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Remote Data Collection: How Broadband Connectivity Affected the Conversion of Physical Performance Testing to the Remote Setting During COVID-19: A Research Assistant's Assessment

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Remote Data Collection:

*How Broadband Connectivity Affected the Conversion of Physical Performance Testing to the
Remote Setting during COVID-19: A Research Assistant's Assessment*

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An Undergraduate Honors Thesis submitted in partial
fulfillment of the requirements for a
Bachelor of Science degree from
Portland State University Honors College &
the School of Public Health in
Health Sciences.

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Abstract

The GET FIT Prostate and Exercising Together trials conducted by Dr. Kerri Winters-Stone incorporate exercise intervention for cancer survivors during or after completing their therapy. Before the COVID-19 pandemic, the laboratory assessment of both studies was conducted in-person. However, the transition to remote assessment was required due to the safety precautions of COVID-19. Protocol outcomes for administering tests like the short physical performance battery (sPPB), which includes the 4m usual walk (4MW; m/s), chair stands (CS; sec), and standing balance measurements, were completed via a video conferencing interface called Cisco Webex.

Transitioning to remote testing determined the validity of remote data collection, correlation R-values, and inter and intra-reliability testing. A mock trial visit was also conducted to explore technology-related sources of error, to determine if differences in our data collection are most likely attributed to remote-testing considerations (connectivity, bandwidth speed, audio/video quality). While preliminary analyses of intra-rater reliability testing were very strong, inter-rater reliability was slightly less favorable.

Further analysis suggests remote testing using a video conferencing interface like Webex likely affects the data's reliability. Figures representing audio/video quality during the mock trial showed weak connection indicators. Transitioning to a remote testing protocol was not an anticipated adjustment, although it proved feasible and reliable within the same tester and could open the doors for others and the broader telemedicine community.

How Broadband Connectivity Affected the Conversion of Physical Performance Testing to the Remote Setting during COVID-19: A Research Assistant's Assessment

INTRODUCTION:

Cancer, one of the most significant chronic illnesses among humans, comes in many different forms. Specific to men, prostate cancer poses a significant threat, especially in older populations. One in 8 men are diagnosed with this disease during their lifetime and 1 in 41 men will die from this disease in their lifetime; however, in most cases, the cancer is identified before it can spread, preventing more severe disease (Rawla, 2019). Nearly half (45%) of men diagnosed with prostate cancer are prescribed androgen deprivation therapy (ADT) (Rawla, 2019). This treatment uses hormone therapy to lower the androgen levels in the male prostate, which reduces cancer growth (University of Michigan, 2019).

Another common cancer is breast cancer, which is most likely to affect women. This disease most commonly starts in breast tissue but grows outward to other body areas if not identified early. The number of individuals with breast cancer has steadily increased every year, making it as high risk as 1 in 8 women will develop breast cancer within their lifetime (DeSatnits et al., 2019). While there are many breast cancer treatment options, the risk associated with death is still high as 1 in 39 women, will die in their lifetime (DeSatnits et al., 2019). The most common treatment methods for breast cancer include surgery, radiation, hormone therapy, and chemotherapy.

While both prostate and breast cancer are treatable, they can cause dysfunction for both men and women. Treatment options for both cancers are vigorous and, because it typically affects the older populations, creates an increased strain on their bodies. The post-therapy effects

can cause both types of cancer patients to lose muscle mass and cause them to become weak and fatigued. The sense of dysfunction felt after therapy can also affect patients mentally because the inability to walk, exercise, lift objects, and even stand-up becomes more challenging to accomplish which can lead to a reduction in quality of life and an increased risk of falling.

In order to combat these debilitating side effects of cancer treatment, Dr. Kerri Winters-Stone and her team were among the first to incorporate an exercise intervention programs for cancer survivors during or after completing their therapy. Exercise intervention uses different exercise programs to help produce more muscle mass, build bone density, and increase balance or flexibility. Dr. Winters-Stone has done a lot of work in this area of cancer survivorship and this paper will focus on the assessments from two ongoing projects: GET FIT Prostate and Exercising Together.

The GET FIT prostate (GFP) project's goal is to explore three different exercise programs to see which is best for reducing falls in prostate cancer survivors who have undergone ADT treatment. The three exercise programs are strength, tai chi, and stretching control groups. Men in the study were characterized based on their different uses of androgen deprivation therapy: whether they previously had ADT or are currently on ADT. This data would provide key evidence in whether exercise intervention will improve and negate the side effects. This exercise is a crucial component to combatting the side effects of ADT therapy as it can lessen the chances of PCS (prostate cancer survivors) falling (Winters-Stone, 2017). As part of the measures for frailty and physical dysfunction, participants complete physical performance testing at baseline and then again at 3, 6, and 12 months.

The next project called the Exercising Together trial, "is the first study in the world that uses exercise to improve the health of both the patient and their partner who has dealt with

breast, prostate or colorectal cancer and all of its consequences" (Winters-Stone et al., 2016).

This project aims to improve the physical, emotional, and relationship health of couples coping with cancer. Couples are assigned to complete resistance-based strength exercises in supervised partnered group classes, supervised separate group classes (survivor and spouse exercise separately), or unsupervised using a home exercise program. Participants were to attend their training exercise class twice a week, and complete body composition, strength, physical function, and self-reported emotional and relationship health assessments measured at baseline, 3, and 6, and 12-month time points

Both of these exercise intervention trials aim to help train the participants to increase mobility, improve strength, and help mitigate the side effects associated with the variety of cancer treatment options. In order to assess if exercise treatment is working for these participants, physical performance testing was required to track their progress throughout the study. Before the COVID-19 pandemic (pre-March 2020), participants completed assessments of sPPB, 1RM, and TUG, measurements during their respective time points at the OHSU Knight Cancer Research building in Portland, Oregon. However, because of the COVID-19 pandemic, lab operations had to be transitioned to a remote setting.

The measurements from the ET study included the short physical performance battery (sPPB), the 4m usual walk (4MW; m/s), chair stands (CS; sec), and standing balance measurements. This scoring method is used to test older participants' physical performance to assess their lower extremity function and mobility. "The test captures limitations in lower extremity functioning that relate to gait, balance and strength" (Guralnik et al., 1994). The GFP study also measured the sPPB, as well as the timed-up-and-go (TUG; sec).

Changing to remote testing data collection caused a big challenge for both trials because, research assistants were now collecting the needed data via CitrixWeb calls (video chat calls). This required the participants to perform the necessary measurements in their homes over their webcams so the research assistant could collect data and record their progress. However, many sources of error occur when collecting data over a web call. These errors include broadband connectivity, inability to assess proper posture, bandwidth speed, and audio/video quality.

Besides comparing the correlational R-values, we also developed a mock trial visit, where each research assistant (rater) got on the same call and collected the same remote assessments (as they would in both Cancer trials); the assessments were completed on the same participant at the same time. The mock trial's goal is to explore other potential sources of error, so we can find that any differences in our data collection are most likely attributed to remote-testing considerations (connectivity, bandwidth speed, audio/video quality).

This research will focus on how broadband connectivity may alter the inter-rater reliability of the GET FIT prostate and Exercising Together physical performance measurements. The data's significance is essential as we hope that current data (data being recorded from virtual meetings).

QUESTION:

How does broadband connectivity alter the reliability of remote physical performance data collection?

METHODS:

The mock trial consisted of four research assistants, one mock participant, and one observer. All members joined the same Webex call at their specific locations at the same time. I assigned one research assistant to lead (RA #1) during the call to guide the mock participant in completing the testing. The testing included the 4-meter-walk, standing balance test, chair stands, and 3-meter TUG. The 4-meter-walk assessment asks the participant to walk 4-meters as quickly as they can. This required the mock participant to set up a 4-meter course using a measuring tape and angle the camera to face the end of the four meters measured, so the research assistants could stop the time right as the participant crossed the finish line. The chair stands require the participant to stand up from a chair five times as fast as they are safely able to (while maintaining correct form and not using their arms for support), all while their camera faces their entire body, so it is visible to the research assistant. The standing balance assessment tests the participant's balance in the semi and full tandem position (one foot slightly or fully in front of the other) for a total of ten seconds. Lastly, the 3-meter TUG evaluates how quickly a participant can sit up from a chair, walk 3-meters, and turn around to sit back into the chair. For the 3-meter TUG test, the camera angle should show the entire 3-meter length and chair, but if not, then the camera should face the chair where the participant will start and finish. All research assistants used a stopwatch to record the specific times measured based on what they could observe on the Webex call when the participant was performing tests.

After each test was completed, the research assistants provided me with the values they received from each test by entering the values into the “chat” function on the Webex call. Once all of the necessary data was recorded and the call was over, we sent the meeting ID, time/location, and hostname to a system/application analyst for Webex at OHSU so that they can

provide background information on the call, such as network connection, audio/video quality and system processing information.

RESULTS:

Table 1. This table represents data collected through the mock trial conducted via Webex. Each numerical value indicates the actual time recorded by the research assistants. The average was not recorded.

	4m Walk #1 (sec)	4m Walk #2 (sec)	4m Walk #3 (sec)	CS #1 (sec)	CS #2 (sec)	SEMI TANDEM (sec)	FULL TANDEM (sec)	3M TUG #1 (sec)	3M TUG #2 (sec)
RA #1	4.84	5.37	4.59	11.97	10.5	10	10	10.16	10.47
RA #2	4.25	4.78	4.25	11.22	10.25	10	10	10.13	10.06
RA #3	4.49	5.52	4.58	10.87	10.49	10	10	9.92	10.3
RA #4	4.44	4.88	4.25	11.69	10.47	10	10	10.07	10.44

Table 2. This table represents data collected from the GET FIT and Exercising Together trials. Each specific box has a Pearson correlation (R-value) for the different reliability tests gathered from actual participants.

Test	Inter-Rater (n=26)	Intra-Rater (n=27)
4 Meter-walk	0.72	0.91
Chair Stands	0.69	0.93
PBB Scoring	0.65	0.90
	Inter-Rater (n=15)	Intra-Rater (n=18)
TUG	0.98	0.96

Figure 1. This figure represents the audio quality throughout the mock trial data collection. The red indicators mean that audio quality was poor for that individual, yellow indicates weak audio quality, and green represents good audio quality.

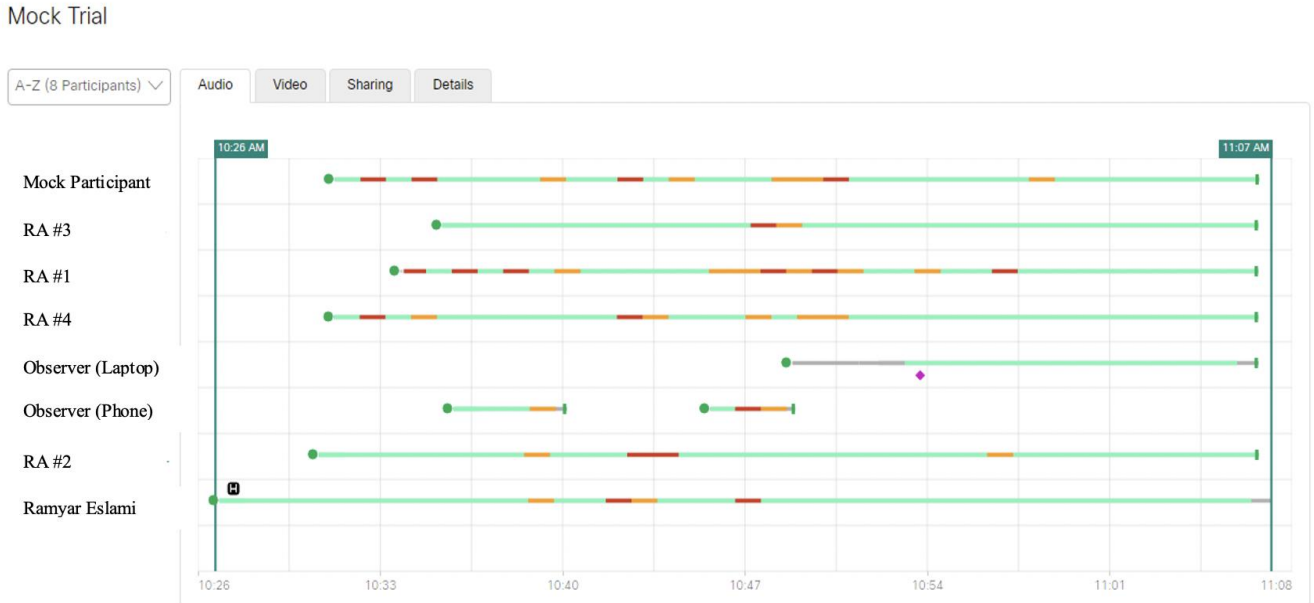


Figure 2. This figure represents the video quality throughout the mock trial data collection. The red indicators mean that video quality was poor for that individual, yellow indicates weak video quality, and green represents good video quality.

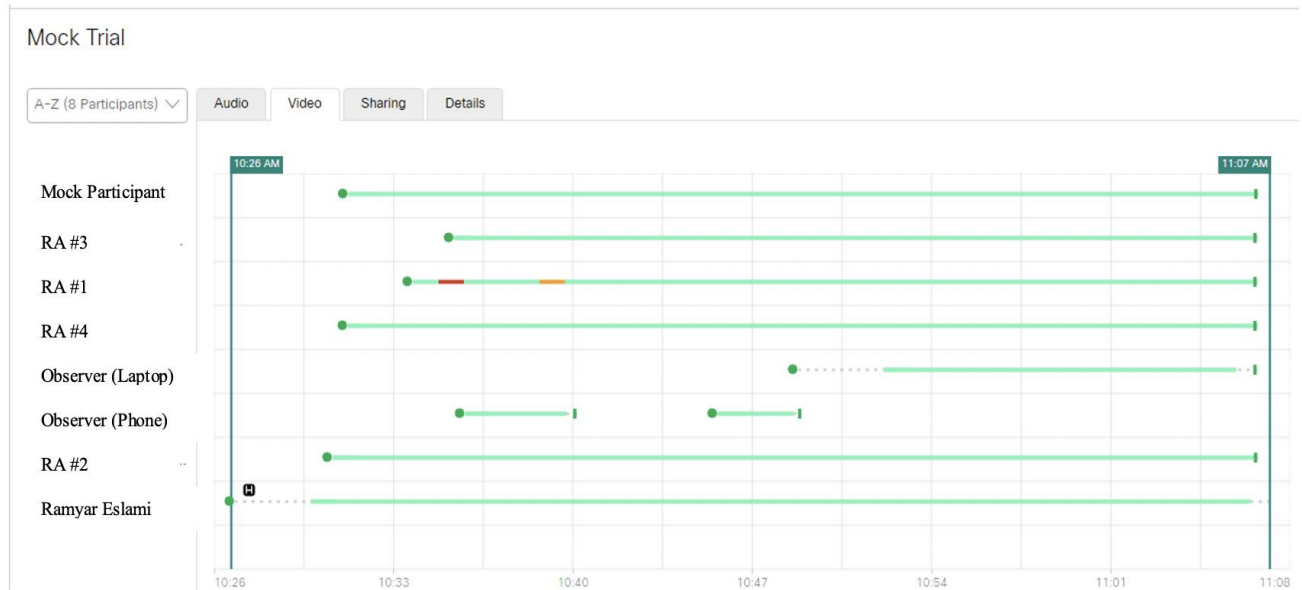


Figure 3. This figure represents suggestions made by a System/Application Analyst to improve call quality during remote visits.

- Wear headphones to improve audio quality.
- Close all other background applications (ex: Netflix, Spotify, YouTube).
- Keep CPU usage below 60%.
- Connect directly to a router via an ethernet cord.
- Make sure to have the most up-to-date version of Webex.
- Ideal to not have an outdated hardware (ex: computers with a single-core)
- Connection and quality are best when not connected to a public IP (VPN).
- Location/Media Node is important when conducting a remote test visit with an individual outside of your area/time-zone.

DISCUSSION:

Transition to the remote data assessments introduces new sources of testing error such as connectivity, bandwidth speed, and audio/video quality. Data from table 2 shows excellent intra-rater reliability and moderate inter-rater reliability. Each research assistant has their unique set-up when conducting assessments, along with specific bandwidth speeds, network connectivity, and audio/video quality which could be why the data's quality is being affected.

The mock trial's importance is to show live differences between the times recorded by each research assistant and to help explain the differences we have seen in the inter/intra-rater correlational values, and by doing so, putting a more objective value on how broadband connectivity affects the data collected between different testers. Since different testers have different computer/internet set-ups when conducting these assessments, this is a potential explanation for lower correlational values.

Through testing and discussion with a Webex analyst, it was determined that broadband connectivity was hard to analyze between individuals on the call; however, more information showed that other factors conflict with the call quality. No members were connected to a router via an ethernet cable; however, because Webex is a multimedia streaming platform, it will operate best when connected directly to the router with an ethernet cable. If this option does not work, it is equally important to close out all other streaming services while on a call to improve the connection's strength. To see if the call is affected by the network that lab members are connected to or by background applications running while on the call, it is essential to check that CPU usage is below 60%. Unfortunately, we could not assess if the lab members on the mock trial had closed other background applications or kept their CPU usage below 60%, although

further analysis did show the following: Three call participants were running outdated Webex application versions, and five call participants were running the Webex app through a public IP (VPN) rather than a local IP. These factors can slow down the ability for the Webex software to function at its highest capacity. Other factors that can affect Webex function are hardware and location/media node of the Webex call. All members on the mock trial and in the research lab are using up-to-date hardware when conducting their virtual visits, and most do not need to worry about location/media nodes as most of our participants all share the same local media node in the greater Oregon area.

As seen in the two figures above, audio and video quality affect the lag times lab members may encounter while on a call. During our mock trial, each member's audio and video quality chart who joined the call was recorded. Both figures are purely a visual representation of the audio and video quality as no quantifiable data was available to provide. The yellow indicators on the graph represent a weaker connection for audio. The graph's red indicators represent a poor audio connection during the call, which persisted for everyone who joined. None of the lab members on the mock trial wore headphones, and it was suggested that to improve audio quality, participants wear headphones while on the call for a better-optimized experience and limit other audio feedback from their surroundings.

As seen in figure 2, video quality was far better than what the audio quality had shown. Although there were a few weak connection indicators for RA #1, the remaining participants showed a consistent connection throughout the call. There are two dedicated servers on Webex, one for audio and another server routed separately for the video, which concludes that the audio server had an issue unrelated to the video or network during the mock trial. Overall, the

audio/video data collected from the mock trial proves that it is one of the likely problems leading to data collection differences.

Sources of error are attributed to other factors outside of Webex alone. "...all measurements, including those derived from questionnaires and physical tests, consist of an error component" (Bartlett and Frost, 2008). One of these additional sources of error is the connection and call quality of the participants at their homes. Participants in the exercise trials may not have the ability to follow all of the necessary recommendations to improve call quality due to a lack of resources. Another source of error may be the participant's ability to set up the tests. In the in-person setting, the Research Assistant sets up the 4-meter walk course. In the remote setting, participants must accurately measure 4-meters in their home so the research assistants can record their progress. Though not specific to remote assessments, the time between tests can also be a source of error due to possible variability in participant function between the two test points (i.e., related to acute injury or illness). To limit the period of time between tests, the research team aims to complete all re-testing within 1-2 weeks of the original test. The research assistants themselves also may be influenced by the results of the participant's first test visit (Portney and Watkins, 2000). It can be expected that errors will occur during the data collection process, but it is up to the research team to minimize these sources of error (Bialocerkowski, A. E., & Bragge, P, 2008).

CONCLUSION:

To adapt to new COVID-19 regulations, Dr. Winters-Stone's team transitioned from in-person physical functioning data collection to remote data collection. The remote data collection methodology used in both GET FIT prostate and Exercising together is the first of its kind. While the preliminary analyses of intra-rater reliability (same tester) testing look promising, inter-rater

(different tester) reliability has been slightly less favorable. However, more analysis (gained from the mock trial) suggests that the video conferencing interface like Webex may affect the data's reliability. Factors such as network, audio and video quality, broadband speed, all affect the ability to record accurate/reliable data.

Ultimately, we have high confidence in the reliability within the same tester data but should be careful if a new tester is introduced because of differences in their technological set up. To improve this, establishing good ethernet connection to all of the research assistants and completing remote test visits in one specific location, like an office space, can eliminate some of technological differences between the research assistants. Using visual cues instead of verbal cues during a call might also reduce error associated with audio quality.

Transitioning assessments to a remote setting is feasible and allowed the research team to continue running these important trials during the unprecedented time of the COVID-19 pandemic. With access to technology rising and the ability to provide computers/tablets increasing, telemedicine and research similar to both studies conducted by Dr. Winters-Stone can provide a broader range of care and assistance to others across the globe. Transitioning to remote delivery and exercise and physical assessments was not an anticipated adjustment, but it did open the doors to expand this research outside of Portland metro area and reach patients that would otherwise not have access to these important programs.

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