From Intuition to Execution: Realizing the Potential of Wearables in Oncology

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As oncologists, we have noticed recently that many of our patients are coming to clinic wearing familiar-appearing wristbands. Although the particular brands are not always apparent, these wristbands are all activity trackers in one form or another. This phenomenon parallels the explosive growth of the consumer wearable industry and the ubiquitous presence of commercially available physical activity monitors throughout society. Oncologists have become enamored with the potential clinical and research usefulness of these devices. Intuitively, physical activity monitors could provide another perspective into how patients with cancer feel and function. The importance of patient-reported outcomes in providing this information has been amply demonstrated in recent years,[1] and physical activity monitors promise to complement or, perhaps in some instances, replace this information with unbiased, objective data. If one patient averages 4,000 steps in a day and another averages 8,000 steps, or if a single patient averages 6,000 steps one week and 2,000 the next, should these differences not be telling us something important?

Against this background, Beg et al[2] provide a perspective on the promise of physical activity monitors in oncology practice in the report accompanying this commentary. The authors highlight existing and emerging data to illustrate: For example, in one study, physical activity monitor data associated inversely with Eastern Cooperative Oncology Group performance status,[3] and in another, a physical activity monitor–based intervention improved quality of life and fatigue in patients with breast cancer.[4] The authors review the use of physical activity monitors in other chronic medical conditions and some of the initial physical activity monitor validation studies in clinical oncology. One of the most important sections, however, is Challenges and Future Directions, which the authors discuss at the end of the review. We agree that there is much work to be done before the potential of these devices can be realized in oncology.

As the authors note, physical activity monitors are not new, nor is the study of physical activity monitors in oncology.[5] What is new is that commercial physical activity monitors are now ubiquitous. This raises an obvious question: Why are physical activity monitors not used more widely in oncology research and practice already? We would argue that despite the intuitive potential of physical activity monitors, the true meaning and utility of the data that they are generating are not entirely clear and require additional research. Even if we could easily see the data coming from our patients' physical activity monitors in clinic, how should we incorporate this information into our decision making? We suggest that those interested in physical activity monitors in oncology will need to focus on several areas to move the field forward.

Context

What is the context in which the physical activity monitor will be used? There are

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several possible roles for physical activity monitors in oncology, and each may require different considerations related to how the monitor is deployed, which variables are used, and how the data are interpreted. Thus, we believe that an active research agenda for each context must be developed. Within oncology, three of these contexts include the following:

First, the physical activity monitor supplies a prognostic measure related to functional status to risk stratify patients for clinical decision making or within clinical trials. Although an intuitive use of physical activity monitors, this context requires that physical activity monitors provide the level of discrimination required of an acceptable diagnostic test. Whether average steps per day (and measured over what period of time?) reaches this threshold requires further study.

Second, the physical activity monitor supplies an outcome measure for use in clinical trials in which the intervention is expected to have an impact on physical function. A recent example outside of oncology is the NEAT-HFpEF (Nitrate's Effect on Activity Tolerance in Heart Failure With Preserved Ejection Fraction) trial published in *New England Journal of Medicine*, in which the primary end point for isosorbide mononitrate versus placebo was daily activity level as measured by an accelerometer.[6]

Third, the physical activity monitor itself is part of an intervention designed to increase physical activity, as prehabilitation (before oncologic surgery or bone marrow transplantation[7]), during active treatment, or during cancer survivorship.

Variables

Which variable from the physical activity monitor will be used within the context chosen? Most people are familiar with steps per day as a primary output from a physical activity monitor, but this measure may be too insensitive for use within most oncology contexts. Daily physical activity is strongly influenced by behavior and motivation and thus may not correlate directly with physical function. If the desired use of the physical activity monitor is as a prognostic variable, for example, then other metrics may be needed. Resting heart rate and the response of the heart rate to exertion vary among individuals as functions of underlying fitness. Although it is difficult to directly estimate aerobic fitness from currently available physical activity monitors, there may be other combinations of variables from available physical activity monitors, incorporating heart rate or respiratory rate response to activity, that better approximate physical function and fitness than average steps per day.

Interpretation of Data

How will data related to the chosen physical activity monitor variable be interpreted? Any measure used within oncology research or to inform clinical practice requires an acceptable level of precision. With many currently available physical activity monitors, it is difficult to determine whether the user has worn the physical activity monitor for all or some hours of the day. This level of imprecision and variation would be unacceptable for other commonly used physiologic metrics; for example, we would not evaluate a patient's heart rate by obtaining a measure of the total number of heart beats per day, not knowing whether several hours of heart beats had been measured or not. Thus, there are many methodologic measurement questions related to physical activity monitors that need to be addressed. These include: First, can we accurately determine how long a patient has worn the physical activity monitor, or whether the physical activity monitor has been adequately charged, during each day? Second, knowing this, what is the minimum number of hours that a physical activity monitor should be worn in a day to provide interpretable data? What is the minimum number of days in a week? Third, how many days of data are required to provide a stable physical activity monitor metric estimate as a unit of analysis? How is this estimate affected by baseline patient characteristics (age, sex, fitness level) or clinical environment (pretreatment, active treatment, survivorship) for the purposes of adjustment and interpretation?

Obtaining Valid Data

How should physical activity monitor data be obtained? To obtain reliable and valid data, physical activity monitors should be worn for as long as possible during the intended period of measurement. Design characteristics related to physical activity monitors may influence adherence to wearing the physical activity monitor and should be studied to choose physical activity monitors for specific contexts. For example, some newer physical activity monitors are now water resistant and allow users to wear the physical activity monitor while bathing. Some physical activity monitors are soft and flexible, whereas others are made of more rigid materials. Although most physical activity monitors are wrist worn, some are worn as an adhesive patch. Nearly every physical activity monitor has different ways of displaying data for users. Among all of these different characteristics, which positively influence adherence?

We believe that additional methods and implementation work will be needed to develop clinically practical and meaningful approaches for integrating physical activity monitors into practice. However, the appeal of these devices to oncologists is clear and intuitive. We urge a commitment in the oncology community to dedicated study of physical activity monitors so that the potential of this technology in oncology research and practice can be realized.

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Author Contributions
Conception and design: All authors
Manuscript writing: All authors
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AUTHORS' DISCLOSURES OF POTENTIAL CONFLICTS OF INTEREST

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