

# Patient-reported outcomes measures (PROMs) and patient-reported experience measures (PREMs) of COVID-19 telerehabilitation

## Prospective pilot program

Jaume Bordas-Martinez, MD<sup>a</sup> , Lluís Matéu Gómez<sup>b</sup>, David Cámara Menoyo<sup>b</sup>, Marta López-Sánchez, MD, PhD<sup>a</sup>, Salud Santos, MD, PhD<sup>a,\*</sup>, Maria Molina-Molina, MD, PhD<sup>a</sup> , Rosa Planas, MD<sup>c</sup>

### Abstract

Telemedicine is proving to be a useful tool in the telemonitoring of respiratory patients and telerehabilitation programs. The use of telemedicine has been proposed by the main medical societies because of the limited resources and the healthcare workers infection risk in the Coronavirus Disease 2019 (COVID-19) pandemic.

The aim of this pilot program is to evaluate the feasibility of COVID-19 telerehabilitation program from the hospital to the home with clinical, functional and patient satisfaction outcomes. Rehabilitation was initiated in the hospital by a physiotherapist and complemented by “Estoi” (a mobile application), which was continued at home with telemonitoring and messaging with the medical team. Patients’ habitual use of smartphones was not queried for inclusion.

Sixteen patients were consecutively enrolled, 47% women with a mean age of 63 years old. 50% of patients completed  $\geq 15$  rehabilitation sessions. In total, 88% of patients referred that the mobile application incentive them to do more physical therapy, and 63% would choose telerehabilitation instead of center-based rehabilitation for new rehabilitation programs. Patient satisfaction (0–10) for the mobile application was 8.4 and 8.9 for the telerehabilitation program.

Beginning telerehabilitation in the hospital could increase the efficacy and efficiency of physical therapy, which is safe for patients and healthcare workers. Following at home, this telerehabilitation program seems to encourage and empower patients who have reported high satisfaction. Further randomized studies with larger numbers of patients and multicenter studies are required to evaluate these results.

**Abbreviations:** COVID-19 = coronavirus disease 2019, PROMs = patient-reported outcomes measures, PREMs = patient-reported experience measures, PEP = positive expiratory pressure, SD = standard deviation, IQR = interquartile range.

**Keywords:** COVID-19, mHealth, PREMs and PROMs, rehabilitation, smartphone application, telemedicine, telerehabilitation

## 1. Introduction

Rehabilitation of patients hospitalized for COVID-19 pneumonia is recommended to be initiated in the early hospital phase and continued at home after hospital discharge.<sup>[1,2]</sup> However, some experts mentioned that comprehensive rehabilitation programs may not be available due to resource limitations during the COVID-19 pandemic.<sup>[1]</sup> Telemedicine has proved as a useful tool in rehabilitation<sup>[3,4]</sup> and offers many opportunities in the COVID-19 era.<sup>[5]</sup>

The use of smartphones in rehabilitation is increasing rapidly in the last few years.<sup>[6]</sup> Elderly age, educational level, and

resistance to change are well-known barriers to adopting telemedicine.<sup>[7]</sup> However, the COVID-19 pandemic has contributed to overcoming these barriers to standardize the use of smartphones in telemedicine.<sup>[8]</sup> The new opportunities provided by smartphones such as real-time video calling, stimulating and tracking adherence to rehabilitation, telemonitoring of symptoms for the early management of exacerbations as well as online personalization of rehabilitation programs have made smartphones a great partner in rehabilitation.<sup>[6]</sup> Hence, rehabilitation programs using smartphones are achieving promising results.<sup>[4,5,9]</sup>

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The datasets generated during and/or analyzed during the current study are publicly available.

<sup>a</sup> Respiratory Department, Bellvitge University Hospital, IDIBELL, University of Barcelona, Hospitalet de Llobregat (Barcelona), Spain, <sup>b</sup> Physiotherapist, Rehabilitation department, Bellvitge University Hospital, IDIBELL, University of Barcelona, Hospitalet de Llobregat (Barcelona), Spain, <sup>c</sup> Rehabilitation department, Bellvitge University Hospital, IDIBELL, University of Barcelona, Hospitalet de Llobregat (Barcelona), Spain.

\*Correspondence: Maria Molina-Molina, ILD Unit, Respiratory Dpt., University Hospital of Bellvitge, IDIBELL, Hospitalet de Llobregat, Barcelona 08907, Spain (e-mail: mariamolinalolina@hotmail.com).

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**Table 1**  
Patient features, PREMs, PROMs, lung function test, and 6-minutes walking distance.

| Gender  | ID1   | ID2   | ID3       | ID4     | ID5       | ID6   | ID7       | ID8       | ID9       | ID10   | ID11   | ID12   | ID13      | ID14  | ID15      | ID16      |
|---|-------|-------|-----------|---------|-----------|-------|-----------|-----------|-----------|--------|--------|--------|-----------|-------|-----------|-----------|
|   | Woman | Woman | Man       | Man     | Man       | Woman | Man       | Man       | Woman     | Man    | Man    | Man    | Woman     | Woman | Woman     | Woman     |
| Age   | 61    | 69    | 57        | 61      | 58        | 72    | 56        | 71        | 68        | 57     | 53     | 55     | 58        | 70    | 65        | 76        |
| Educational level   | No HS | No HS | HS & AD   | HS & AD | HS & AD   | No HS | HS & AD   | No HS     | No HS     | C & GD | C & GD | C & GD | C & GD    | No HS | No HS     | No HS     |
| Regular previous use of mobile phones   | No    | No    | Yes       | Yes     | Yes       | No    | Yes       | Yes       | Yes       | Yes    | Yes    | Yes    | Yes       | No    | No        | Yes       |
| Completed physical therapy sessions using app (n <sup>o</sup> )                           | 1-15  | ≥15   | 0         | ≥15     | ≥15       | 1-15  | ≥15       | 1-15      | ≥15       | ≥15    | 1-15   | ≥15    | ≥15       | 1-15  | 0         | 0         |
| Clinical follow-up sent using app (n <sup>o</sup> )                                       | ≥15   | 1-15  | 0         | ≥15     | 1-15      | 1-15  | ≥15       | 1-15      | 1-15      | ≥15    | 1-15   | ≥15    | 1-15      | 1-15  | 0         | ≥15       |
| Messages sent using the app (n <sup>o</sup> )   | 0     | 1-9   | 0         | >10     | 0         | 1-9   | 1-9       | 0         | 0         | >10    | 1-9    | >10    | 1-9       | 1-9   | 0         | 1-9       |
| Changes in medical treatment or rehabilitation program due to telemonitoring at discharge | No    | Yes   | No        | Yes     | No        | Yes   | No        | No        | No        | Yes    | Yes    | Yes    | No        | No    | No        | No        |
| PROMs   |       |       |           |         |           |       |           |           |           |        |        |        |           |       |           |           |
| EQ-VAS before COVID19 infection   | 10    | 9     | 8         | 10      | 10        | 8     | 10        | 10        | 10        | 10     | 10     | 10     | 8         | 10    | 10        | 8         |
| EQ-VAS after COVID19 at 8 weeks of hospital discharge                                     | 6     | 5     | 6         | 7       | 7         | 8     | 7         | 8         | 7         | 9      | 7      | 7      | 7         | 4     | 6         | 7         |
| mMRC before COVID19 infection   | 0     | 1     | 1         | 0       | 0         | 1     | 0         | 0         | 0         | 0      | 0      | 0      | 1         | 0     | 0         | 0         |
| mMRC after COVID19 at 8 weeks of hospital discharge                                       | 1     | 2     | 1         | 2       | 0         | 1     | 1         | 1         | 1         | 1      | 0      | 2      | 1         | 3     | 1         | 0         |
| Lung function test and 6-minutes walking distance at 8 weeks of hospital discharge        |       |       |           |         |           |       |           |           |           |        |        |        |           |       |           |           |
| BMI   | 28.8  | 31.8  | NA*       | 30.4    | 20.4      | 22    | 27.2      | 30.4      | 27.8      | 29.7   | 28.7   | 26     | 27.6      | 26.8  | 28.4      | 32        |
| FVC (ml)  | 2600  | 2220  | NA*       | 2360    | 2290      | 1600  | 4490      | 2830      | 2330      | 3780   | 1620   | 4500   | 3120      | 1520  | 2190      | 1780      |
| FVC (%)   | 107   | 75    | NA*       | 60      | 51        | 71    | 100       | 79        | 94        | 108    | 43     | 102    | 122       | 75    | 94        | 99        |
| FEV1 (ml)   | 2080  | 2090  | NA*       | 2070    | 2220      | 1350  | 3690      | 2010      | 1970      | 2980   | 1440   | 3700   | 2430      | 1300  | 1890      | 1420      |
| FEV1 (%)  | 102   | 88    | NA*       | 67      | 62        | 73    | 104       | 73        | 95        | 106    | 47     | 107    | 113       | 79    | 98        | 103       |
| FEV1/FVC  | 80    | 75.9  | NA*       | 75.6    | 97        | 75.4  | 82.2      | 71        | 84.4      | 76.9   | 89.2   | 72.23  | 78        | 85.7  | 86.5      | 74.6      |
| DLC0 (ml/min/mm Hg)   | 16.6  | 13    | NA*       | 11      | NA        | 8.9   | 16.7      | 15.7      | 14.6      | 27.3   | 3      | 5.56   | 21.3      | 9.3   | 10.5      | 10.5      |
| DLC0 (%)  | 79    | 56    | NA*       | 41      | NA        | 45    | 55        | 64        | 69        | 111    | 11     | 59     | 98        | 50    | 52        | 60        |
| KCO (%)   | 97    | 90    | NA*       | 87      | NA        | 82    | 76        | 79        | 107       | 119    | 17     | 68     | 98        | 64    | 83        | 88        |
| 6MWD O2 added (L/min)   | 0     | 0     | NIW       | 3       | NIW       | 3     | 0         | 0         | 0         | 0      | NIW    | NA     | 0         | NIW   | 0         | 0         |
| 6MWD SpO <sub>2</sub> minimum (%)   | 96    | 91    | NIW       | 86      | NIW       | 96    | 93        | 87        | 94        | 94     | NIW    | NA     | 95        | NIW   | 90        | 94        |
| 6MWD distance (m)   | 440   | 308   | NIW       | 360     | NIW       | 300   | 410       | 310       | 175       | 540    | NIW    | NA     | 457       | NIW   | 300       | 328       |
| PREMs   |       |       |           |         |           |       |           |           |           |        |        |        |           |       |           |           |
| I am satisfied with the follow-up   | Yes   | Yes   | Yes       | Yes     | Yes       | Yes   | Yes       | Yes       | Yes       | Yes    | Yes    | Yes    | Yes       | Yes   | Yes       | Yes       |
| Access to health professionals has been easy  | Yes   | Yes   | Partially | Yes     | Yes       | Yes   | Yes       | Yes       | Yes       | Yes    | Yes    | Yes    | Yes       | Yes   | Yes       | Partially |
| I felt safe with the confidentiality of my data   | Yes   | Yes   | Yes       | Yes     | Yes       | Yes   | Yes       | Yes       | Yes       | Yes    | Yes    | Yes    | Yes       | Yes   | Yes       | Yes       |
| Physiotherapy telemedicine follow-up has helped my recovery                               | Yes   | Yes   | Yes       | Yes     | Partially | Yes   | Yes       | Partially | Partially | Yes    | Yes    | Yes    | Yes       | Yes   | Yes       | Yes       |
| The follow up through the mobile application has made me do more physical therapy         | Yes   | Yes   | No        | Yes     | Yes       | Yes   | Partially | Partially | Yes       | Yes    | Yes    | Yes    | Partially | Yes   | No        | Yes       |
| I would have preferred center-based rehabilitation program                                | No    | No    | Yes       | No      | Yes       | No    | No        | Partially | Yes       | No     | Yes    | No     | No        | No    | Partially | No        |
| I would use this telemedicine app again and recommend it to others                        | Yes   | Yes   | No        | Yes     | Yes       | Yes   | Yes       | Yes       | Yes       | Yes    | Yes    | Yes    | Yes       | Yes   | No        | Yes       |
| Satisfaction  |       |       |           |         |           |       |           |           |           |        |        |        |           |       |           |           |

(Continued)

**Table 1**  
**(Continued)**

| Gender  | ID1   | ID2   | ID3        | ID4 | ID5 | ID6   | ID7 | ID8 | ID9   | ID10 | ID11 | ID12 | ID13  | ID14  | ID15       | ID16  |
|---|-------|-------|------------|-----|-----|-------|-----|-----|-------|------|------|------|-------|-------|------------|-------|
|   | Woman | Woman | Man        | Man | Man | WoMan | Man | Man | Woman | Man  | Man  | Man  | Woman | Woman | Woman      | Woman |
| Satisfaction with the mobile application (0 none -10 maximum)                                 | 10    | 10    | No opinion | 7   | 7   | 10    | 8   | 7   | 7     | 8    | 8    | 10   | 9     | 9     | No opinion | 8     |
| Satisfaction with the telerehabilitation program (from hospital to home) (0 none -10 maximum) | 10    | 10    | 9          | 10  | 7   | 10    | 8   | 8   | 7     | 10   | 8    | 10   | 8     | 9     | 10         | 8     |

BMI = Body mass index, C & GD = College and Graduate degree, DLCO = diffusing lung capacity for carbon monoxide, EQ-VAS = EuroQol, visual analog scale, FEV1 = Forced expiratory volume during the first second, FVC = Forced vital capacity, HS & AD = High School and Associated degree, KCO = carbon monoxide transfer coefficient, mMRC = modified medical research council, NA = not available, NIW = no independent walking, No HS = No High School.

\*The patient had a tracheostomy performed during coronavirus infection at ICU.

The outcomes of test metrics such as lung capacity or exercise tolerance, while important, do not always are correlated with the patient’s perspective of the impact of healthcare intervention and how it has been performed.<sup>[10,11]</sup> Therefore, the use of Patient-Reported Outcomes Measures (PROMs)<sup>[11]</sup> and Patient-Reported Experience Measures (PREMs)<sup>[10]</sup> are recommended to assess the patient’s perspective after a medical action. PROMs<sup>[11]</sup> are tools to assess the patient’s perception of the impact of health care intervention on their condition (e.g., health-related quality of life or dyspnea scale), while PREMs<sup>[10]</sup> assess the patient’s perception of how the health care is received (e.g., Am I satisfied with the follow-up?).<sup>[10,11]</sup>

Therefore, a prospective pilot study to evaluate the feasibility and patient outcomes of the COVID-19 telerehabilitation program using a mobile application was carried out.

**2. Methods**

Moderate–severe pneumonia COVID-19 patients with smartphone availability were consecutively included after accepting the informed consent. Patients with unstable clinical status or cognitive impairment, as well as those who did not have a smartphone were excluded. Predisposition to perform rehabilitation with a smartphone or its regular previous use was not queried for inclusion. This study has been approved by the center’s ethics committee (ref.PR168/20).

The telerehabilitation program was designed “from hospital to home,” beginning the physical therapy in sessions once a day under the supervision of a physical therapist. Patients were encouraged to perform extra sessions during admission and to continue the rehabilitation at home using the paper support or mobile application according to their preference. The rehabilitation program was designed and encouraged to be performed twice a day, which included 6 exercises of 5 recommended repetitions at a mild–moderate intensity according to the patient’s tolerance (4–6 on the Borg dyspnea scale). Exercises involved muscle strength and endurance, inspiratory/expiratory muscle training, guided ventilations, self-drainage, and positive expiratory pressure (PEP). The devices used for the breathing exercises were Threshold® PEP<sup>[12]</sup> or PEP-bottle.<sup>[13]</sup> PROMs and PREMs were collected at 8 weeks of discharge. “Estoi” was the mobile application used, which enables: (1) performing rehabilitation through videos with explanatory texts; (2) telemonitoring rehabilitation and clinical data, making the required changes; (3) messaging with their medical team.

**2.1. Statistical analysis**

For descriptive analysis, categorical data were described as a number of cases and percentage, while continuous variables were described as mean and standard deviation (SD) or median and interquartile range (IQR) for continuous variables, when appropriate according to Shapiro–Wilk test. For comparative analysis of continuous variables Student T-Test for the parametrical test or Wilcoxon signed-rank test for the nonparametrical test were used, when appropriate. Differences were considered significant when *P* < 0.05. Data were analyzed with the SPSS for Windows® 25.0 (IBM, USA).

**3. Results**

Patient data are shown in Table 1. 16 patients were enrolled, 47% women with a mean age of 63 years old (standard deviation [SD] 7.2). One patient had a history of emphysema without decompensation and 1 had stable ischemic cardiopathy. The mean of body mass index was 27.9 (SD 3.2), forced vital capacity 85.3% of predicted (SD 22.7), diffusing lung capacity for carbon monoxide 60.7% of predicted (SD 24.3) and 309 meters at 6-min walk distance (SD 144). 50% of patients did not attend

high school and 31% did not use their mobile phone regularly. Referred EQ-VAS showed a significant worsening from a median of 10 (IQR 2.0) before COVID-19 to 6.75 (IQR 1.0) at 8 weeks of hospital discharge ( $P < 0.001$ ). According to app data, 81% of patients performed rehabilitation sessions, 88% sent their clinical follow-up, and 63% sent messages to the medical team using the app. Program complete satisfaction in physical recovery, follow-up, and personal data security were reported by all patients. Easy access to the medical team was reported by 87% of patients. Up to 88% of cases believed that the mobile application incentives them to do more physical therapy, also they would use this telemedicine app again and recommended it to others. Interestingly, 63% of our patients would have chosen home telerehabilitation instead of center-based rehabilitation at hospital discharge for a new rehabilitation program. Evaluating patient satisfaction over 10, satisfaction with the usefulness of the mobile application in rehabilitation was 8.4/10 (SD 1.2) and satisfaction with the start of rehabilitation in the hospital followed by telerehabilitation was 8.9/10 (SD 1.1). No significant differences were found between satisfaction among the mobile application and the rehabilitation (8.4 vs 8.9,  $P = .208$ ). However, at 8 weeks postdischarge, the PROMs (EQ-VAS) scored significantly lower than the PREMs on satisfaction referred with both mobile app (6.75 vs 8.4,  $P = .015$ ) and rehabilitation (6.75 vs 8.9,  $P = .001$ ).

#### 4. Discussion

Taking rehabilitation programs' design into consideration, our telerehabilitation program integrates the telemedicine benefits<sup>[14]</sup> with the rehabilitation recommendations.<sup>[1,2]</sup> Different from other COVID-19 rehabilitation programs that require a physiotherapist to perform the video call rehabilitation,<sup>[15]</sup> our program focuses on empowering the patient with videos and explanatory texts of physical therapy without physiotherapist supervision.

Regarding rehabilitation adherence, Lambert et al<sup>[4]</sup> found better adherence to home-based programs of physical therapy with remote app support against those with paper support. Likewise, 88% of patients felt that they did more rehabilitation due to having the mobile application available. Interestingly, 1 patient did not perform the physical therapy with the application but he sent clinical follow-up and messages using the application, with an opinion referred that the telerehabilitation program had encouraged him to perform more physical therapy sessions despite their personal preferences to use paper support.

The successful telemonitoring by the application and the messages received by the medical team helped to optimize the medical treatment and rehabilitation program in 37% of the patients between discharge and the 8-week follow-up visit. Similarly, Ding et al<sup>[6]</sup> published the potential of chronic obstructive pulmonary disease telemonitoring in the early remote intervention of exacerbations. Opposite to a previous COVID-19 telemonitoring study, our patients didn't require Emergency department visits.<sup>[17]</sup>

Similar to our program, satisfaction is generally high in telemedicine programs.<sup>[4]</sup> Further, the COVID-19 pandemic context and avoidance of displacement have likely played an important role in that satisfaction with the mobile application and rehabilitation were evaluated better than general condition (EQ-VAS) at 8 weeks after discharge. Interestingly, 63% of our patients would have chosen home telerehabilitation for a new rehabilitation program.

Patient selection is often a limitation in telemedicine studies, with benefits usually found in selected populations.<sup>[18]</sup> Likewise, in our study, 2 patients without extreme characteristics did not use the application either in physical therapy or in follow-up or to contact the medical team. Nonetheless, by providing both paper and app support without having to choose, patients were able to perform the pulmonary rehabilitation with high overall satisfaction with the program. For this reason, in our opinion,

telemedicine programs should always consider including paper support for avoiding any exclusion.

Our study has several limitations such as the limited number of patients included and the lack of a randomized control group. In this way, our results must be interpreted with caution but show the potential use of telerehabilitation.

In conclusion, the use of a telerehabilitation program from the hospital to the home of patients affected by COVID-19 is viable and safe, with a good patient response in both PREMs and PROMs. Furthermore, it can empower patients with more efficient use of resources in times of the COVID-19 pandemic. Further studies on telerehabilitation and telemonitoring are required.

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