delta variants. Furthermore, most patients in this study were still unvaccinated and had higher mortality. A previously published study found that vaccination prevented death from COVID-19 in 185 countries and territories[37].

Conclusion

During the third wave of the COVID-19 pandemic, the in-hospital mortality at the Bussarakham Field Hospital was slightly higher than the nationwide mortality of Thailand. The following factors were associated with higher in-hospital mortality: male gender, elderly, diabetes mellitus, pregnancy, lower respiratory tract symptoms and pneumonia with hypoxemia. Therefore, initial triage or prompt transfer of patients with the above factors to a higher-level healthcare facility should be considered.

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Conflict of interest

The authors declare no conflict of interest.

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Supplementary Table 1 Data sources and roles

Groups	Variables	Roles	Sources
Demographic data	gender, age, body weight, BMI, smoking status	Exposure	Standard admission record for COVID-19
Underlying disease/ Comorbidity	any, HT, DM, cirrhosis, CVD, CKD, COPD, CVA, immunocompromised, pregnancy	Exposure	Standard admission record for COVID-19
Clinical presentation	fever, headache, myalgia, sneezing, running nose, anosmia, dysgeusia, dyspnea, tachypnea, dry cough, productive cough, rash, diarrhea	Exposure	Standard admission record for COVID-19
Initial admission parameter	BT, HR, SBP, DBP, RR, SpO_2 at room air	Exposure	Standard admission record for COVID-19
Investigation data within 24 hours	CBC, CRP, LDH, LFT, BUN, SCr, electrolyte, glucose, albumin	Exposure	Electronic laboratory report
	chest radiography (pneumonia)	Exposure	Progress note
Management data	antiviral therapy, oxygen support, high-flow nasal cannula, mechanical ventilator, and ICU admission	Exposure	Progress note
COVID-19 vaccination	SV, AZ, SNP	Exposure	Database of the MoPH: national identification number matched
Treatment outcome	survived/ deceased	Outcome	Discharge summary
Patient's identification*	name, hospital number, national identification number	Identifier	Discharge summary

BMI=body mass index, HT=hypertension, DM=diabetes mellitus, COPD=chronic obstructive pulmonary disease, CVD=cardiovascular disease, CKD=chronic kidney disease, COPD=chronic obstructive pulmonary disease, CVA=Cerebrovascular disease, BT=body temperature, HR=heart rate, SBP=systolic blood pressure, DBP=diastolic blood pressure, R=respiratory rate, SpO_2=oxygen saturation, CBC=complete blood count, CRP=C-reactive protein, LDH = lactate dehydrogenase, LFT=liver function test, BUN=blood urea nitrogen, SCr=serum creatinine, SV=CoronaVac® (Sinovac), AZ=ChAdOx1 nCoV-19 (Vaxzevria®, Oxford/AstraZeneca), SNP=BBIBP-CorV (Covilo®, Sinopharm [Beijing]), MoPH=ministry of public health

*All personally identifiable information, including the patient's name and national identification numbers, were encrypted for storage and de-identification after completing the data collection.

Note: All data were collected and managed using REDCap (Research Electronic Data Capture): a secure, web-based software platform designed to support data capture for research studies. An investigator, blinded to patient outcomes, performed data cleaning before the final analysis.

Supplementary Table 2 Sensitivity analyses: assuming that all transferred-out patients died or survived

Factors	Multivariable logistic regression model					
	Original cohort (excluded transfer out)		Transferred out: deceased		Transferred out: survived	
	Adj. OR (95% CI)	p-value	Adj. OR (95% CI)	p-value	Adj. OR (95% CI)	p-value
Gender						
Female	1		1		1	
Male	1.91 (1.35, 2.70)	<0.001	1.52 (1.24, 1.85)	<0.001	1.90 (1.34, 2.68)	<0.001
Age, years						
≤65	1		1		1	
>65	5.37 (3.75, 7.69)	<0.001	2.24 (1.79, 2.80)	<0.001	5.32 (3.72, 7.61)	<0.001
Smoking status						
Non-smoker	1		1		1	
Current smoker	0.68 (0.34, 1.36)	0.281	0.62 (0.41, 0.92)	0.019	0.79 (0.41, 1.52)	0.475
Had the following comorbidity						
No	1		1		1	
Hypertension	1.03 (0.71, 1.50)	0.872	1.15 (0.91, 1.45)	0.234	0.94 (0.65, 1.37)	0.754
Diabetes mellitus	2.55 (1.75, 3.71)	<0.001	1.91 (1.50, 2.43)	<0.001	2.59 (1.79, 3.77)	<0.001
Cardiovascular disease	1.29 (0.66, 2.53)	0.452	1.30 (0.81, 2.10)	0.283	1.30 (0.67, 2.53)	0.437
Cerebrovascular disease	1.14 (0.32, 4.06)	0.838	0.72 (0.25, 2.12)	0.554	1.23 (0.35, 4.33)	0.749
Chronic kidney disease	0.82 (0.24, 2.87)	0.763	1.92 (0.97, 3.80)	0.063	0.71 (0.20, 2.46)	0.589
Pregnancy						
No	1		1		1	
Yes	6.40 (2.15, 19.08)	0.001	4.52 (2.40, 8.52)	<0.001	4.73 (1.56, 14.37)	0.006
COVID-19 vaccination: SV/SV						
No	1		1		1	
Yes	0.78 (0.24, 2.52)	0.675	0.86 (0.49, 1.50)	0.597	0.79 (0.24, 2.53)	0.686
Had the following symptom						
No	1		1		1	
Fever	1.09 (0.76, 1.55)	0.637	1.24 (1.01, 1.53)	0.036	1.09 (0.77, 1.55)	0.616
Headache	1.05 (0.69, 1.60)	0.828	1.01 (0.80, 1.28)	0.936	1.02 (0.67, 1.55)	0.944
Upper respiratory tract	0.63 (0.42, 0.94)	0.023	0.65 (0.53, 0.81)	<0.001	0.63 (0.42, 0.94)	0.022
Lower respiratory tract	2.81 (1.88, 4.19)	<0.001	2.01 (1.62, 2.50)	<0.001	2.89 (1.93, 4.31)	<0.001
Body temperature, °C						
<38	1		1		1	
≥38	1.42 (0.57, 3.53)	0.450	3.18 (1.88, 5.38)	<0.001	1.29 (0.53, 3.17)	0.576
Pneumonia on admission						
No	1		1		1	
Yes	1.13 (0.74, 1.75)	0.571	1.10 (0.85, 1.42)	0.459	1.23 (0.80, 1.89)	0.347

Supplementary Table 2 (continued)

Factors	Multivariable logistic regression model					
	Original cohort (excluded transfer out)		Transferred out: deceased		Transferred out: survived	
	Adj. OR (95% CI)	p-value	Adj. OR (95% CI)	p-value	Adj. OR (95% CI)	p-value
Low age-adjusted oxygen saturation at RA*						
No	1		1		1	
Yes	1.30 (0.74, 2.27)	0.358	1.80 (1.23, 2.65)	0.003	1.13 (0.65, 1.97)	0.664
COVID-19 severity						
Category 1	1		1		1	
Category 2	0.36 (0.13, 1.00)	0.050	1.14 (0.68, 1.91)	0.611	0.38 (0.13, 1.06)	0.064
Category 3	1.07 (0.54, 2.12)	0.845	2.00 (1.25, 3.19)	0.004	1.10 (0.55, 2.22)	0.792
Category 4	3.11 (1.35, 7.15)	0.008	4.07 (2.29, 7.24)	<0.001	2.96 (1.27, 6.90)	0.012

Adj. OR=adjusted odds ratio, RA=room air, SV=CoronaVac® (Sinovac)

*Low age-adjusted low oxygen saturation: ≤90% (age >50 years) and ≤93% (age ≤50 years)

Appendix

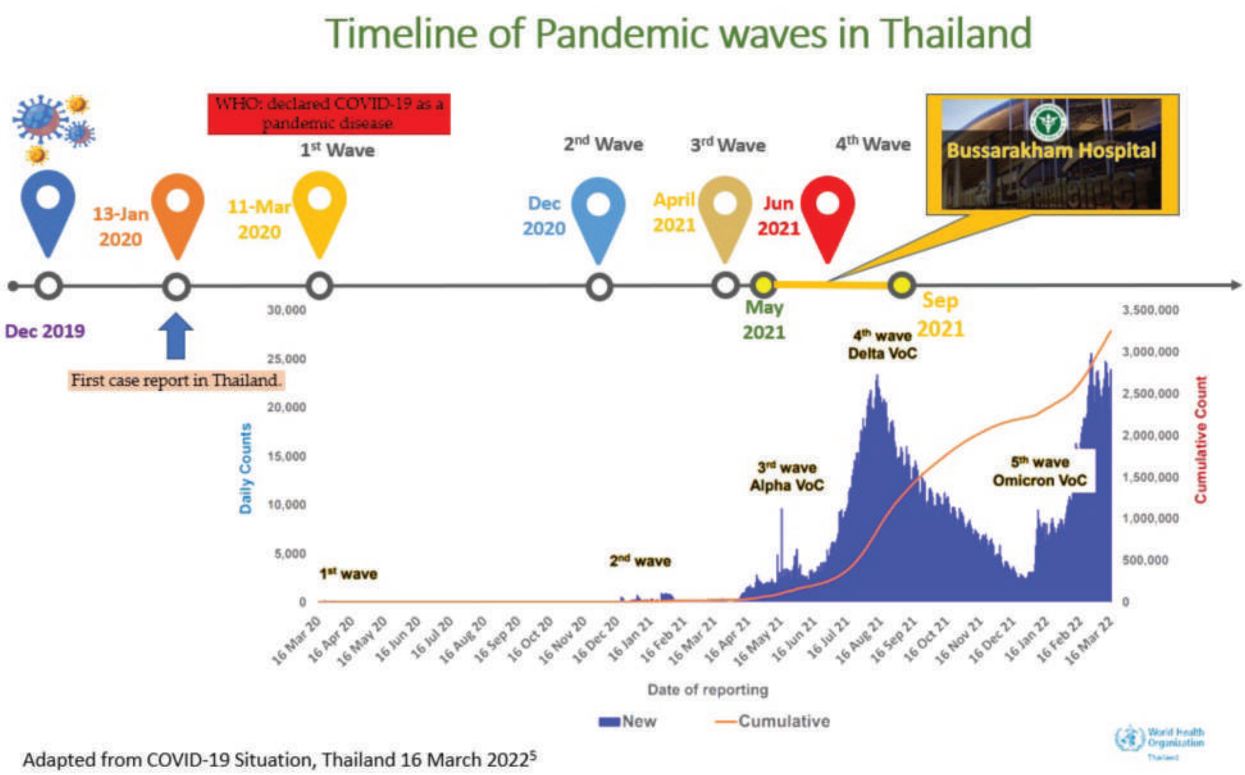

Figure 1 Timeline of pandemic waves in Thailand

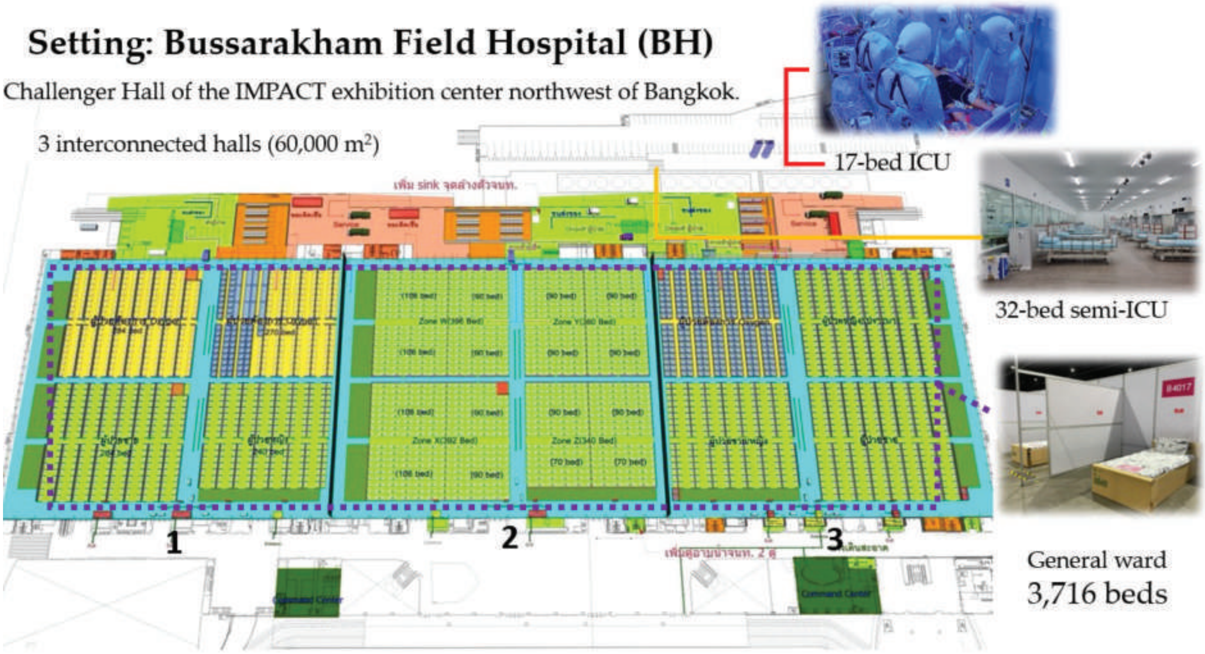

Figure 2 Setting: Bussarakham Field Hospital