

## Video Telehealth Pulmonary Rehabilitation Intervention in Chronic Obstructive Pulmonary Disease Reduces 30-Day Readmissions

To the Editor:

Hospitalizations for acute exacerbation of chronic obstructive pulmonary disease (COPD) result in significant respiratory morbidity and account for two-thirds of the healthcare costs associated with the disease (1). After hospitalization, the 30-day readmission rate is approximately 20% (2). In 2014, the Centers for Medicare and Medicaid Services initiated penalties of up to 3% of Medicare reimbursement for 30-day readmission rates that are over the historic rate. In response to this, a number of hospitals have initiated multidisciplinary interventions targeted at reducing hospital readmissions, with minimal to modest success (2–4). These interventions have included varying combinations of discharge planning, frequent phone calls, close follow-up, smoking cessation, inhaler training, and social support. In this regard, pulmonary rehabilitation (PR) is associated with a 56% reduction in hospital readmission over a median duration of 9 months after discharge (5), but access to PR remains poor (6, 7). We hypothesized that early application of a video telehealth PR intervention would reduce 30-day all-cause readmission rates after hospitalization for a COPD exacerbation. Some of the results of this study have been previously reported in the form of an abstract (8).

### Methods

**Study design.** We enrolled patients who had been hospitalized for an acute exacerbation of COPD in a video telehealth PR intervention at a single quaternary care academic hospital from March 2015 onward. Potential participants were identified by means of a daily hospital census, and patients were approached for enrollment irrespective of disease severity, except for those with unstable arrhythmias, congestive heart failure with a left ventricular ejection fraction of <25%, receiving mechanical ventilation, oxygen requirement of >5 L/min at rest, or other comorbidities that precluded participation in exercise, including orthopedic conditions and severe dementia. Written informed consent was obtained from all telehealth participants. Participants exposed to telehealth PR were retrospectively matched 1:2 by readmission risk with contemporaneous subjects who had been hospitalized for a COPD exacerbation but did not receive the telehealth PR intervention. Readmission risk was calculated using the LACE (length of stay, acuity of admission, comorbidities, and emergency

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room visits in the previous 6 months) index for predicting early mortality or unplanned readmission after discharge from the hospital (9). All participants received a comprehensive bundled care for readmission reduction during hospitalization and after discharge that was comprised of a uniform duration of 5 days of systemic steroids and antibiotics, disease management education, follow-up in the COPD clinic within  $10 \pm 2$  days, smoking cessation counseling when applicable, home health or palliative care when suitable, and referrals to traditional PR (2). All participants received phone calls within 2 days of discharge via an automated telephone system (Emmi Solutions, LLC) to inquire about symptoms, use of inhalers, physical activity, diet and nutrition, vaccines, disease management, and smoking cessation. Any deterioration in a patient's symptoms was relayed to the healthcare providers for appropriate action (2).

**Telehealth PR intervention.** Participants were enrolled at index hospitalization, and on return to the COPD clinic within  $10 \pm 2$  days were provided a data-enabled smartphone with video capabilities to facilitate two-way live videoconferencing using a Health Insurance Portability and Accountability Act–compliant application. The intervention consisted of a standardized regimen of 36 exercise sessions over 12 weeks per traditional PR guidelines (10). Exercise was prescribed by an exercise physiologist after an initial outpatient exercise assessment and tailored according to the subject's baseline functional level as well as impairment before the exacerbation (11). The exercise regimen included a combination of initial stretching and breathing exercises, followed by 20 minutes of aerobic exercises using a portable foot pedaler provided as part of the study to achieve heart rates between 60% and 80% of the maximum recorded on the baseline 6-minute-walk test. Other types of equipment, such as treadmills and exercise bikes, were used when available. Resistance training was done with the use of a resistance band. In addition, breathing exercises such as pursed-lips breathing, paced breathing, diaphragmatic muscle strength training, and basic yoga exercises were administered. Educational sessions were also included in the videoconference calls regarding smoking cessation, appropriate inhaler techniques, disease education, monitoring and reporting exacerbations, and self-efficacy. Safety was monitored by providing automatic sphygmomanometers to measure blood pressure before and after exercise, and a pulse oximeter was used to assess heart rate and oxygen saturation. Long-term recommendations for exercise were made at the time of graduation from PR. Subjects who participated in at least 20 sessions were considered completers (10, 12).

**Outcomes.** The primary outcome was the 30-day all-cause readmission rate, and secondary outcomes included 30-day readmissions due to acute exacerbation of COPD, and time to first readmission due to any cause.

**Statistical analyses.** Proportions of readmission within 30 days were compared between the exposed and unexposed groups using the chi-square test. The time to first readmission was compared between groups using Kaplan-Meier and Cox proportional hazards analyses. All analyses were performed using SPSS v22.0 (SPSS Inc.), and a two-tailed  $\alpha$  of 0.05 was deemed statistically significant.

### Results

Eighty participants were enrolled in telehealth PR and matched with 160 unexposed subjects (Table 1). The two groups had similar

**Table 1.** Baseline Characteristics of Patients in the Video Telehealth Pulmonary Rehabilitation and Unexposed Arms

	Telehealth PR (n = 80)	Unexposed (n = 160)
Age, yr	64.5 (10.1)	63.4 (11.8)
Sex, F	49 (61.3%)	92 (57.5%)
Race, African American	26 (32.5%)	57 (35.6%)
Body mass index, kg/m <sup>2</sup>	29.0 (10.2)	28.2 (8.2)
Current smoker	21 (26.3%)	60 (37.5%)
FEV <sub>1</sub> ,% predicted*	45.4 (18.1)	48.6 (21.1)
FEV <sub>1</sub> /FVC*	0.52 (0.15)	0.57 (0.15)
Domiciliary oxygen use	43 (53.8%)	44 (27.5%)
Coronary artery disease	16 (20.0%)	31 (19.4%)
Atrial fibrillation	8 (10.0%)	13 (8.1%)
Congestive heart failure	10 (12.5%)	24 (15.0%)
Hypertension	55 (68.8%)	111 (69.4%)
Diabetes mellitus	22 (27.5%)	46 (28.8%)
Depression	16 (20.0%)	40 (25.0%)
Anxiety	15 (18.8%)	32 (20.0%)
Hospitalizations in prior 12 mo	0.9 (1.4)	0.9 (1.7)
ER visits in prior 6 mo	1.0 (1.5)	0.7 (1.4)
Length of stay, d <sup>†</sup>	4 (2)	4 (3)
LACE index	10.7 (2.8)	10.6 (3.0)

Definition of abbreviations: ER = emergency room; LACE = length of stay, acuity of admission, comorbidities, and ER visits in the previous 6 months; PR = pulmonary rehabilitation.

All data are expressed as mean (SD) or n (%) unless otherwise stated.

\*Spirometry data were available for 77 intervention and 94 control subjects.

<sup>†</sup>Median (interquartile range).

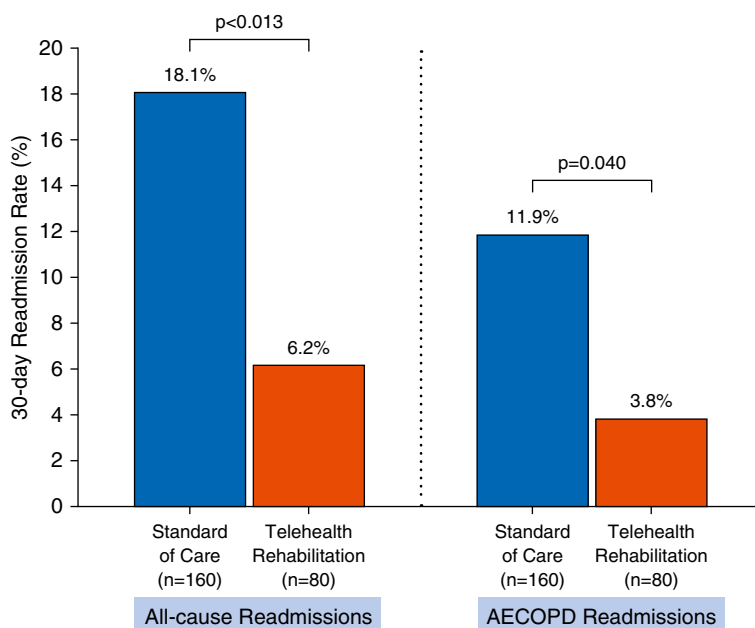
demographics and comorbidities, but a greater proportion of telehealth patients were on domiciliary oxygen. The 30-day all-cause readmission rate was significantly lower in the telehealth PR

group than in the unexposed group (6.2% vs. 18.1%;  $P=0.013$ ) (Figure 1). Thirty-day readmissions due to acute exacerbation of COPD were also lower in the telehealth PR group (3.8%) than in the unexposed group (11.9%,  $P=0.040$ ). The time to first readmission was longer in individuals who received telehealth PR than in those who did not (265 d [95% confidence interval (CI), 235–295 d] vs. 211 d [95% CI, 187–233 d]; unadjusted hazards ratio, 0.60; 95% CI, 0.40–0.90;  $P=0.012$ ). No adverse events were reported with telehealth PR, and 66 subjects (82.5%) completed at least 20 sessions of telehealth PR, resulting in an attrition rate of 17.5%. Forty-two of the 160 unexposed subjects (26%) were referred to traditional PR after discharge. Ten subjects (6%) enrolled in traditional PR within 3 months of discharge, and two of these subjects were already participating in PR at the time of admission. Of these, only eight (5%) enrolled in traditional PR within a month of discharge, and three completed at least 20 sessions.

## Discussion

We demonstrate that a video telehealth PR intervention administered early after hospitalization for an acute exacerbation of COPD is feasible and safe and is associated with significantly lower 30-day all-cause readmission rates.

To our knowledge, this is the first active telehealth intervention to be associated with a significant reduction in 30-day all-cause readmission rates in COPD. Previous multidisciplinary interventions targeting 30-day readmissions have either failed or shown modest success. Jennings and colleagues randomized hospitalized patients with COPD to usual care or a pre-discharge bundle and found no difference in 30-day readmission rates (3). However, they assessed only readmissions due to acute exacerbations of COPD, and not all-cause readmissions, which is the target for the Centers for Medicare and Medicaid Services Hospital Readmissions Reduction Program. A retrospective study of a comprehensive care plan comprised of smoking cessation and inhaler education; pulmonary consultation;



**Figure 1.** Comparison of 30-day readmission rates for all causes and for acute exacerbation of chronic obstructive pulmonary disease (AECOPD) after an index admission for AECOPD.

comorbidity assessment; palliative care assessment; mucus clearance device and inhaler selection based on clinical assessment of patient dexterity, competence, and peak inspiratory flow; and close outpatient follow-up showed a 16% reduction in all-cause readmissions (4). However, a similar multidisciplinary bundle of interventions developed by our group did not result in a reduction in all-cause readmission rates (6). These data suggest that interventions based on monitoring patients' symptoms or physiologic signs, and triggering alerts that result in using existing medications to treat exacerbations early are not sufficient to reduce readmissions. The mechanisms by which early telehealth PR reduced readmissions requires more research, but PR increases patients' physical, psychological, and social resilience as a result of improved exercise capacity, reduced sensitivity to dyspnea, improved mood, and greater self-efficacy, and a combination of these effects likely increases the symptomatic threshold for an exacerbation (13).

Our study has some limitations. Although we matched individuals by readmission risk, the participants were not randomized, and this can introduce bias. The LACE index has moderate discrimination for readmission risk in COPD but is commonly used for all-cause readmission risk assessments (14). Although the subjects were matched by readmission risk, the possibility of residual confounding cannot be excluded. We recorded all readmissions in the intervention group, but it is possible we missed readmissions at other hospitals in the control arm. This would, however, only bias the results in favor of the intervention. These results require confirmation with a randomized controlled trial. ■

**Author disclosures** are available with the text of this letter at [www.atsjournals.org](http://www.atsjournals.org).

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## Choosing between Practicing Good Medicine and Following the Law in Texas

To the Editor:

Recent changes to the Texas Advance Directives Act (TADA) (1) have put critical care physicians in Texas in the position of having to choose between practicing good medicine and following the law. The law has changed the way physicians place in-patient Do Not Attempt Resuscitation (DNAR) orders. Although there are a number of ethically questionable aspects of the law (2), commentators have yet to highlight the following scenario. Imagine an elderly patient on ventilator support. She does not have either a terminal or an irreversible illness and is expected to recover to her baseline with continued standard interventions. When speaking with her spouse, her critical care intensivist learns that the patient

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