MAYO CLINIC

Estimated Cardiorespiratory Fitness Assessment as a Patient Vital Sign

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Cardiorespiratory fitness (CRF), often expressed as the maximum volume of oxygen consumption, is influenced by the degree of cardiac output and arteriovenous oxygen difference. The time course of adaptations in CRF can be relatively short (eg, 3 weeks), with the proportion of training-induced determinants (eg, cardiac output and arteriovenous oxygen difference) of CRF likely to be age-dependent.[1] Cardiorespiratory fitness is a strong predictor of all-cause mortality, cardiovascular disease-specific mortality, cancer-specific mortality, as well as various chronic diseases.[2] Furthermore, CRF is inversely associated with cancer incidence, and thus, eliminating low CRF may attenuate cancer morbidity and reduce its societal and economic burden.[3] Such an effort is of great clinical and public health interest for patients without cancer as well as cancer patients and cancer survivors.

Further emphasizing the importance of CRF, the association between CRF and health is often stronger than the effect of physical activity on health.[4] This may be a result of several factors. For example, direct measures of CRF may be more precise than assessment of physical activity; physical activity is often assessed over short periods of time, whereas CRF may be considered an enduring trait influenced by chronic habituation of physical activity. In addition, independent of physical activity, CRF may be influenced by genetics and subclinical disease.[5]

Objective measures of CRF can provide valuable diagnostic and prognostic utility, particularly when using invasive cardiopulmonary exercise testing indices.[6] Although objective measures of CRF may be superior to estimated CRF (eCRF),[7] their broad clinical utility is limited by the need to undertake such measurements. As a result, recently, there has been a call to consider eCRF as a patient vital sign, and thus, incorporate its inclusion in routine patient health assessment.[8] Its integration into patient care and risk management, particularly in high-risk populations, has been recently emphasized.[9] In addition to objective assessments of CRF,[10] emerging work demonstrates that eCRF is also inversely associated with mortality risk.[2] Nonexercise eCRF assessments often include the evaluation of various demographic, biologic, and behavioral parameters, all of which may influence cancer risk[11] and are easily obtainable in clinical practice. Thus, inclusion of eCRF as a patient vital sign may not only enhance the clinician's assessment of the patient's risk of future disease but, based on the nature of the parameters included in the eCRF algorithm, it may also provide valuable current patient health information in targeting health behavior change. Furthermore, eCRF assessments can be integrated with other predictive health risk assessments (eg, pooled cohort equations) in improving patient care,[8] the latter also benefited by the use of age-specific CRF categories.[12]

Demonstrating the importance of integrating eCRF assessments into clinical practice, Wang et al,[13] in the present issue of *Mayo Clinic Proceedings*, evaluated the association of nonexercise eCRF with all-cancer mortality. Data from the Third National Health and Nutrition Examination Survey (NHANES III) were used, including 8506 adults with complete data. The NHANES III, which was conducted by the National Center for Health Statistics of the Centers for Disease Control and Prevention, used a multistage, probability-based national sample of adults in the United States. Baseline estimates from this periodic survey were conducted between 1988 and 1994, with follow-up assessment of mortality status determined through 2011. To evaluate eCRF, Wang et al[13] used a sex-specific nonexercise eCRF algorithm that included assessments of age, body mass index (calculated as the weight in kilograms divided by the height in meters squared), waist circumference, resting heart rate, physical activity, and smoking status. Their findings

showed that, over a mean 19.5-year follow-up period, for every 3.5 mL/kg/min increase in estimated oxygen consumption, there was a 30% and 27% risk reduction for all-cancer mortality in men and women, respectively. These important findings add to the accumulating body of research highlighting the importance of CRF in health, including reduced risk for several cancer types. Recent work also demonstrates that factoring weight status into eCRF algorithms can predict cancer-specific mortality risk.[14]

These findings also highlight the importance of considering integrating eCRF assessments into clinical practice. Importantly, however, simply adding an assessment of eCRF into clinical practice may not be sufficient. Using counseling-based motivational interviewing techniques, or facilitating behavior change via technological applications, may improve patient CRF.[15] In addition to structured exercise interventions, even lifestyle interventions focused on improving cognitive (eg, via patient education) and behavioral skills (eg, enlisting social support) are effective in enhancing CRF and reducing biomarkers related to cardiovascular disease and cancer among sedentary adults.[16] Clinicians are well positioned to integrate such behavioral and cognitive skills during patient interactions. These factors, as well as others, such as exercise history, engagement in other health-related behaviors, and knowledge and skills of exercise, should be taken into consideration because they may influence the adherence to exercise during and after cancer treatment.[17] Critically, such exercise promotion by clinicians should focus on promoting exercise behaviors that induce a positive affective response; the latter may facilitate sustained exercise behavior across the lifespan.[18] In addition to promoting aerobic-based physical activities, a prudent and comprehensive approach encourages engagement in muscle strength activities[19] and avoidance of prolonged sedentary behaviors.[20]

Vital signs are relatively easy to assess, and when abnormal, they may alert clinicians to existing or impending disease—the same may also be said for eCRF and hence the consideration of eCRF as an additional vital sign.

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Potential Competing Interests: The author reports no competing interests.

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