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Wearables, Respiratory Rehabilitation, Acute Myocardial Infarction and Frailty, and High-Intensity Respiratory Muscle Training

Rens N, Gandhi N, Mak J, Paul J, Bent D, Liu S, Savage D, Nielsen-Bowles H, Triggs D, Ata G, Talgo J, Gutierrez S, Aalami O. Activity data from wearables as an indicator of functional capacity in patients with cardiovascular disease. PloS ONE. 2021;16(3):1–10. doi:10.1371/journal.pone.0247834

As the use of remote clinical management methods increases with advancements in technology and general necessity, there is a need to evaluate the efficacy of these methods to optimize patient safety and improve clinical care. Rens et al. aimed to determine the accuracy of a home-based 6-minute walk test (6MWT) as compared with a clinic-based 6MWT to evaluate frailty in patients with cardiovascular disease (CVD).

Methods: iPhones and Apple Watches (series 3) with the VascTrac research app were provided to 110 ambulatory participants scheduled for vascular or cardiac procedures at the Palo Alto VA Hospital. Participants completed the in-clinic 6MWT before their medical intervention, 2 weeks postprocedure, and at months 1, 3, and 6. In-clinic 6MWT outcomes were tracked by smartphone and measured by a clinician. Participants received push notifications to complete the at-home 6MWT during the weeks they did not have a clinic appointment for the duration of the 6-month study. At-home activity data were also collected for daily total steps, maximum steps without stopping, and distance walked each day. At-home testing and activity data were used to explore usefulness in predicting in-clinic 6MWT and evaluation of frailty. Less than 300 m achieved was used as the threshold to define frailty.

Results: For in-clinic based 6MWT, both smartphone-captured step counts ($r = 0.84$) and distance ($r = 0.78$) were strongly associated with distance measured by the clinician. When predicting frailty status, smartphone-captured step counts were a better predictor than smartphone-captured distance. Using both smartphone steps and distance enhanced the accuracy of identifying an in-clinic 6MWT as frail, with 90% sensitivity and 85% specificity. The at-home 6MWT best predicted if a patient would be classified as frail by the in-clinic 6MWT performance when the highest value of steps counted by either smartphone or watch was used, demonstrating 83% sensitivity and 60% specificity. Passive activity data, the highest value total steps per day determined by either the smartphone or watch, approached the predictive value of the in-clinic 6MWT.

Discussion: Accurate patient monitoring and assessment beyond the clinic setting, especially in the current times, is extremely valuable to clinicians. The current study provides evidence that smart technology (iPhones and Apple watches) can effectively assess functional capacity in CVD populations through activity monitoring in the clinic and at home. It appears using both step counts and distance optimizes the ability of smart technology to accurately detect frailty. Home-based 6MWT and passive activity data appear clinically relevant, as they are effective for predicting clinic-based testing. Considerations should be made as to the impact of patients' gait on accurate step counts. Additional factors that can pose challenges in implementing smart technology-based monitoring include technical literacy or ability of the patient and accessibility to cellular service.

Liu K, Zhang W, Yang Y, Zhang J, Li Y, Chen Y. Respiratory rehabilitation in elderly patients with COVID-19: a randomized controlled study. Complement Ther Clin Pract. 2020;39(5):1–4. doi:10.1016/j.ctcp.2020.101166

The pathogen responsible for the coronavirus disease 2019 (COVID-19), severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), results in most who are infected experiencing mild to moderate respiratory illness with higher incidents of severe respiratory conditions, including pneumonia, in elderly and other at-risk populations. The use of respiratory rehabilitation may be important in those recovering from COVID-19, as respiratory function is associated with activities of daily living (ADL) and quality of life (QoL). In a randomized control trial, Liu et al. (2020)

examined the impact of a respiratory rehabilitation program on both performance and psychological outcomes in elderly COVID-19 patients.

Methods: Participants were elderly patients (65 years or older) who were hospitalized for COVID-19 and discharged from Hainan General and Huanggang Central Hospitals. Additionally, participants had a forced expiratory volume in 1 s (FEV1) >70% of predicted and were free of chronic obstructive pulmonary disease or other respiratory diseases. Participants were randomized (1:1) to either an intervention group or a control group. The 6-week respiratory rehabilitation intervention was performed 2 days per week and included respiratory muscle training, diaphragm contraction training, cough training, respiratory muscle stretching, and pursed-lip breathing and coughing at home. Respiratory function was evaluated (FEV1, forced vital capacity, diffusing capacity of the lungs for carbon monoxide). A 6MWT was used to assess endurance, and the Short Form-36 (SF-36) was used to evaluate ADL and QoL.

Results: A total of 72 participants completed the study. The intervention (24 males; 12 females) and control (25 males; 11 females) groups did not differ in age or body mass index at baseline. Significant improvements were noted for all pulmonary function test outcomes, 6MWT distance, and the SF-36 both within the intervention group and between groups after the 6-week intervention. ADL scores did not change over the course of the study.

Discussion: COVID-19 has the potential to cause serious acute and persistent pulmonary complications, particularly in elderly populations. It appears that incorporating respiratory rehabilitation with elderly patients who are recovering from COVID-19 can aid in improving outcomes such as respiratory function, endurance, and QoL. The 6-week respiratory rehabilitation program used in this study emphasized respiratory muscle activation through resistive breathing techniques and diaphragm training while also incorporating therapist-guided stretching. Targeting respiratory muscles may aid in optimizing respiratory function and preventing associated issues of dyspnea and altered breathing mechanics. The rising number of patients recovering from COVID-19, along with the emerging effects of "long COVID syndrome," warrants continued research to guide clinical care and establish best practices to restore function and mitigate potential long-lasting effects of the disease.

Sanchis J, Sastre C, Ruescas A, Ruiz V, Valero E, Bonanad C, Garcia-Blas S, Fernandez-Cisnal A, Gonzalez J, Minana G, Nunez J. (2021). Randomized comparison of exercise intervention versus usual care in older adult patients with frailty after acute myocardial infarction. Am J Med. 2021;134(3):383–390. doi:10.1016/j.amjmed.2020.09.019

Rehabilitation programs after myocardial infarctions (MIs) are tailored toward younger patients rather than older and frail patients. However, these patients may benefit from rehabilitation programs. Previous researchers have identified difficulty with exercise adherence among this population. The purpose of this study was to assess change in frailty while performing an exercise intervention in older, frail patients after an acute MI.

Methods: One-hundred fifty postacute MI patients with prefrailty or frailty (Fried scale) were randomized (1:1) into an intervention or control group. Frailty status was determined throughout the study. The exercise intervention group performed a 3-month supervised exercise program and continued at home for the remainder of the study. The intervention included 3 60-minute sessions per week and incorporated cardiovascular, resistance, balance, and flexibility components. The primary outcome was frailty at 3-month and 1-year clinical events (e.g., mortality and hospital readmission).

Results: Study participants ranged in age from 70 to 96 years. Only 23 of those randomized to exercise completed the supervised program. Of these completers, 14 adhered to the at-home portion. At 3 months, the intervention group displayed a more favorable yet not significant effect on frailty score with improvements in the gait speed and exhaustion components. Frailty scores improved (i.e., lower score) for both the intervention (from 2.82 ± 1.15 to 2.37 ± 1.45 points, $P = 0.02$) and control groups (from 2.60 ± 1.11 to 2.04 ± 1.30 points, $P = 0.008$) at 1 year. Twelve patients died, 12 patients were hospitalized due to acute MI, and 31 were hospitalized unrelated to MI. No negative outcomes were attributed to the exercise intervention.

Conclusion: Benefits of an exercise program for older patients with frailty after an acute MI were associated with directionally favorable effect after a 3-month supervised exercise program. Poor adherence to the at-home program may have attributed to the lack of progress at 1 year. The authors of this study recognize the challenges associated with implementing exercise interventions with frail patients and identify the need to explore methods to increase adherence to at-home programming with a goal to improve frailty status. Additionally, the current study was limited to an exercise intervention. A comprehensive approach that includes other health-related aspects, including nutrition and behavioral interventions, may be considered to optimize frailty status and reduce mortality.

Messaggi-Sartor S, Marco E, Matinez-Tellez E, Rodriguez-Fuster A, Palomares C, Chiarella S, Muniesa JM, Orozco-Levi M, Barreiro E, Guell MR. Combined aerobic exercise and high-intensity respiratory muscle training in patients surgically treated for non-small cell lung cancer: a pilot randomized clinical trial. Eur J Phys Rehabil Med. 2019;55(1):113–122. doi:10.23736/S1973-9087.18.05156-0

After lung resection surgery for non-small cell lung cancer (NSCLC), patients may experience dyspnea, fatigue, as well as reductions in physical activity, physical tolerance, and

QoL for 6 months or longer. Exercise training improves postsurgical outcomes; however, there is no published exercise program for patients with NSCLC who were surgically treated. The purpose of this study was to examine the impact of aerobic exercise and high-intensity respiratory muscle training on surgically treated NSCLC patient outcomes.

Methods: Thirty-seven surgically treated NSCLC patients were randomly assigned to exercise training (n = 16) or usual care (n = 21). Exercise training included aerobic exercise and high-intensity respiratory muscle training for 24 supervised sessions, performed 3 times per week over 8 weeks. Exercise capacity (VO_{2peak}) was assessed at 4 time points: presurgery and postsurgery and preintervention and postintervention for both groups. Secondary outcomes were changes in inspiratory (PI_{max}) and expiratory (PE_{max}) respiratory muscle strength and insulin binding protein (IGFBP-3) levels used as markers of prognosis, and QoL.

Results: Reductions in VO_{2peak} (−2.39 $mL \cdot kg^{-1} \cdot min^{-1}$, [95% confidence interval (CI): 1.38–3.41], $P < 0.001$), peak ventilation (−6.34 $L \cdot min^{-1}$, [95% CI: 2.37–10.3], $P = 0.03$), and PE_{max} (−8.51 cmH_2O, [95% CI: 1.2–15.7], $P = 0.02$) were found in all patients after lung resection surgery. The exercise group showed an improvement in mean VO_{2peak} from preintervention (14.1 + 1.5 $mL \cdot kg^{-1} \cdot min^{-1}$) to postintervention (16.7 + 2.14 $mL \cdot kg^{-1} \cdot min^{-1}$), as compared to the control group, which decreased in mean VO_{2peak} from preintervention (16.0 + 2.2 $mL \cdot kg^{-1} \cdot min^{-1}$) to postintervention (13.7 + 2.5 $mL \cdot kg^{-1} \cdot min^{-1}$). This group difference was significant ($P = 0.05$) with an effect size of 1.28.

The mean improvement in postintervention VO_{2peak} relative to baseline was 2.13 $mL \cdot kg^{-1} \cdot min^{-1}$ (95%CI [0.06, 4.20]) greater for the exercise group as compared to the control group ($P = 0.04$). Both PI_{max} (13.42 cmH_2O, $P = 0.02$) and PE_{max} (18.76 cmH_2O, $P = 0.02$) muscle strength increased after the intervention compared with the control group. The exercise group also had a significant (P = 0.02) increase in serum IGFBP-3 levels postintervention compared with the control. In the 2-year follow up, the authors noted lung cancer recurrence occurred in 6 patients, resulting in 4 deaths (1 from the exercise group and 3 from the usual care group).

Discussion: Exercise capacity measured as VO_{2peak} is a prognostic indicator in those with NSCLC. Additionally, improvement in serum IGFBP-3 has been associated with an improved tumor microenvironment in other forms of cancer and may result in an improved prognosis. An increase in respiratory muscle strength was also observed in this pilot study after completion of the 8-week exercise program. Therefore, aerobic exercise intervention combined with high-intensity respiratory muscle training may be considered in rehabilitation programs for cancer patients