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Early View

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Research Letter

Home-monitoring reduced short stay admissions in suspected COVID-19 patients: COVID-box project

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Most COVID-19 cases can be managed in the outpatient setting, however approximately 10-15% deteriorate and require hospitalization.[1, 2] Worldwide, including the Netherlands, the COVID-19 pandemic causes severe pressure on the national healthcare system and laboratory testing capacity.[3] Home-monitoring has been suggested as potentially beneficial to monitor (suspected) COVID-19 patients while reducing hospital admissions and viral exposure to healthcare workers.[4] We performed a retrospective single-center case-control study on the implementation of a home-monitoring programme of suspected COVID-19 patients presenting to the Emergency Department (ED) of the Leiden University Medical Center (LUMC, the Netherlands). Home-monitoring in this study, refered to the clinical pathway (the COVID-box project) in which patients were given tools and devices (blood pressure monitor, pulse oximeter, thermometer and concomitant instructions) upon discharge from the ED to monitor their vital parameters at home three times a day combined with daily teleconsultations (preferably videoconsultations) carried out by a healthcare professional, as extensively reviewed elsewhere.[5] The healthcare professional was a nurse practitioner or resident supervised by a medical specialist. When patients arrived home, e-health consultants contacted patients to ensure digital on-boarding of patients, giving instructions and guidance for adequate use of the devices. Thereafter, daily teleconsultations were conducted to assess patients' symptoms and vital parameters based upon which an indication for reassessment at the ED was made. Also, patients were given the possibility to actively contact our healthcare professionals in case of deviating measurements from personalized target values or progressive complaints. When reassessment was indicated, patients were seen at the ED of the LUMC. Home-monitoring ended when patients recovered or were (re)admitted to the hospital.

In this study, our source population consisted of all patients that visited the ED from March 1st through June 15th 2020 and who were suspected of COVID-19, i.e. had flu-like symptoms and/or at least one diagnostic test for COVID-19 performed (e.g. nasopharyngeal swab and/or Computed Tomography (CT)-scan). Physicians were given the possibility to allocate home-monitoring to patients suspected for COVID-19. Allocation was based on physicians' clinical judgement for patients with moderate symptoms or underlying comorbidities posing patients at risk for worse prognosis.[6] To assess the effect of implementing a home-monitoring system, we matched each patient discharged with home-monitoring to two control patients who were discharged without home-monitoring. Propensity-score matching (PSM) analysis was performed to match cases to controls in a 1:2 ratio using R statistical software 4.0.3.[7] We used nearest neighbor PSM without replacement with a propensity score estimated using logistic regression of the group on the covariates: nasopharyngeal swab, CT scan, age, sex, Charlson comorbidity index[8], chronic obstructive pulmonary disease,

diabetes mellitus, chronic kidney disease and immunocompromised state.[6] This study was approved by our local medical ethics committee and did not allow accessing EMRs of other hospitals.

In total 55 patients with home-monitoring were compared to 110 matched patients discharged without home-monitoring (table 1). As primary outcome, the number of total hospital admissions for related to COVID-19 after visiting the ED within 28 days of follow-up was assessed and demonstrated 9% hospitalizations (5/55 patients) in the home-monitoring group compared to 27% (30/110 patients) the control group. This equals to a risk ratio of 0.27 (95%CI 0.097-0.733; p=0.007) for hospitalization. The median duration of home-monitoring was 4 days [IQR 3-7]. Noteworthy, 25/30 (83%) admissions in the control group could be classified as 'short-stay admissions', i.e. less than 24 hours.
As secondary endpoints we observed that 47 home-monitored patients (85%) completed the follow-up duration of 28 days without ED reassessment compared to 76 patients (69%) in the control-group (p=0.023). We calculated that the bed occupancy was 20 days per 100 patients discharged with home-monitoring compared to 47 days per 100 patients discharged without home-monitoring, equal to a 58% reduction.

The present study is the first controlled study demonstrating the effectiveness of home-monitoring for suspected COVID-19 patients to reduce hospitalizations. In a systematic literature search 16 relevant studies have reported on different concepts of home-monitoring in patients with suspected/confirmed COVID-19 infection. Taken all reports together, 92% [IQR 83-96] of the patients could stay at home while surveyed with home-monitoring and 5% [IQR 2-10] required hospital admissions. Altogether, reported studies confirm the safety of home-monitoring for suspected as wel as established COVID-19 patients. The low frequency of hospital admissions further corroborated our observation that hospital admission can be reduced with home-monitoring strategies.

It is important to note that the positive results of our study were largely explained by a reduction in so-called "short stay admissions", i.e. less than 24 hours. An in-depth analysis showed that 9/25 (36%) did not receive any treatment or received only oral antibiotics. Both compatible with the assumptions that these patients could have been managed through-home-monitoring. In 12/25 (48%) of short stay admissions oxygen supplementation was given and tapered within 24 hours, illustrating the heterogeneity of the indication to start oxygen therapy. It is plausible that the latter can potentially be replaced or influenced by the option of home-monitoring. Not unimportant, home-monitoring indirectly reduces viral

exposure for healthcare workers and other non-COVID patients which is an invisible benefit during the current pandemic.

In our study, the number of COVID-19 confirmed cases was higher in the home-monitoring group despite the equal frequency of COVID-19 diagnostics performed. The difference of confirmed COVID-19 cases between the groups is likely due to physicians' adequate risk-assessment of patients with suspected symptoms. For our study, it re-affirms the effectiveness of home-monitoring to reduce hospitalization rate despite the overrepresentation of COVID-19 patients in the home-monitoring group. However, we need to be careful in drawing definitive conclusions on the efficacy of home-monitoring for *confirmed* COVID-19 infection.

The low number of (re)admissions and the high proportion of patients surveyed at home are encouraging results for healthcare providers to consider strategies of home-monitoring. Our study provides evidence that home-monitoring can indeed bring relief to the burden that the COVID-19 pandemic puts on hospitals. However, implementation of home-monitoring is not without costs and efforts when hospital management teams want to consider implementing a home-monitoring strategy. Our local clinical practice of home-monitoring of patients after myocardial infarction or kidney transplantation were the base to extend home-monitoring to suspected COVID-19 patients at a time that the COVID-testing capacity was limited in the Netherlands.[9, 10] The latter, together with the retrospective approach of the study, were a limitation to the study. Therefore, our study addressed these issue by employing a propensity score-matching case-control design based on the diagnostic tests conducted and the comorbidities that could have influenced the clinical outcome of patients. Importantly during this period of shortages, diagnostic testing with nasopharyngeal swabs and CT scans would indicate a strong suspicion of COVID-19 infection.

In conclusion, we demonstrated the potential of home-monitoring to reduce hospital admissions by safely surveying clinical symptoms and vitals. These encouraging results should be further corroborated in larger patient groups and notably in patients with a confirmed COVID-19 diagnosis.

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Table 1. Characteristics of suspected COVID-19 patients at the emergency department (propensity score-matched)

	Home monitoring (n = 55)	No home monitoring (n = 110)	P-value
Age	61 [45-69]	59 [46-70]	0.909
Sex			
Female	27 (49%)	53 (48%)	0.912
Medical history			
Charlson comorbidity index	3 [1-6]	3 [1-5]	0.989
Hypertension	22 (40%)	36 (33%)	0.356
Diabetes mellitus	4 (7%)	6 (5%)	0.733
Coronary heart disease	0 (0%)	13 (12%)	0.005
Chronic obstructive pulmonary disease	8 (15%)	13 (12%)	0.620
Malignancy	17 (31%)	40 (36%)	0.487
Chronic kidney disease	6 (11%)	12 (11%)	1.000
Immunocompromised	23 (42%)	44 (40%)	0.823
COVID-19 diagnostics			
Nasopharyngeal swabs	44 (80%)	85 (77%)	0.689
CT scan	18 (33%)	35 (32%)	1.000
Performed COVID-19 diagnostics	46 (84%)	90 (82%)	0.772
COVID-19 outcomes			
Nasopharyngeal swab positive	13 (24%)	7 (6%)	0.002
CORADS≥4	8 (15%)	3 (3%)	0.004
Confirmed COVID-19	16 (29%)	9 (8%)	<0.001

(continued)	**Home monitoring (n = 55)**	**No home monitoring (n = 110)**	**P-value**
Primary outcomes			
Hospital admission (total)	5 (9%)	30 (27%)	**0.007**
Short stay admission	0 (0%)	25 (23%)	**<0.001**
Length of home monitoring (days)	4 [3-7]	-	**-**
Secondary outcomes			
Stayed at home	47 (85%)	76 (69%)	**0.023**
Bed occupancy (days per 100 patients)	20	47	