Infection (2021) 49:327–332
https://doi.org/10.1007/s15010-020-01527-z

BRIEF REPORT

Hospital at home for the management of COVID-19: preliminary experience with 63 patients

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Received: 2 July 2020 / Accepted: 14 September 2020 / Published online: 29 September 2020

Abstract
Alternatives to conventional hospitalization are needed to increase health systems resilience in the face of COVID-19 pandemic. Herein, we describe the characteristics and outcomes of 63 patients admitted to a single HaH during the peak of COVID-19 in Barcelona. Our results suggest that HaH seems to be a safe and efficacious alternative to conventional hospitalization for accurately selected patients with COVID-19.

Keywords COVID-19 · Hospital at home · Alternative medical care facilities · Alternatives to conventional hospitalization

Introduction

The COVID-19 pandemic poses a serious challenge to health system resilience across the globe [1]. Particularly, hospital capacity and availability of intensive care unit (ICUs) beds and respirators have been identified among the upmost relevant factors, which have been critically exceeded in a number of countries during the first wave of COVID-19 [1]. As many hospitals devoted the bulk of their resources in COVID-19, various alternative medical facilities have been used to alleviate hospitals and avoid collapse [1].

Hospital at home (HaH) units have proven to be an effective and safe alternative to conventional hospitalization for admission avoidance and early discharge [2]. HaH units have been successfully used in a variety of conditions, e.g., serious bacterial infections and respiratory viral infections, including potentially health system-collapsing situations such as the annual peak of seasonal influenza [3–6].

We aimed to describe the characteristics and outcomes of patients with COVID-19 transferred from the hospital to a HaH unit during the peak of the first wave of the pandemic in Barcelona, Spain.

Methods

Patients

Consecutive patients with COVID-19 from March 10 to April 5 2020 admitted to the HaH Unit were included. A follow-up period of 30 days after discharge from HaH was completed for all patients.

Members of the Hospital Clínic 4H Team are listed in the Appendix.

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Definitions

The diagnosis of COVID-19 was based on clinical, radiological, and laboratory criteria and microbiological confirmation in all patients until March 27, since when disruptions in the supply of polymerase-chain reaction tests for SARS-CoV-2 in Spain resulted in increasing number of suspected but not confirmed cases.

Setting

Hospital Clinic is a 750-bed public, tertiary teaching hospital which serves 560,000 people in the metropolitan area of Barcelona. The Hospital Clinic's HaH Unit started providing hospital-level, specialized, health care at patients' homes in 1996 [7]. The HaH Unit has a maximum capacity of 48 patients, with approximately 1200 patients treated each year and a mean length of stay of 7 days (standard deviation 3 days) [8]. Patient care during HaH admission included daily medical and nurse visits (in-person, phone calls, and video calls), a round the clock call center, usual tests at home (blood tests, cultures, EKG, and ultrasound), oral or iv drug administration, and transfer to hospital for either further tests (e.g., chest X-ray) or planned conventional hospitalization if required. In case of rapid deterioration of the clinical status objectified during medical or nurse visits or worsening of symptoms referred by the patients to the call center, medical staff could decide transferring patients via ambulance to a reserved area in the hospital, equipped as a semi-intensive care unit with two high-level isolation boxes (originally set up to visit patients with suspicion of Ebola during the 2014–2016 outbreak), whereby conducting clinical exploration and complementary tests. From there, patients could be admitted to the hospital (either to a COVID-19 ward or ICU) or be transferred back to HaH.

Notably, during the study period, a medicalized hotel run by HaH staff was being set up and 230 patients visited in the ER were transferred there with the same inclusion criteria as HaH. After April 5, almost all HaH resources were invested in the medicalized hotel, thereby precluding further admissions of COVID-19 patients at home, but instead were admitted to the medicalized hotel.

Criteria for transfer to HaH

(1) Caregiver available 24 h at the patients' home; (2) home conditions allowing patient isolation from cohabitants; (3) early discharge from hospital ward: more than 6 days since the start of symptoms; no fever in the last 24 h; respiratory rate < 22 rpm and oxygen saturation > 95% with $F_iO2 < 0.35$; C Reactive protein < 5 mg/dl or descending, normal LDH or descending, lymphocytes > 800 cells/mm^3 or ascending; no radiological progression of pneumonia; (4) admission from Emergency room: bilateral pneumonia in patient without high-risk factors (> 65 years old, hypertension, chronic obstructive pulmonary disease, cardiovascular disease, diabetes, cancer, and immunosuppression); respiratory infection without pneumonia, or unilobar pneumonia in patients with risk factors.

Ethics

The Ethical Board of the Hospital Clínic evaluated and approved the study protocol (HCB.2020.0443). A waiver for informed consent was granted due to the state of pandemic emergency.

Statistical analysis

Descriptive analysis was performed using SPSS for Windows, version 23.0 (SPSS Inc. Chicago. Illinois. USA).

Results

During the study period, 1783 patients with a diagnosis of COVID-19 were visited in the ER. Out of them, 1320 (74%) were admitted to the hospital: 63 were transferred to the HaH Unit (4.8%), 984 were initially admitted to COVID-19 wards (74.5%), and 273 were transferred to ICU from the ER (20.7%). During the same period, a total of 69 patients were evaluated for HaH admission. Six patients were rejected (8.7%): 2 patients lived out of the catching area of the HaH Unit, 2 patients did not meet the clinical criteria for admission, 1 patient lived alone, and 1 patient declined the transfer to HaH.

The baseline characteristics and features of the 63 patients at the moment of admission to HaH are shown in Table 1. Median age was 51 years (IQR 40–62) and 54% of patients were female. A history of smoking was found in 14.3%, 9.5% had diabetes mellitus, and 17.5% had hypertension, of whom 45.5% either received angiotensin converter enzyme inhibitors or angiotensin receptor blockers. Half of the patients (50.8%) were transferred to HaH from hospital wards, while a 39.7% were admitted directly from the emergency room. Most patients (90.5%) had a positive PCR for SARS-CoV-2 infection. The total median length of stay was 7 days (IQR 3.8–10.2), being 1 day in median at the hospital and 6 days (IQR 4–8) at HaH.

Fever and cough were the most frequently found clinical manifestations, with a median of 6 days and 10 days of symptoms duration prior to hospital and HaH admission, respectively (Table2). One patient received oxygen supply at HaH. The most common radiological findings were bilateral

Table 1 Baseline characteristics and transfer data of COVID-19 patients admitted to the Hospital at Home the study period ($N=63$)

Baseline characteristics	
Age, years (median, IQR)	51 (40–62)
Female sex, *n* (%)	34 (54)
Smoker, *n* (%)	
No	54 (85.7)
Former	5 (7.9)
Active	4 (6.3)
Dyslipidaemia, *n* (%)	10 (15.9)
Diabetes mellitus, *n* (%)	6 (9.5)
Hypertension, *n* (%)	11 (17.5)
Drug treatment, *n* (%)	10 (15.9)
ACEi	3 (4.8)
ARB	2 (3.2)
CA	2 (3.2)
Diuretics	2 (3.2)
Other	1 (1.6)
Chronic lung disease, *n* (%)	4 (6.3)
Ischemic heart disease, *n* (%)	3 (4.8)
Moderate–severe chronic renal failure, *n* (%)	2 (3.2)
Moderate–severe chronic liver disease, *n* (%)	1 (1.6)
Neoplasm, *n* (%)	4 (6.3)
Data at Hospital at home admission	
Department of referral, *n* (%)	
ED	25 (39.7)
Ward	32 (50.8)
Other	6 (9.5)
Number of live-in partners at home, median (IQR)	1 (1–2)
Nasopharyngeal swab for SARS-CoV-2, *n* (%)	60 (95.2)
Days after admission, median (IQR)	0 (−0.5 to 1)
Days after symptoms onset, median (IQR)	6 (3–8)
Positive PCR, *n* (%)	57 (90.5)
Total length of stay in days, median (IQR)	7 (3.8–10.2)
Length of stay at HAH days, median (IQR)	6 (4–8)

ACEi Angyotensin converter enzyme inhibitors, *ARB* Angyotensin II receptor blockers, *CA* calcium antagonists, *ED* emergency department, *HaH* hospital at home, *PCR* polymerase-chain reaction

interstitial infiltrates (34.9%). Four patients (6.3%) were admitted to the ICU before transfer to HaH. Most patients (82.5%) received antiviral treatment and 17.5% also received antibacterial agents. Notably, none received systemic glucocorticoids. Nineteen percent of patients discontinued at least one antiviral drug due to adverse events or intolerance. Three (4.8%) patients required a new hospitalization. No patients died during either HaH or follow-up.

Discussion

Our study shows that HaH Units seem to be safe and effective in the care of non-severe COVID-19 patients and those who presented severely and have overcome the acute phase when selection criteria for HaH admission are properly applied. Remarkably, the median time from symptoms onset to transfer to HaH was 10 days, and the 25% percentile was 7 days, which is around the timeframe described as the one with higher risk of presenting complications [9]; namely, a notable proportion of patients were transferred still in risk of presenting complications and yet the outcomes were overall very good, with no patients readmitted either to the hospital or the ICU nor dying. The criteria applied for considering HaH admission were based on previous staff experience in home admissions and agreed with the Infectious diseases specialists in light of the growing knowledge and experience in COVID-19 at the time. Retrospectively, these criteria might have been conservative, although larger studies to validate a HaH admission score for COVID-19 should be proposed.

Although safety was overall good when considering clinical outcomes and readmissions, a more nuanced approach is required to address drug-related side effects, which led to a 19% discontinuation rate. This points to very aggressive local treatment guidelines indicating by that time the largely not evidence-based use of drugs in a low-risk population in which the "do not harm" motto should prevail.

Thorough cost-effectiveness studies are needed to comprehensively evaluate the sustainability and economic impact of alternatives to conventional hospitalization during the COVID-19 pandemic; however, our study interestingly showed a short median length of admission at the hospital before transfer and also an overall short admission including the HaH stay. Studying alternatives to conventional hospitalization during the COVID-19 pandemics is of utmost importance not only due to the relationship between the healthcare systems capacity, including shortages on medications, respirators, and protective equipment with overall outcomes during the peak in each country [1, 9, 10], but also because the COVID-19 entails a large economic burden that has still not yet at its fullness. HaH units are integrated, flexible, and easy scalable platforms that can be cost-efficiently adapted to high demand situations such as the COVID-19 pandemic.

Our study is constraint by several limitations. First, the sample size is small and the analysis is based on limited experience of patients collected during a short period of time as previously simultaneously HaH staff was responsible for adapting a Hotel for COVID-19 patients with the same admission criteria as in HaH. Second, the small

Table 2 Clinical and therapeutic features and outcomes of COVID-19 patients admitted to the Hospital at Home during the study period

Clinical characteristics	
Symptoms, *n* (%)	
Fever	50 (79.4)
Cough	50 (79.4)
Dyspnea	20 (31.7)
Hyposmia/anosmia	8 (12.7)
Dysgeusia	9 (14.3)
Gastrointestinal	9 (14.3)
Length of symptoms until transfer in days, median (IQR)	10 (7–16)
Use of oxygen supply, *n* (%)	1 (1.6)
Blood test parameters at admission	
C Reactive Protein, median mg/dL (IQR)	2.6 (1.0–4.9)
Procalcitonin, median ng/mL (IQR)	0.03 (0.03–0.05)
Lactate dehydrogenase, median U/L (IQR)	249 (191.5–299.8)
Lymphocytes per 10^6/L, median (IQR)	1100 (900–1400)
D-dimer, median ng/mL (IQR)	400 (300–575)
Ferritin, median ng/mL (IQR)	262 (110–526)
AST, median U/L (IQR)	31.5 (24.8–44)
ALT, median U/L (IQR)	28 (22–53)
Bilirubin, median mg/dL (IQR)	0.5 (0.4–0.6)
Alkaline phosphatase, median U/L (IQR)	66.5 (51–82.8)
Gamma-glutamyl transpeptidase, median U/L (IQR)	30 (20–55)
Creatinine, median mg/dL (IQR)	0.79 (0.68–0.94)
Prothrombin time, % (IQR)	90.8 (83.9–99.2)
Initial radiological findings	
No initial chest X-ray performed, *n* (%)	8 (12.7)
Radiological pattern, *n* (%)	
Normal chest X-ray	6 (9.5)
Unilateral interstitial infiltrates	19 (19.2)
Unilateral spotted interstitial infiltrates	2 (3.2)
Bilateral interstitial infiltrates	22 (34.9)
Other	6 (9.5)
Complications, *n* (%)	
Admission to ICU	4 (6.3)
ARDS	0
Mechanical ventilation	
Non-invasive	0
Invasive	1 (1.6)
Pulmonary emboli	0
Shock	0
Therapeutic features	
Received treatment for COVID-19, *n* (%)	52 (82.5)
Lopinavir/ritonavir, *n* (%)	39 (61.9)
Median days (IQR)	7 (3.2–10)
Hydroxychloroquine, *n* (%)	51 (81.0)
Median days (IQR)	5 (5–7)
Azithromycin, *n* (%)	38 (60.3)
Median days (IQR)	5 (5–5)
Remdesivir, *n* (%)	1 (1.6)
Tocilizumab	5 (7.9)
Other antiviral agents, *n* (%)	5 (7.9)
Received antimicrobials to cover a potential bacterial infection, *n* (%)	11 (17.5)

Table 2 (continued)

Received glucocorticoids, *n* (%)	0
Outcomes	
Treatment discontinuation due to adverse events, *n* (%)	12 (19)
Readmission to hospital during HaH, *n* (%)	1 (1.6)
Days after transfer to HaH, median (IQR)	5 (−)
New consultation after HaH discharge, *n* (%)	3 (4.8)
Days after discharge, mean (IQR)	4 (2–6)
Readmission to hospital after HaH discharge, *n* (%)	2 (3.2)
Days after discharge, mean (IQR)	3.5 (1–6)
Death, *n* (%)	0

ALT aspartate aminotransferase, *ALT* alanine aminotransferase

number of events prevented us to analyze risk factors of readmission, new consultations to the hospital, or death. Third, our HaH unit has some particularities (strong infrastructural assets and expertise) that might at some extent hamper reproducibility. Fourth, due to the lack of evidence available at during the study period, the clinical criteria for indicating HaH transfer either from the hospital wards or the ED included in the local protocols of our institution was largely not based on evidence coming from studies on COVID-19 (e.g., risk scores for the progression of disease or ICU admission in COVID-19 patients were still not available). And finally, during the study period and before hospitals risked collapsing, the general trend in Catalonia and in our institution, in particular, was to admit almost all COVID-19 patients either to the HaH or the hospital unless they were asymptomatic, without chest infiltrates, and symptoms had started more than 2 weeks earlier. In spite of these shortcomings, we believe that our preliminary findings might be of great use to guide potential decentralization pathways of COVID-19 care from hospitals, therefore improving efficiency and patients' comfort, and reducing hospital overload during COVID-19 peaks, as well as costs and nosocomial infections, among other.

In conclusion, hospital at home units seems to be safe and efficacious for providing care to selected patients with COVID-19 and, therefore, can be used as a measure to reduce the healthcare pressure at hospitals. Patients' selection based on severity or potential development of complications seems crucial to optimize the outcomes; however, further studies investigating the optimal criteria for admission of COVID-19 patients in these outpatient facilities are warranted.

Author contributions JMP, DC, and DN designed the study; DC, OT, JC, JS, EA, NR, AA, and JH systematically collected the data; JMP and DN obtained permissions; JMP and DC performed the statistical analyses and drafted the tables and figure; JMP wrote the first draft of the manuscript; all other authors contributed by gathering data, critically revising the manuscript and providing final approval.

Compliance with ethical standards

Conflict of interest None of the authors declare competing interests with regards to the current work.

Appendix

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