Remote patient monitoring in COVID-19: a critical appraisal

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To the Editor:

With great interest, we read the article by GRUTTERS *et al*. [1], in which they share their results of the largest patient cohort of coronavirus disease 2019 (COVID-19) home monitoring to date. Based on these results, remote patient monitoring (RPM) was praised and was claimed as a tool to reduce the hospital stay of COVID-19 patients by 5 days.

The SARS-CoV-2 virus infected 237 million people by October 2021, leading to 4.8 million deaths worldwide [2]. On average, 5–15% of SARS-CoV-2-infected patients required hospitalisation, causing a tremendous overload on the healthcare system in nearly every country [3, 4]. During the emerging healthcare crisis, we developed and implemented an RPM programme to facilitate the early discharge of COVID-19 patients admitted to the pulmonology ward. At the time, the goal of this project was purely clinical, not scientific. However, RPM programmes have gained significant popularity and have been implemented in many centres to alleviate the healthcare system overload and avoid hospital admissions, or facilitate discharge in patients with COVID-19 or suspected COVID-19 infection [1, 5–9]. These experiences have led to several claims about the results of this powerful modality [1, 8]. We have retrospectively analysed our experiences with the RPM of COVID-19 and would like to share our findings that may help put some of these claims into context.

At the beginning of the COVID-19 pandemic in Belgium in April 2020, we implemented an RPM programme to facilitate early discharge of patients admitted to the pulmonology ward with a COVID-19 infection, with or without previous intensive care unit (ICU) stay. Invitation to the RPM programme was left to the discretion of the clinician. The invited patient population consisted of patients ready for discharge requiring prolonged oxygen therapy or suffering anxiety to return home. The RPM programme allowed monitoring patients' vital parameters at home, registering symptoms with a standardised questionnaire, and allowing interaction with the monitoring team through a "free text box" or telephone. Patients or family were instructed to measure their heart rate, blood pressure, respiratory rate, blood oxygen saturation and body temperature three times daily using an automated blood pressure monitor, a portable fingertip saturation probe and a thermometer. The patient registered their parameters on a secure hospital server which they could access with a personal login and password. At each registration, patients were asked to grade their dyspnoea on a Borg scale (0 "no dyspnoea", to 10 "maximal dyspnoea"), to report whether they had fever during the last 24 h, and to comment on their general condition (better, unchanged, worse). Patients could also pose questions to the telemonitoring team in a free text box at any moment. The RPM data were read and interpreted by specialised telemonitoring nurses who contacted the patient by phone if a deterioration of vital signs or symptoms was noted or if the patient wrote remarks or questions in the free text box. Whenever deemed necessary, the nurse consulted with the pulmonologist. Prior experience of our hospital RPM team was mainly in the field of cardiology and gynaecology [10, 11]. Patients were allowed to self-manage the duration of their RPM. They were asked to return the pulse oximeter when they felt better and re-engaged in their daily activities. Patients who stopped recording measurements for 2 days were asked to return the equipment or to continue recording.

We included all COVID-19 patients discharged with RPM from the hospital Ziekenhuis Oost-Limburg, Genk, Belgium, during the first wave between 8 April and 9 May, 2020 (30 days). Statistical analysis of this data was performed using the statistical program SPSS version 27.0 (Chicago, IL, USA). As appropriate, comparisons were made using one-way analysis of variance, the Kruskall–Wallis H-test or the Pearson's chi-squared test. Statistical significance was always set at a two-tailed probability level of <0.05.

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The study complied with the Declaration of Helsinki and was approved by the ethical review board of Ziekenhuis Oost-Limburg (Genk, Belgium).

During this period, 181 patients hospitalised for a COVID-19 infection were discharged home. 47 patients were discharged with RPM, and 134 patients were discharged without RPM. The mean±SD age was 56±13 years in the RPM group compared to 73±14 years in all other patients ($p<0.001$). Thus, patients who received RPM were younger and suffered less chronic lung disease and chronic kidney disease than those without RPM. The baseline characteristics of both groups are shown in table 1. There was no difference in hospital or ICU stay duration, oxygen therapy during hospitalisation, or oxygen therapy at discharge between both groups. The median (interquartile range) length of stay in the RPM group was 9 (4–14) days, 30% were hospitalised in the ICU, and 4% had been intubated. 34% required oxygen therapy at discharge at a mean flow of 1±1 $L \cdot min^{-1}$ in this group. After discharge, all patients that engaged in the RPM programme performed at least three measurements. The median RPM time (time between discharge and last RPM measurement) was 10 (5–36) days. Compliance was highest during the first days of RPM patients. From day one to day four, 91% of the patients performed at least one daily measurement, and 68% performed all three. After day 5, compliance declined significantly. The longest RPM time was 75 days. A total of 1259 measurements were registered, of which 5% triggered a phone call by a specialised nurse and 2% triggered a phone call by a physician. During the first month after discharge or during the entire RPM time, 4% of patients were readmitted and 9% visited an emergency department in the RPM group, compared to 10% and 15% in the unmonitored group, respectively ($p=0.20$ and $p=0.27$).

TABLE 1 Patient characteristics and results of the COVID-19 remote patient monitoring programme

	Remote patient monitoring	No remote patient monitoring	p-value
Demographics			
Subjects	47	134	
Age, years	56 (±13)	73 (±14)	**<0.001**
Male	28 (60%)	68 (50%)	0.25
BMI, $kg \cdot m^{-2}$	30 (±6)	29 (± 5)	0.51
Medical history			
Arterial hypertension	15 (32%)	59 (44%)	0.15
Chronic kidney disease	1 (2%)	38 (28%)	**0.01**
Chronic lung disease	3 (6%)	29 (22%)	**0.02**
Congestive heart failure	6 (13%)	24 (18%)	0.41
CVA/TIA	3 (6%)	15 (11%)	0.34
Diabetes	8 (17%)	42 (31%)	0.06
Hospitalisation			
Length of stay, days	9 (4–14)	11 (6–17)	0.12
Admission to intensive care	14 (30%)	27 (20%)	0.17
Length of stay on intensive care, days	8 (5–18)	7 (5–10)	0.43
Oxygen therapy during hospitalisation			
Nasal oxygen or non-rebreather mask	25 (51%)	60 (45%)	0.32
NIV or high flow oxygen therapy	13 (28%)	23 (17%)	0.12
Intubation	2 (4%)	9 (7%)	0.54
Oxygen therapy when discharged	16 (34%)	34 (25%)	0.25
Oxygen flow, $L \cdot min^{-1}$	1 (1–2)	1 (1–2)	0.75
Remote patient monitoring			
Total measurements	1258		
Total alerts	59 (5%)		
Alerts requiring physician attention	19 (2%)		
Oxygen therapy at end of RPM	4 (9%)		
Duration of RPM, days	10 (5–36)		
Measurements per patient	20 (13–33)		
Outcome			
Readmissions	2 (4%)	14 (10%)	0.20
ED visits	4 (9%)	20 (15%)	0.27

Normally distributed data are presented as mean±SD. Non-normally distributed data are presented as median and interquartile range. Categorical data are presented as numbers and proportions. BMI: body mass index; CVA: cerebrovascular accident; TIA: transient ischaemic attack; NIV: non-invasive ventilation; ED: emergency department.

These results should be interpreted with great caution since this is not a randomised controlled trial. Patients in the RPM were younger and tended to have fewer comorbidities than COVID-19 patients who were not included in the RPM programme. Therefore, the RPM population is a subgroup of the COVID-19 patients. This causes a potential bias when comparing RPM results with unmonitored COVID-19 patients. In the studies of Grutters *et al*. [1] and O'Carroll *et al*. [8], the clinical characteristics of the RPM groups were very similar to our RPM group for age and comorbidities, but the characteristics of unmonitored COVID-19 patients were not disclosed in these studies. The inclusion of elderly patients in RPM trials is essential since this high-risk group might benefit the most. In our experience, 19% of the RPM patients were older than 65 years, and the oldest patient was 84 years. Digital literacy is a critical threshold that should be overcome by simplifying the RPM programme and allowing relatives to assist in the RPM tasks. In the study of Grutters *et al*. [1], the conclusion that RPM reduces hospital stay of COVID-19 patients by 5 days is premature, since there was no control group to benchmark these results. In our observational study, we did not see a significant difference in hospital length of stay. Also, the trend towards fewer emergency department visits and readmissions in the RPM group was not statistically significant. Again, the same reservations apply; this was not a randomised controlled trial. This project was not designed to evaluate the benefit of RPM but was instead a modality to facilitate the discharge of COVID-19 patients during an acute healthcare crisis.

However, we share the vision of Grutters *et al*. [1] that RPM has the potential to reduce the hospital length of stay of COVID-19 patients and possibly reduces emergency visits and readmission rates. We believe RPM is an essential tool to cope with the shortage of hospital beds, especially when the health system is challenged. This study demonstrates that RPM can facilitate a safe discharge home after a short or prolonged hospitalisation for COVID-19 and can assist patients in tapering home oxygen therapy. However, the assumed benefits of RPM (shorter hospitalisations, fewer readmissions, and safe tapering of home oxygen therapy) should be confirmed in randomised controlled trials before developing reimbursement strategies for RPM by healthcare payers [12].

In conclusion, our experience demonstrates that an RPM programme, monitoring vital parameters and symptoms, implemented at a moment of sanitary crisis, facilitated discharge and tapering of home oxygen therapy with few readmissions in COVID-19 patients. In addition, this paper puts the results of other RPM programmes in similar patient cohorts in perspective and stresses the need for randomised controlled trials to evaluate the benefit of RPM.

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