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## Dedicated team to ambulatory care for patients with COVID-19 requiring oxygen: Low rate of hospital readmission

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### ABSTRACT

**Objectives:** We aimed to determine the impact of a dedicated medical team (DMT) on ambulatory care for patients requiring oxygen.

**Methods:** The DMT selected patients requiring oxygen for less than 5 l/min in the emergency department (ED). The rate of ED readmission was compared in patients managed by the DMT and those managed by the ED physicians (EDPs). Consensual treatment for COVID-19 pneumonia with oxygen requirement was steroids + preventive anticoagulation.

**Results:** A total of 1397 patients with COVID-19 came to our ED from the first to the 31<sup>st</sup> of August, 2021, among whom 580 (41%) had ambulatory care. A total of 82 (14.1%) patients were managed by the DMT, with a rate of ED readmission of 4.8% (4/82), compared with 13.6% (68/498) for those managed by EDPs ( $P < 0.001$ ). Focusing on the 45/498 (9.0%) patients requiring oxygen and managed by EDPs, the rate of ED readmission was 20%,  $P = 0.017$ . Prescription of the consensual treatment concerned 96% versus 40% for those patients requiring oxygen for the DMT and the EDP, respectively ( $P < 0.001$ ).

**Conclusion:** A DMT for ambulatory care of patients with COVID-19 requiring oxygen was associated with less return to the ED than usual practices.

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### Introduction

The current pandemic of COVID-19 infections has led to successive waves, depending on several factors such as host immunity and the viral variant of the SARS-CoV-2 (Hu *et al.*, 2021; Rahman *et al.*, 2021). The main target of the virus is the pulmonary tract, potentially leading to respiratory failure, especially in elderly patients and/or those with multiple comorbid conditions (McCullough *et al.*, 2021). The combination of a huge number of cases and the limited hospital resources, especially in terms of intensive care units (ICUs), led to the necessity of dedicated wards and sometimes dedicated hospitals (Borgen *et al.*, 2021; Ye *et al.*, 2021).

However, with growing experiences and management improvement of these patients, it became possible to propose new care models (Ramzi, 2022; Ye *et al.*, 2021), in particular when a new wave is detected early by epidemiological data. Moreover, an audit of clinical practices of our infectious diseases department during the first three waves in Guadeloupe showed two significant facts. First, 74% of the patients not requiring ICU had a length of hospital stay  $\leq 3$  days, and second, 17% of our patients were managed as outpatients with oxygen therapy. These data suggested that ambulatory management was possible in selected patients.

Based on these results and because the fourth wave of COVID-19 in our territory was exclusively due to the Delta variant of SARS-CoV-2, which was more contagious than previous variants (Hu *et al.*, 2021; Levine-Tiefenbrun *et al.*, 2021), we anticipated the risk of our hospital's saturation and proposed a dedicated medical team (DMT) for ambulatory care of patients with COVID-19 requiring oxygen. The aim of the study was to describe such an organization and its clinical impact on patient's outcomes.

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## Methods

This was a prospective, observational cohort conducted in the University Hospital of Guadeloupe (Pointe-à-Pitre, French West Indies), the reference hospital of the island for COVID-19.

### Ethics

This study was approved by the institutional review board of our institution (reference number A72\_13\_12\_21\_AMBCOVIDO2). The protocol was explained to the patients and/or their relatives, who approved the proposition of ambulatory care for their medical conditions, including the phone call until day 28.

### Study population

All adult patients (aged >18 years) included were hospitalized in the emergency department (ED) for a confirmed SARS-CoV-2 infection. Ribonucleic acid detection of SARS-CoV-2 was assessed by reverse transcription-polymerase chain reaction (RT-PCR) using nasopharyngeal swab.

All patients required oxygen therapy without exceeding 5 l/min.

All demographic, clinical, and biological data were collected in the patient's file.

Comorbidities were defined by their specific treatments prescribed to the patient before hospital care or if the diagnosis was newly established during the hospital stay.

Computed tomography (CT) scan analysis was performed at the physician's discretion, respecting the guidelines of the French Society of Thoracic Imaging (Ohana, 2020).

### Standard of care for COVID-19 in our hospital in August 2021

Patients with COVID-19 were treated following institutional protocols available through paper and electronic forms. In accordance with previous reports, parenteral dexamethasone was the single-steroid therapy used in the ED, and oral prednisolone (40 mg once daily) was proposed for patients with ambulatory care for no more than 7 days (Fadel et al., 2020; Jeronimo et al., 2021; RECOVERY Collaborative Group et al., 2021). Because Guadeloupe is an endemic area for *Strongyloides stercoralis* infection, all patients were also treated with a single dose of ivermectin to prevent hyperinfection syndrome (Nicolas et al., 2006; Nutman, 2017). Enoxaparin was used in the prevention of thromboembolism in the absence of renal insufficiency (defined by a creatinine clearance <30 ml/min), with a dosage related to the weight. In case of severe renal insufficiency, Calciparine was used (Susen et al., 2020). All patients were hydrated with intravenous fluid when necessary, had insulin therapy in case of diabetes, and gastric ulcer prevention with lansoprazole.

All these treatments were proposed for outpatients.

A consensual set of treatments was defined by the combination of oxygen + steroids + antithrombotic prophylaxis, considering that ivermectin was not an emergency drug prescription.

### Ambulatory care organization

The dedicated team, including one senior infectious diseases specialist and two residents in general medicine with clinical experience in handling COVID-19, worked from Monday to Friday, throughout August 2021, from 8 am to 6 pm, at the peak of the fourth COVID-19 wave in our territory. Every morning, the team was present in the ED to identify patients with confirmed SARS-CoV-2 infection requiring an oxygen therapy  $\leq 5$  l/min because this was the maximal delivery with at home concentrators.

The team had to evaluate the clinical severity of the patients, and those with a respiratory rate  $\geq 30$  and/or a chest CT scan showing  $\geq 50\%$  of pulmonary involvement should be excluded.

If the clinical evaluation of the patients allowed ambulatory care, the dedicated team had to obtain the family's and/or the patient's agreement for such a program before organizing the return home of the patients with home care services.

These services were in charge of putting in place home oxygen concentrators, monitoring equipment, and daily nursing services. They were informed of each component of the treatment in a face-to-face discussion together with the patient and/or their family. Also, for all patients, we tried to phone the family's practitioners to explain these ambulatory care perspectives.

A systematic short hospital report containing clinical, biological, and radiological data was given to the patients or their relatives, with a copy for the home care services. This report indicated a dedicated phone line, open 24 hours per day and 7 days per week, in case of worsened clinical conditions.

Our primary goal was to determine the rate of failure of such ambulatory care, defined by the need for readmission in our ED. To detect all readmissions, we used the patients' electronic records, especially those patients receiving care from ED physicians (EDPs).

This research also allowed us to analyze the missing opportunity for therapeutic means, such as neutralizing antibodies of SARS-CoV-2 (Weinreich et al., 2021). At the time of the study, this therapy was indicated for patients with a duration of the disease  $\leq 5$  days and not requiring oxygen therapy.

To know the outcome at home, the dedicated team systematically phoned the patients and/or their relatives by day 7 and day 28.

### Statistical analysis

The data were analyzed with StatView software version 5.0, and statistical significance was established at  $\alpha = 0.05$ . The continuous variables were compared with the Student's *t*-test or the Mann-Whitney test when appropriate. Proportions were compared with the chi-square test or Fisher's exact test when appropriate.

## Results

In August 2021, a total of 1397 patients with COVID-19 were admitted to our ED, among whom 580 (41%) had ambulatory care. At the time of the study, all cases were due to the Delta variant of SARS-CoV-2.

Among these, 82 patients (14%) requiring oxygen were managed by the DMT; the mean age was 59 years, with a sex ratio of male to female of 0.90. The main characteristics of these patients are indicated in Table 1. At least one comorbid condition was observed in 78%, the most frequent (40%) was hypertension. The mean duration of symptoms before ED admission was 9.3 days. The mean respiration rate at admission was 24/min.

A biological analysis was obtained for 62 (76%) patients, the mean C-reactive protein was  $104 \pm 69$  mg/l.

A chest CT scan was obtained for 50 (61%) patients, with less than 25% of pulmonary involvement for 27 (54%) patients. Three patients had a pulmonary embolism associated with minimal parenchymal disease.

In accordance with our inclusion criteria, all patients managed by the DMT required oxygen therapy, from 1–5 l/min (mean 2.3 l/min), delivered through a nasal catheter. All these patients went home with a consensual set of treatments. This ambulatory management was explained to the patient and their family in 77 (94%) cases. Of note, the dedicated line was used by three patients for clinical alterations, among whom one patient had to return to the ED for respiratory deterioration.

**Table 1**

Main characteristics of the patients managed by the DMT and those readmitted to the ED after ambulatory management by EDP.

Characteristics	DMT, n = 82 (%)	EDP, n = 68 (%)	P
Age (years)	59±13	55±14	0.076
Sex ratio (M/F)	0.90	0.78	0.673
<b>Underlying conditions</b>			
At least one comorbid condition	64 (78)	44 (65)	0.070
Hypertension	33 (40)	22 (32)	0.318
Diabetes	25 (30)	16 (24)	0.341
Obesity	19 (23)	12 (18)	0.405
Pulmonary diseases	8 (10)	9 (13)	0.503
Other comorbid conditions <sup>a</sup>	16 (20)	19 (28)	0.224
<b>Reasons for ED admission</b>			
Respiratory symptoms	73 (89)	10 (15)	< 0.001
Others <sup>b</sup>	9 (11)	58 (85)	
Duration of symptoms before admission	9.3±4.2	7.1±4.6	< 0.001
Respiration rate on admission (/min)	24±4	27±7	0.001
Respiration rate ≥ 30/min	7 (9)	25 (38)	< 0.001
<b>Chest CT scan on admission</b>			
Lung affected ≤ 25%	50 (61)	17 (25)	< 0.001
Lung affected 25 - 50%	27 (54)	11 (65)	0.441
Lung affected > 50%	16 (32)	4 (24)	0.721
Lung affected > 50%	7 (14)	2 (12)	> 0.999
<b>Pulmonary embolism</b>			
C-reactive protein (mg/l), n = 134	3 (4)	2 (3)	> 0.999
	104±69	74±58	0.040
<b>Treatments provided at home</b>			
Oxygen therapy	82 (100)	9 (13)	< 0.001
Steroid	82 (100)	13 (19)	< 0.001
Thrombosis prevention <sup>c</sup>	79 (96)	9 (13)	< 0.001
Consensual set of treatments	79 (96)	2 (3)	< 0.001
<b>Reasons for ED readmission</b>			
Respiratory failure	4 (5)	40 (59)	0.265
Other causes	0	28 (41)	
<b>Unfavorable outcome (death)</b>			
	3 (3.6)	11 (16.1)	0.019

<sup>a</sup> Other comorbid conditions (n = 35): 13 neuropsychiatric diseases, 12 vascular diseases, five active cancers, three inflammatory disorders, two chronic hepatitis.

<sup>b</sup> Other reasons for ED admission: acute fever and/or digestive symptoms and/or neurologic alterations.

<sup>c</sup> Three patients had previously a long-term anticoagulation treatmentCT, computed tomography; DMT, dedicated medical team; ED, emergency department; EDP, emergency department physicians; M/F, Male or female

The electronic medical records of all the patients admitted to our ED during the study's period allowed us to determine that 72/580 (12.1%) patients receiving ambulatory care had to be readmitted within 28 days, including four of 82 (4.8%) patients who managed by the DMT.

Among these four patients, three patients returned to the ED for respiratory failure on day 1, day 4, and day 10, respectively, after their first admission, and they finally died during the hospitalization of their acute respiratory distress. The patient who returned on day 4 had nearly 50% of pulmonary involvement on a chest CT scan. The fourth patient came back on day 3 for a pulmonary embolism despite prevention, considering that the patient did not have a chest CT scan on his first admission. Clinical follow-up until day 28 did not reveal late unfavorable outcomes.

As our aim was to determine the clinical impact of such an organization, we also studied the 68 patients managed by the EDP who were readmitted to the ED. Their main characteristics are described in Table 1. Obviously, patients managed by the DMT and those managed by the EDP did not present the same reasons for their first ED admission. Also, several parameters, such as comorbid conditions and severity criteria, were different between these two groups of patients with different managements. Of note, among the 68 readmitted patients managed by the EDP, 27/29 (93%) returned home during night duty care (from 8 pm to 8 am), compared with 41/121 (34%) patients managed during day-care,  $P < 0.001$ .

Because these patients readmitted to the ED were not comparable with those managed by the DMT, we focused on the 45 patients leaving the ED with oxygen therapy prescribed by the EDP in the same period of time: their main characteristics are reported in Table 2. We found that despite several comparable parameters at baseline, except a higher respiratory rate for patients managed

by the EDP, the consensual set of treatments was more frequently prescribed by the DMT than the EDP: 96% versus 40%,  $P < 0.001$ . Also, the rate for ED readmission was significantly lower in the first group: 4.8% versus 20.0%,  $P = 0.017$ .

## Discussion

Our study shows that the management of patients with COVID-19 requiring oxygen by a DMT was associated with less readmission in the ED than usual management by EDP.

The main limitation of our work is that we did not have an adequate control group due to emergency conditions caused by a dramatic fourth wave that overwhelmed our hospital. However, our data showed that patients managed by the DMT appeared more at risk of unfavorable outcomes than the patients managed by other physicians, with a trend for older age and more comorbid conditions. In contrast, our comparative data suggest that the severity of the disease, as suggested by a higher respiration rate over 30/min in the group managed by the EDP, was underdiagnosed, probably leading to an incomplete consensual set of treatments, early ED readmission, and unfavorable outcome.

To the best of our knowledge, no report evaluated such organization of ambulatory care for patients requiring oxygen. Previous studies reported that around 50% of patients with COVID-19 admitted to an ED presented with mild disease, allowing ambulatory care, in accordance with our own measurement (Borgen et al., 2021; Ramzi, 2022; Ye et al., 2021). However, in these studies, the rates of hospital readmission were over 10%, despite a low percentage of patients requiring oxygen (<5%). Nevertheless, they were realized before the favorable assessment of steroid use for COVID-19 pneumonia (Fadel et al., 2020; RECOVERY Collaborative Group et al., 2021), and the thromboembolic prevention was not described.

**Table 2**

Comparison of the ambulatory patients with COVID-19 pneumonia, all requiring oxygen, managed by the DMT or by the EDPs. For the patients readmitted in the ED, the values concerned their first admission.

Characteristics	DMT, n = 82 (%)	EDPs, n = 45 (%)	P
Age (years)	59±13	62±13	0.197
Sex ratio (M/F)	0.90	0.95	0.886
<b>Underlying conditions</b>			
At least one comorbid condition	64 (78)	27 (60)	0.030
Hypertension	33 (40)	17 (38)	0.785
Diabetes	25 (30)	13 (29)	0.850
Obesity	19 (23)	6 (13)	0.182
Pulmonary diseases	8 (10)	2 (4)	0.470
Other comorbid conditions	16 (20)	9 (20)	0.947
<b>Reasons for ED admission</b>			
Respiratory symptoms	73 (89)	37 (82)	0.281
Others	9 (11)	8 (18)	
Duration of symptoms before admission	9.3±4.2	8.7±3.6	0.757
Respiration rate on admission (/min)	24±4	28±7	< 0.001
Respiration rate ≥ 30/min	7 (9)	13 (31)	0.002
<b>Chest CT scan on admission</b>			
Lung affected ≤ 25%	50 (61)	24 (53)	0.403
Lung affected 25 - 50%	27 (54)	9 (37)	0.183
Lung affected > 50%	16 (32)	10 (41)	0.414
	7 (14)	5 (21)	0.455
<b>Pulmonary embolism</b>			
C-reactive protein (mg/l), n = 134	3 (4)	2 (7)	0.967
	104±69	94±55	
<b>Treatments</b>			
Steroid	82 (100)	22 (49)	< 0.001
Thrombosis prevention	79 (96)	22 (49)	< 0.001
Consensual set of treatments	79 (96)	18 (40)	< 0.001
<b>Readmission to ED</b>			
	4 (4.8)	9 (20.0)	0.017
<b>Reasons for ED readmission</b>			
Respiratory failure	4 (5)	6 (67)	0.510
Other causes	0	3	
Unfavorable outcome (death)	3 (3.6)	1	

CT, computed tomography; DMT, dedicated medical team; ED, emergency department; EDP, emergency department physician; M/F, Male or female

In a large retrospective study including 621 patients with COVID-19 pneumonia managed with ambulatory care, the rate of hospital readmission was 8.5% at day 30, and ultimately, 1.3% of the patients died. However, the ambulatory management was established in the ED for 149 (24%) patients only and after a hospitalization stay for 472 (76%) patients (Banerjee et al., 2021). Also, the therapeutic means for COVID-19, as discussed previously, were not described, except oxygen therapy.

We observed a relationship between the prescription of an incomplete set of treatments for COVID-19 pneumonia and the ED readmission (see Table 1). Even when the patients required oxygen for COVID-19 pneumonia, the complete set of treatments was not systematically prescribed (see Table 2). This shortcoming could be explained by inadequate knowledge of internal guidelines and/or a high turn-over of EDP with heterogeneous practices during COVID-19 waves, this last point is even increased with physicians' reinforcements from mainland France. Our results suggest that the management of COVID-19, which depends on the stages of the illness (early viral vs late inflammatory stages), needs an audit with feedback, as recommended in antimicrobial stewardship policy (Dutey-Magni et al., 2021).

Finally, how ivermectin, which is systematically associated with other ambulatory treatments in our clinical practice, played a role in our low rate of ED readmission, could still be debated (Rajter et al., 2021).

The favorable outcome associated with the ambulatory management of patients with COVID-19 pneumonia has two major advantages. First, it will preserve acute care access for patients with the most severe conditions. Accordingly, for the next wave on our territory, we have planned to reinforce both the DMT and the coordination between hospital practitioners and providers of home care, with medical service 7 days per week. Of note, by the end of the study period, five patients could not benefit from ambulatory care

because all available oxygen concentrators were used. Second, by limiting the number of hospitalized patients with active COVID-19 infection, it is possible to reduce nosocomial transmission of SARS-CoV-2 to hospitalized patients and health care workers. Therefore, it is crucial to explain the hygiene rules to the patients and their families to reduce viral transmission at home (McCullough et al., 2021).

Lastly, a cost-effectiveness analysis for such hospital organizations with a DMT should be performed precisely. In a preliminary approach, we remind that in the current French social security system, the mean cost for 1 day of hospitalization in a non-ICU medical department is 1370 € (including most drug costs), compared with 140 € for ambulatory care at home (without drug costs). Of note, the mean (± SD) duration of hospital stay for COVID-19 pneumonia among 279 patients during the third wave was 7.8 ± 6.6 days [unpublished data].

In conclusion, the DMT for ambulatory care of patients with COVID-19 pneumonia requiring oxygen was associated with a low rate of ED readmission. Further studies will determine the optimal set of treatments and their duration with such care. Finally, the clinical assessment of patients with COVID-19 and their therapeutic means need to be audited.

#### Declaration of Competing Interest

The authors have no competing interests to declare.

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## Ethics approval

Audits are sponsored by the French National Health Agency. In accordance with national directives, patient privacy was protected; no personal data were extracted or copied from the electronic medical records.

## Author contributions

S.V., L A-M., P-M.R, D.D., T.F., and P.P. contributed to the study design. P-M.R. and S.V. contributed to the statistical analysis; S.M., S.V., and P-M.R. contributed to the writing of the article; S.V., L.A-M, and P-M.R. contributed to the study design and patient inclusion.

## Availability of data and material

The data used during the current study are available from the corresponding author on reasonable request.

## Code availability

StatView software version 5.0.

## Consent for publication

All authors have read the paper and consent to its publication.

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