"Kinect-ing" With Clinicians: A Knowledge Translation Resource to Support Decision Making About Video Game Use in Rehabilitation

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[Levac D, Espy D, Fox E, et al. "Kinect-ing" with clinicians: a knowledge translation resource to support decision making about video game use in rehabilitation. *Phys Ther.* 2015;95:426–440.]

Published Ahead of Print:
September 25, 2014
Accepted: September 13, 2014
Submitted: December 19, 2013

Microsoft's Kinect for Xbox 360 virtual reality (VR) video games are promising rehabilitation options because they involve motivating, full-body movement practice. However, these games were designed for recreational use, which creates challenges for clinical implementation. Busy clinicians require decision-making support to inform game selection and implementation that address individual therapeutic goals. This article describes the development and preliminary evaluation of a knowledge translation (KT) resource to support clinical decision making about selection and use of Kinect games in physical therapy. The knowledge-to-action framework guided the development of the Kinecting With Clinicians (KWiC) resource. Five physical therapists with VR and video game expertise analyzed the Kinect Adventure games. A consensus-building method was used to arrive at categories to organize clinically relevant attributes guiding game selection and game play. The process and results of an exploratory usability evaluation of the KWiC resource by clinicians through interviews and focus groups at 4 clinical sites is described. Subsequent steps in the evaluation and KT process are proposed, including making the KWiC resource Web-based and evaluating the utility of the online resource in clinical practice.

The rapidly developing field of virtual reality (VR) offers substantial promise for rehabilitation research and clinical practice. Virtual reality systems use hardware and software to create interactive simulations that engage users in realistic environments.[1] Platforms range from expensive, immersive, laboratory-based systems to low-cost, off-the-shelf video games. Therapy that incorporates the use of VR is currently used to target clinical outcomes in many patient populations. Systematic reviews summarizing the evidence in this diverse field support the use of VR in upper limb rehabilitation[2,3] and call for ongoing, high-quality methodological research to support its optimal use in practice.[4–8] Yet, evidence for effectiveness is only one relevant piece of the puzzle. Clinicians also require support in the form of knowledge translation (KT) resources to inform decisions about *how* to use VR in clinical practice.[9,10] Developing accessible, clinically relevant KT resources may enhance integration of VR systems into rehabilitation.

Using KT to address the evidence-to-practice gap is a key priority for both the National Institute on Disability and Rehabilitation Research (NIDRR)[11,12] and the Canadian Institutes of Health and Research (CIHR). *Knowledge translation* is defined by CIHR as "a dynamic and iterative process that includes synthesis, dissemination, exchange and ethically-sound application of knowledge to improve the health of Canadians, provide more effective health services and products and strengthen the health care system."[13] Traditional KT strategies include the use of printed educational materials, audit and feedback, and tailored interventions.[14] Although little is known about which specific KT strategies are most effective in physical therapy,[15] active strategies involving multiple methods have the greatest support.[14,16] In addition, using the Internet as a platform for KT resources or tools is becoming increasingly popular because of the potential to lead large numbers of individuals through self-paced, self-directed learning of up-to-date multimedia content.[17,18]

Accessible, user-friendly KT resources to support clinical decision making about VR integration into practice are needed because clinicians worldwide are embracing the use of these systems.[19–21] A focus group reported that video gaming is the most prevalent assistive technology used by therapists in stroke rehabilitation in the United Kingdom.[21] In Australia, 76% of stroke rehabilitation units have access to the Nintendo Wii (Nintendo, Redmond, Washington).[19] A survey of occupational therapist and physical therapists working in a Canadian rehabilitation hospital showed that 76% of respondents believed the Wii to be beneficial for inpatient clients, with 73% agreeing that its use could enhance client adherence to intervention programs.[20] However, platforms and games are released at a pace surpassing that at which research exploring their utility can be conducted and disseminated. For example, the Wii was released in 2007, with the first case report with application to rehabilitation published in 2008[22] and a game analysis to guide clinical decision making disseminated in 2011.[23] However, the evidence for this system compared with standard of care is only recently becoming available[20,24–34] and is inconclusive.

The newest game console in the clinical environment is Microsoft's Kinect (Microsoft Inc, Redmond, Washington). Its infrared sensor allows full-body, motion-controlled play. The Kinect sensor, designed for use with Xbox 360 games, removes the potential for "cheating" inherent to the Wiimote (Wii remote), although it has limitations recognizing users in seated positions. Evidence is emerging for use of the Kinect Xbox games as rehabilitation interventions for diverse populations, including adults with stroke[28,35] and multiple sclerosis,[36] children with cerebral palsy (CP)[37] and ataxia,[38] and adolescents with ankle sprains.[39] This early literature demonstrates benefits for individuals undergoing training using the Kinect toward a variety of short-term outcomes related to upper limb use, balance, and mobility.

Despite the growing evidence in support of the Kinect and other VR systems as an adjunct to physical therapy, many factors affect translation of this technology into practice.[40] Physical therapists and occupational therapists in brain injury rehabilitation identified barriers in knowledge and time as constraints to using the Interactive Rehabilitation Exercise System (IREX).[9] Even though they perceived the IREX as useful and applicable, they had difficulty with implementation into practice. Increased use of this VR system was facilitated by knowledge translation initiatives.[9] Levac and Miller[10] found that physical therapists using the Wii in a pediatric brain injury setting felt a strong responsibility to learn how to use the system appropriately and wanted education on how to do so. Lack of time and knowledge appear to be the main barriers to implementing VR video games in practice.

Given the history of difficulties adopting previous VR and video game technologies, we sought to proactively address these barriers with the creation of a knowledge resource pertaining to the Kinect with the aim of reducing the knowledge barrier directly and the time barrier indirectly. We focused on the Kinect because we speculate that its hands-free, camera-based interaction

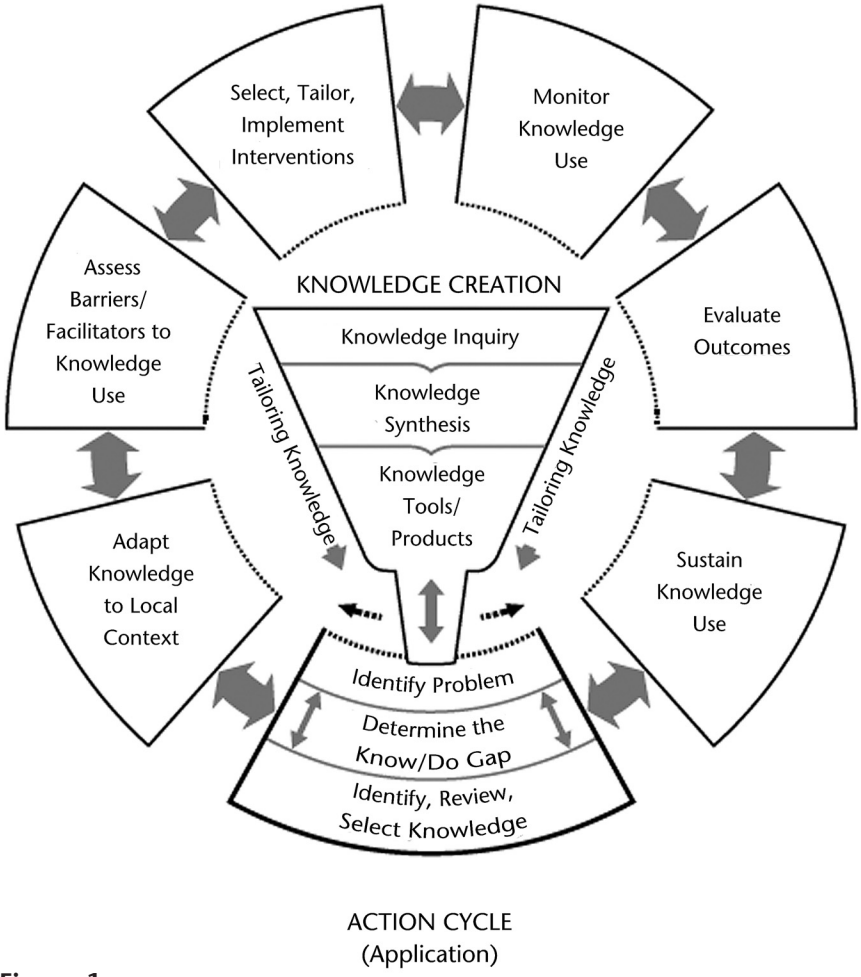

Figure 1.
The knowledge-to-action framework. Reprinted with permission of John Wiley & Sons from: Strauss SE, Tetroe J, Graham ID, eds. *Knowledge Translation in Health Care: Moving From Evidence to Practice.* 2nd ed. Chichester, United Kingdom: John Wiley & Sons Ltd; 2013.

will appeal to clinicians who may be inspired to integrate these games into clinical practice if they had support to inform decisions about game use within goal-oriented rehabilitation programs. Skills in any VR implementation include decision making about matching the intervention to the client, implementation of treatment parameters, and progression through different levels of the game or task.[41] A KT resource to support development of these competencies may maximize the potential benefits of VR use for clients.[9,41] Importantly, we view the knowledge resource as a tool to bridge the gap between the technology and its implementation in physical therapy.

Indeed, successful translation of an innovative technology such as VR into clinical practice depends partially on the availability and quality of appropriate KT resources for that new technology. Creation of those KT resources may best be accomplished with a framework to guide development and evaluation.[42,43] The knowledge-to-action (KTA) cycle[42] (Fig. 1) guides researchers in the process of creating, implementing, and evaluating sustainable KT initiatives. In this article, we describe our use of the KTA framework to guide the development, preliminary usability evaluation, and proposed evaluation of a resource designed to support clinical decision making about selection and implementation of Kinect games for rehabilitation.

Methods

The KTA cycle guided our approach to the development and planned eventual integration into practice of a knowledge resource about Kinect games in rehabilitation. The KTA framework contains 2 components. The first is a knowledge creation cycle in which information is synthesized to create knowledge products, resources, or tools that are directed toward the needs of specific end users. Next, an action cycle outlines distinct steps in activities inherent to translating the knowledge product into practice, including monitoring and evaluating knowledge use.[42] The KTA framework is illustrated in Figure 1. The specific methodology we used for the assessment of the knowledge resource was 4 usability studies conducted as either focus groups or formative evaluations with subject matter experts. The KTA application, namely identifying the problem and creating a knowledge resource, is presented in Figure 2 (parts A and B) and the usability methodology is presented in Figure 2C.

Identifying the Problem

Our approach began with the first step in the action cycle: identifying the problem (Figs. 1A and 2A). In this case, the problem was a lack of information to support use of Kinect for Xbox 360 games in physical therapy toward a variety of clinical goals. When we surveyed the literature, there was no resource to support clinicians' use of Kinect in practice. The authors, a group of physical therapists with VR and video game expertise and publication histories

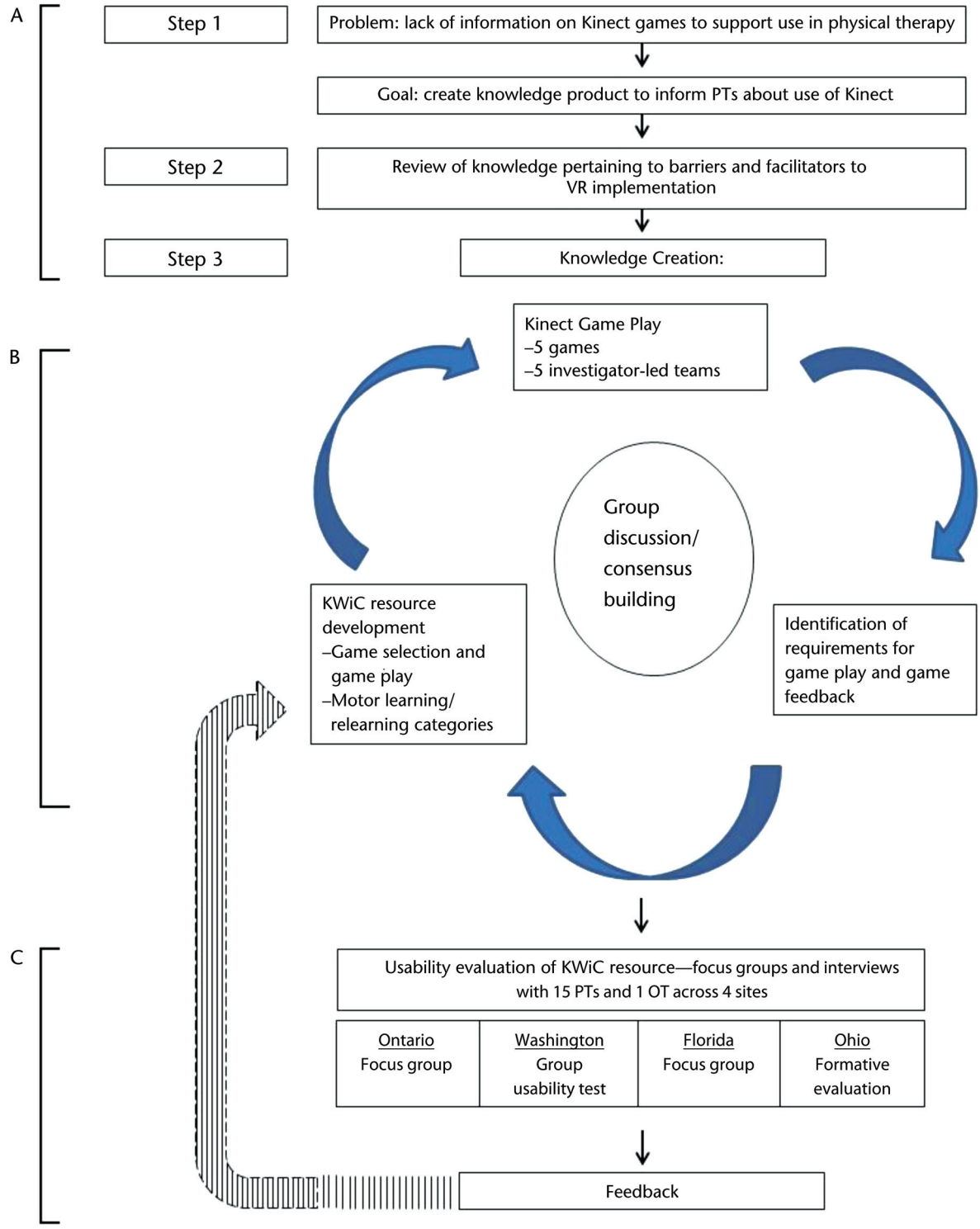

Figure 2.
Knowledge translation-to-action cycle and study method: (A) identifying the problem, (B) creating the knowledge resource, and (C) usability methodology. VR=virtual reality, KWiC=Kinecting With Clinicians, PT=physical therapist, OT=occupational therapist.

in different areas of this field, were invited by one researcher (J.E.D.) to collaborate on this project. We had all observed anecdotal interest in Kinect use among our clinician colleagues and valued its potential in rehabilitation. However, we were familiar with the literature identifying barriers to VR adoption, which suggests that overburdened clinicians were unlikely to have the time or guidance to fully explore the potential of this gaming platform.[9,10] Our goal, therefore, was to create an accessible and clinically relevant knowledge product to inform physical therapists about integrating the Kinect system into practice. Recognizing that the information needed to be applicable across a range of practice settings and client populations, an iterative process to product development was planned, understanding that final content and format would emerge through our team interactions and feedback from end users.[44]

We then sought to identify and review the knowledge relevant to the problem. This knowledge included information described earlier about barriers and facilitators to VR implementation, which motivated our vision of the product as being easily accessible and providing synthesized, clinically relevant knowledge about Kinect game play in written and video formats.

Creating the Knowledge Resource

The knowledge creation component (Figs. 1 and 2B) began with synthesizing the knowledge and experience from previous work in this area, including a Wii game analysis,[23] a classification framework of pediatric VR systems,[45,46] experimental studies using and adapting the Kinect games for rehabilitation,[47,48] and a systematic framework to guide clinical decision making in gaming choices for therapeutic use.[49] We then familiarized ourselves with Kinect game play. Three Kinect games believed to be representative of a variety of movements and virtual environments were selected: Soccer (Sports Season One), Boxing (Sports Season One), and 20,000 Leaks (Adventures). The games were played individually and with each investigator's clinical or research teams. We documented the movements required, the type of feedback provided by the games, and other details that we thought would be relevant to clinicians. These initial observations informed the early version of the content and format of the knowledge product, which we called the Kinecting With Clinicians (KWiC) resource.

We organized the KWiC resource (Appendix 1) into 2 sections: (1) information to inform game selection (ie, what game would a clinician select as most relevant for a particular goal or client) and (2) information to inform game play (ie, specific details about playing an individual game). We then decided on a list of operationally defined game characteristics by which to organize the information in the resource (Tab. 1). Next, we analyzed the 5 Kinect Adventure games, as they come bundled with the purchase of the console and offer a variety of game play options. We developed a print version of the KWiC resource as well as videos illustrating game play of each of the 5 games at beginner and advanced levels.

Resource categories whose therapeutic importance became apparent to us through iterations of game analysis were agreed on after discussion and consensus among the group: game description, entry point, player or game driven, game score, game modifications, and progression. Typically, one member would suggest a category, then the team would discuss their understanding of that construct, its potential importance for clinicians, and how to name, define, and structure it. Each author scrutinized the consensus definition during the next iteration of game analysis, and any needed changes were discussed and agreed on at the following meeting (Fig. 2B).

Other specific therapeutic components of video games were derived from previous work[9,20,42–44] following the same iterative and consensus forming approach (Fig. 2B,) but, in this case, informed by motor learning and motor control principles.[50] Virtual reality, including off-the-shelf games, is appealing as a therapeutic tool, in part, because it can mimic many of the task and environmental features one would modulate in a motor learning treatment approach.[51,52] This approach emphasizes, among other things, active involvement by the patient, the interrelatedness of posture and movement, context (person, task or environment)–specific training or retraining, and appropriate feedback.[53,54] This approach originated in neurological rehabilitation, but its application has been advocated across practice areas[55] and across the life span.[56,57]

The KWiC categories "Stability" and "Mobility" recognize the importance of the interrelatedness of posture and movement[53,58] and were defined from Gentile's constructs of body stability versus body transport,[59] the idea that gait and other human mobility require both stability (not falling) and mobility (moving in the desired direction),[60] and the construct of proximal stability to allow more effective distal mobility.[60] "Mobility plus" was a term we coined to describe those motions that we felt were more demanding than stepping or walking, such as jumping, lunging, and tasks performed in single-leg stance. Motor learning also emphasizes that prac-

Table 1.
Operational Definitions for Categories in the Kinecting With Clinicians (KWiC) Resource

Category	Operational Definition
Game description	Game goal, environment, and major movements
Game entry point	Fixed or variable levels available when a player enters a game
Player or game driven	Player-driven games rely largely on the actions of the player and wait for a response before continuing; game-driven environments progress independent of the player's response
Stability	Maintain a posture or orientation of the trunk and limbs to: allow movement of other body segments, hold body and body segments in a required game position, and resist perturbations[59,60]
Mobility	Movement of body segments to reach a target, avoid obstacles, assume required positions, or "drive" or "steer" the game task[59,60]
Mobility plus	Higher-level movement required, including more athletic balance or mobility tasks such as jumping, lunging, or running in place[59,60]
Spatial accuracy	The type of accuracy required for aiming movements for which spatial position of the movement's end point is important to task performance[65]
Temporal accuracy	The type of accuracy required of rapid movements for which accuracy of movement time is important to task performance[65]
Cognitive operations	Executive functions of planning, response selection, and switching attention[66]
Augmented feedback	Information from an external source that is intended to enhance or replace the intrinsic feedback that comes from a person's own sensory, visual, and auditory systems[50]
Progression	The extent to which the physical or cognitive difficulty level of the game progresses within a single trial of game play
Game score	Performance indicators reflecting a player's success
Game modifications	Potential modifications that can be made in the virtual environment, the physical environment, or the task

tice should be structured around analysis of the person and the task or environment and with attention to feedback.[53,58,61] Spatial and temporal accuracy are crucial regulatory conditions of the environment that must be structured appropriately into relearning of motor skills,[58] making the accuracy demands inherent to individual games important information for clinicians. The definitions we agreed on were taken from the motor control literature[50] (Tab. 1). The ability to augment feedback beyond the means available in more typical therapy sessions has been recognized as a powerful therapeutic advantage of virtual reality,[51,62,63] thus its inclusion as a consideration in this resource. Likewise, the additional cognitive demands imposed by game play are recognized[64] and thus were included.

Usability Evaluation of the KWiC Knowledge Resource

Although the subsequent steps of the KTA action cycle focus on integrating knowledge into practice, we first needed to get feedback from end users about the print and video content of the KWiC product. This is an important step in the development of a new knowledge product, particularly because we had not consulted with end users thus far. We used an exploratory, preliminary usability evaluation[44] methodology with institutional review board/research ethics board approval from our respective institutions. The exploratory usability evaluation involved seeking feedback about the resource from end users through interviews and focus groups at each of our sites.

The 4 sites used the same questionnaire to obtain written demographic information from all participants. Participants were provided with a paper or electronic copy of the KWiC resource and access to the game play videos (hosted on a private YouTube channel). Although all sites used the same questions, the process of familiarizing participants with the resource and obtaining feedback varied slightly. At each site, researchers documented feedback during the session. The list of questions asked during the focus groups or interviews is presented in Appendix 2. The sites differed in their methodology; Figure 2C outlines the process. Ontario and Florida used focus groups, and Washington and Ohio conducted individual interviews. Ohio used a formative evaluation methodology[67] with experts in game analysis.

At 2 sites (Ohio and Ontario), participants perused the resource and vid-

Table 2.
Participant Demographics[a]

Site	No. of Participants	Years of Clinical Practice	Current Practice Area	Confidence Choosing the Most Appropriate Kinect Game for a Client (1=Not at All Comfortable, 7=Extremely Comfortable)
Ontario	6 (PTs)	$\bar{X}$=23.16 SD=7.05 Range=12–30	Outpatient neurorehabilitation (6)	$\bar{X}$=1.8 Range=1–4
Washington	3 (PTs), 1 (OT)	$\bar{X}$=15.5 SD=10.54 Range=8–31	Adult acute care (1), pediatrics (1), neurology/geriatrics (1)	$\bar{X}$=3 Range=2–5
Florida	3 (PTs)	$\bar{X}$=3.5 SD=1.89 Range=0.5–4.5	Adult neurology (2), pediatrics (1)	$\bar{X}$=2 Range=1–4
Ohio	3 (PTs)	$\bar{X}$=24 SD=12.66 Range=11–35	Neurology (2), pediatrics (1)	$\bar{X}$=2 Range=0–4

[a] PT=physical therapist, OT=occupational therapist.

eos on their own prior to meeting with the researcher. At the Florida site, participants were provided with the video links prior to the meeting, and Kinect games were played in person with the researcher prior to introducing and obtaining feedback on the resource. At the Washington site, participants were provided with the resource and shown the videos at the focus group. Participants were asked to read through the game descriptions on the paper resource and select a game that they thought would be most appropriate for a typical client who they may see in their practice prior to participating in the facilitated discussion.

Following the focus groups or interviews, each researcher summarized the feedback obtained per question. Three group discussions were used to synthesize the findings across sites. These findings were then consolidated into Tables 2, 3, and 4. User responses to the quality and clarity of the KWiC were coded as changes to the resource or verification of existing plans. Decisions about changes to the resource were based on the frequency of comments. When there was controversy regarding the comments, the group decided to evaluate that aspect in future studies.

Results of the Exploratory Usability Evaluation

Participant Demographics

Feedback was obtained from 16 participants. Their demographics are summarized in Table 2. Participants had an average of 17.75 years of clinical experience (SD=11.52).

Participants had greater experience using the Wii and relatively little

Table 3.
Responses to Specific Questions

Question	Site			
	Ontario	Washington	Florida	Ohio
1. Game description	No comment	Clarify goal of game	Make more concise/succinct Indicate game movements first	Useful
2. Game selection vs game play	No comment	Not useful	Would use all categories for game selection	Not useful
3. Category names	Stability, mobility, mobility plus need clarification	Some need more explanations Mobility needs clarification	Mobility plus needs clarification	Mobility plus needs clarification
4. Technical terms	Avoid technical terms	Some need more explanations	Mobility plus is a problem	May not be intuitive for less experienced users
5. Videos	Helpful	Helpful	Helpful	Helpful
6. Would resource help you?	Yes	Yes	Yes	Yes
7. Would you use the resource?	Yes, in different form	Yes, in different form	Yes	Yes

Table 4.
Responses to Open-Ended Questions

Question	Site			
	Ontario	Washington	Florida	Ohio
Other categories that could be added	Evidence for Kinect Recommendations for specific populations	Precautions Fall risk Endurance Populations for whom game is inappropriate	None	Modifications Minimal game play movement requirements Recommendations for specific populations Environmental distractors
Other information that could be added	Client version of resource Comparison Wii vs Kinect Game ranking	More info in the progression category Game ranking Video with participant who is unsuccessful	Game rating Game sorting decision-making algorithm	More operational definitions
What could be taken out	Streamline information	Nothing	Too much information in augmented feedback	Advanced videos might not be needed Take out score
Other comments	More information needed on motor categories Advanced videos could better illustrate potential of game play	None	Information under stability, mobility is confusing and inconsistent	Categories may not apply in same way with kids Add the word "required" to spatial and temporal and to cognitive operations Temporal accuracy is important, could be more objective Spatial accuracy (ie, how sensitive the game is to accuracy can be variable) Game duration is nice to have Game vs player driven is clear because familiar with games; if not, this may not make much sense

expertise implementing Kinect games in clinical practice. At the Ontario site, 3 therapists had previously used the Wii with clients in clinical practice, and the same therapists had experience using Wii games recreationally. Two participants had used the Kinect recreationally. However, none had used this system with their rehabilitation clients. Ohio site participants were more familiar with Wii than Kinect, although 1 participant did use Kinect recreationally. All participants reported that their method of game choice was clinical reasoning based on how well the games matched the clients' goals and therapeutic needs. In Florida, all participants had familiarity with VR video games. Two of the 3 therapists had used VR in the clinic, and 1 participant had previously used the Kinect in the clinic. Participants reported that their current method of decision making to use games is to determine patient impairments and select games that appear to meet these needs. Washington site therapists were all familiar with the Wii, and only 1 therapist had used the Kinect for recreational purposes. These therapists reported that they consider patient safety, interest in games, and their own prior experience with the games when making decisions.

Feedback Summaries by Site

Tables 3 and 4 summarize the feedback obtained per site.

Decisions About Changes to the KWiC Resource

In deciding how to interpret the feedback across the 4 sites, we focused primarily on the comments that were similar across the groups.

Changes

- Game description: will be standardized by the order and detail of information across each (in terms of starting with goal of the game or the movements required).
- Game selection versus game play: will be further evaluated using the Web interface when the resource will be tested in the context of clinical decision making.
- Category names: the labels and definitions of "Stability," "Mobility," and "Mobility plus" need to be renamed and revised for clarity using labels that are consistent with clinicians' terminology.[68]

Verification and Enhancements

- Videos were uniformly viewed as an important component of the KWiC resource. Advanced-level videos will be reviewed to better illustrate the movement potential of

this challenge level. Filming more videos illustrating players having difficulty with movements required for the games will be considered in order to facilitate clinician problem solving.

- Participants uniformly reported positive responses about using the KWiC resource. It is anticipated that the Web implementation will make it user-friendly.
- Comments regarding categories and information that could be added were numerous and specific. Clinicians requested ranking information for the games in the different categories, as well as including a decision-making algorithm in the online resource to facilitate finding the games that might best fit a particular goal or client population.

Discussion

Given the rapid development of motion capture technology and the decline in the cost of video game consoles, we identified a need to support clinicians in their efforts to adopt these technologies into practice. This need is specifically relevant for off-the shelf consoles such as the Kinect for Xbox 360, where the games were not designed for rehabilitation. We used the KTA framework to inform the development and eventual evaluation of a knowledge product to facilitate clinical integration of Kinect games into practice. This article describes the first step in this research program, a preliminary usability evaluation of the KWiC resource, with clinicians at 4 clinical sites. Our assumption that clinicians want a knowledge resource was universally supported by the participants, solidifying our plans to create a Web-based, video-enhanced resource. We learned the importance of using familiar and standardized terminology. The feedback obtained through this evaluation will guide decisions about changes to be made to the KWiC resource. We now discuss the methodological advantages and disadvantages of the usability evaluation used in this study as a way to inform future research. Finally, we outline how the KTA framework will guide our subsequent research plans.

Methodological Advantages and Disadvantages

Obtaining feedback in slightly differing ways from a variety of clinicians was both advantageous and problematic with respect to summarizing and utilizing that feedback to make changes to the KWiC resource. We discuss how feedback was obtained according to relevant features of our process.

Participants and their relationship to investigators. Our participants had varied clinical and VR experience. This range of experience was potentially advantageous as it allowed us to obtain richer feedback on the resource and was potentially representative of future users of the resource. However, participants practiced primarily in neurologic and pediatric settings. Inclusion of clinicians working with clients with orthopedic and geriatric conditions will enhance the generalizability of the KWiC. The participants had a professional association with the researchers. The advantage of this prior association was reflected in the depth of discussion regarding the resource and the apparent interest the participants had in contributing to improvements in the resource. The limitation or disadvantage is the potential reluctance of the participants to provide highly critical feedback to a colleague.

Familiarization with the resource. Our initial aim was to provide the resource ahead of time for review by participants. We assumed that participants would familiarize themselves with the resource, but this did not always occur. This lack of familiarization resulted in less rich feedback than we had anticipated, as some participants needed to familiarize themselves with the resource during the brief interview time. Some sites anticipated this limitation and allowed time during the focus group to review the resource and discuss it, but others did not.

Differing methods. Slight differences in terms of whether participants were interviewed alone or in a focus group as well as whether games were played during the focus group may have had an impact on the depth of feedback provided. In addition, users in a group setting may influence each other, resulting in some data loss from a user study perspective.[69] Methodological differences were largely in an effort to individualize the process for the participants and to obtain the most useful feedback. Another limitation is that the way we asked participants to consult the resource was not particularly context-based in that it was isolated from a clinical sense. Clinicians may have been able to give more feedback had they been asked to think about a particular client (as was done at the Washington site) and consider whether the resource would be helpful in making decisions about that particular client.

In a true user-centered design, we would have involved users from the beginning of the study.[44] We chose instead to use our experiences and perspectives, as we all had worked with clinicians and or physical therapist students to implement games in practice. We acknowledge this as a limitation in our process.

Subsequent Research Plans

The action cycle of the KTA framework will structure the next steps in the research process. First, we will make the changes described above to the KWiC resource. We will then adapt the new version to an online format. Online KT resources aim to

disseminate research findings or translate evidence-based knowledge into practice with the goal of increasing awareness and stimulating practice change.[70] Using the Internet as a platform for KT resources or tools is becoming increasingly popular because of its potential to lead large numbers of individuals through flexible self-paced, self-directed learning of up-to-date multimedia content.[71,72] Evidence supporting the use of online resources to translate knowledge in rehabilitation is emerging.[18,73–75] Best practice guidelines for the development of online KT resources in rehabilitation were proposed by Levac et al[70]; these guidelines will be followed in creating the website. An online resource may be an efficient method of achieving KT aims across geographic boundaries while applying adult learning principles to promote self-paced and self-directed ongoing learning. The online KWiC resource will include a "wiki" component, allowing clinicians to contribute their knowledge by suggesting therapeutic adaptations to games, analyzing new games, and providing ongoing feedback on resource content.

Next Steps

Mixed-method evaluation of content and format of the new Web-based KWiC resource. This step will involve a larger sample size that is more representative of different practice areas. The method will be an online survey with a qualitative content analysis.[76] We will first present participants with a selection of 1 of 4 case scenarios representative of use of the Kinect in different physical therapy practice areas. Participants will peruse the KWiC resource in the context of making a decision about which game to select for that particular client. They will provide feedback about content and format of the resource through an online questionnaire. The next phase of the KTA action cycle—assessing barriers to knowledge use—will be targeted through the questionnaire by asking participants questions about factors that would influence their use of an online KWiC resource to inform their clinical practice.

Tailor the intervention. We will then tailor the intervention by making subsequent changes to KWiC resource based on feedback received from this questionnaire. We also will expand the resource to include more Kinect games.

Implement intervention, monitor knowledge use, and evaluate outcomes. Once we have completed the usability evaluations and are confident that the content and format of the resource meets clinicians' needs, we will evaluate the impact of use of the KWiC resource on clinical decision making. Possible research methods could include a comparative study evaluating clinicians who use the KWiC to inform their Kinect intervention programs and those who are not exposed to the resource.

Sustain knowledge use. This phase of the KTA action cycle will be targeted following successful and effective integration of the KWiC resource into practice by continually adding new games as they become available, summarizing emergent research evidence, monitoring the wiki, facilitating a discussion forum, and uploading additional video content to the resource, including short videos illustrating tips and techniques related to Kinect use with different patient populations.

Conclusion

Kinect for Xbox 360 games are accessible, motivating, and potentially challenging options for a variety of rehabilitation clients. The diversity of the games and their development for healthy populations implies that busy clinicians may require resources to support decision making about integration into rehabilitation clinical practice. Rather than simply deciding to use a new technology because it is popular, clinicians can learn to match the features of the system and the game characteristics to the needs of individual clients to achieve therapeutic benefit. It is important for clinicians to be comfortable enough with the technology to evaluate its effectiveness and to adapt it to changing needs. These goals informed the development and exploratory usability evaluation of a KT resource (ie, KWiC) designed to meet these goals. This article described the process and feedback received from the usability evaluation and outlined subsequent research plans for improving and further evaluating the KWiC resource using the KTA framework to guide the proposed research methods. We believe that an online KT resource that incorporates multimedia content and contains a discussion forum is the ideal format. After further user-based evaluation and feedback, we will explore the clinical utility of the KWiC resource by monitoring and evaluating outcomes related to its use.

All authors provided concept/idea/project design, writing, data analysis, and facilities/equipment. Dr Levac, Dr Espy, Dr Fox, and Dr Pradhan provided data collection and participants. Dr Levac and Dr Deutsch provided project management and consultation (including review of the manuscript before submission). The authors acknowledge University of Florida undergraduate student research assistants for assistance with data collection at the Florida site and Bryan Barker, PT, PhD, and Andrew Grando, PT, PhD, research assistants in the Rivers Lab, for extensive work on game analysis at the New Jersey site.

Funding for this project was provided by the Rutgers Foundation and the Rivers Lab. Dr Levac is supported by a postdoctoral fellowship from the Canadian Institutes of Health Research.

DOI: 10.2522/ptj.20130618

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Appendix 1.

Kinecting With Clinicians (KWiC) Resource[a]

Game	20,000 Leaks	River Rush	Rally Ball	Reflex Ridge	Space Pop
Description	Using hands, feet, and head, player side steps or lunges to reach and close the leaks that are generated by fish and sharks crashing into the glass bubble separating the player from the sea.	Standing on a raft, player leans forward and sideways and jumps to navigate down the rapids while contacting targets with arms, head, and body. Pinwheel gates only give you the coins that you hit with the raft. If you hit the gate on the inside, you get the bonus; if you hit the gate on the outside, you do not get the bonus.	Using limbs, head, and trunk, player side steps to contact moving balls in order to hit boxes and 2 kinds of targets in an arcade environment.	Standing on rail cart, player avoids obstacles by bending and side stepping (or medial lateral displacements) from side to side while concurrently using arms to collect coins. Jumping makes the cart go faster.	Player side steps and squats to move around and flaps and raises arms to elevate the avatar in a spacescape in order to hover over and pop bubbles and obtain coins.
Game Selection					
Entry Point	Flexible entry point: 9 levels (3 beginner, 3 intermediate, 3 advanced)				
Player or Game Driven	Player driven	Game driven	Game driven except to restart	Game driven; speed adjusted by player jumping	Game driven
Stability	YES: Trunk	YES: Standing, trunk	YES: Standing; trunk for UE use	YES: Standing	YES: Trunk
Mobility	YES: UEs, LEs, trunk, head	YES: UEs, LEs, trunk	YES: UEs, LEs, trunk	YES: UEs, LEs, trunk	YES: UEs, LEs, trunk
Mobility Plus	NO	YES: Jumping and side stepping (give you a better score)	YES: Side stepping at higher levels	YES: Jumping, dodging (with a weight shift), and ducking to avoid obstacles	NO
Game Play					
Spatial Accuracy	YES: UEs, LEs, trunk, head must have the correct end point in order to plug the leak	YES: When jumping to land the raft on different areas throughout the game and weight shifting to steer the raft	YES: You must be positioned correctly to hit balls and accurately hit targets	YES: When avoiding obstacles	YES: Avatar has to be in the right location to pop bubbles
Temporal Accuracy	NO	YES: Timing to get raft through the gates, directing the raft in the air to land on objects, jumping over objects	YES: Accurate timing required to hit balls	YES: Accurate timing required to avoid obstacles	YES: Low component (time constraint to pop the bubbles)
Game Duration	2:15 (3 rounds, 45 seconds each)	Variable, approximately 2–3 minutes	2:15 (3 rounds, 45 seconds each)	1:50 to complete track	Three waves: (approximately 3 minutes)
Cognitive Operations	Planning: • must plan placement and position of UEs, LEs, and head to plug the leaks • fish make different noises, allowing you to prepare for more or less cracks (3 beginner, 3 intermediate, 3 advanced) Response selection: • choosing which part of the body to use to block the leaks	Planning: • see the gates and coins while maneuvering the raft in advance to get to the gates Switching attention: • if getting through the gates, landing on objects, or collecting coins is a task, then you must switch attention between gates, coins, and objects Response selection: • at junctures, the player selects different river routes	Planning: • select the best direction, velocity, and amplitude of the movement to maximize the number of targets • learn how to control the ball Switching attention: • keep track of target and hit balls • switch attention between changing targets and moving ball	Planning and response selection: • planning pattern of jumping, ducking, and reaching for coins in advance Switching attention: • switch between getting coins and avoiding obstacles	Planning: • plan on how to pop the bubbles • holes on the walls light up where bubbles will emerge Switching attention: • switch between bubbles and lights on the wall

(Continued)

Appendix 1.
Continued

Game	20,000 Leaks	River Rush	Rally Ball	Reflex Ridge	Space Pop
Augmented Feedback	Visual: • when body part is appropriately placed over a leak, the body part lights up • see the water either flow or stop flowing • timer on the left side of screen • when leaks are plugged correctly, you see coins go into the coin counter on the right • medal color appears on the right under the coin counter • confetti at the conclusion of the round • multiple leaks can be connected by a crack in the glass, indicating that those leaks are to be plugged simultaneously • if crack-connected leaks are not plugged fast enough, the cracks disappear, allowing the cracks to be plugged individually Auditory: • a ding is heard when leak is plugged properly • can hear the water leaking in when leak is not plugged • hear a tick for every second during the 10-second countdown • hear the coins dropping into the coin counter after they are earned • louder bell sounds when you attain a medal • hear the crowd cheer when you plug a big leak (multiple leaks connected with cracks)	Visual: • wind streaks after passing through pinwheel gates • see coins move into the raft coin meter after they are collected • see the environment move past you on the raft • water splashes in front of raft as you move • gates and wooden objects shatter if you hit them • water splashes on the screen when raft lands after a jump • see coins received for passing through gates with red flags Auditory: • hear the water splash as you land • hear the coins get counted as you collect them • hear the crowd cheer • hear the wind blowing when you get a speed boost	Visual: • ball is on fire when hit hard • trajectory of the ball after contact • contact with a target rewards the player with more balls to hit or the explosion of a box • if you finish in less time, you get bonus points • see timer • see coin counter • see medals appear as they are earned Auditory: • hear boxes or targets explode • hear coins entering coin counter • hear a sound when you are rewarded a medal • hear sound of hand hitting ball • hear flames when ball is hit hard • hear the timer count down the last 10 seconds • hear crowd cheering • game noises for success or failure	Visual: • sparks on the rails when you jump • see stars when you hit an object • see coins accruing when you avoid an obstacle • see counter increase when coins are acrued • jumping and accurate lever pull increase your speed (see wind streaks) • hitting an object slows you down (see environment slow down) • written cues to "jump to increase speed" • confetti and crowd cheering Auditory: • whoosh sound and wind streaks re-enforce accuracy of grab bars • bonk when you hit an object • coin sound when you avoid an obstacle • sound when you get the coins	Visual: • blue mist appears when bubbles pop • see the coins go into the coin counter for each bubble popped • score in the top right corner of the screen • see medals appear as they are earned • cylinder in back left corner of screen holds water that decreases in level to represent each wave of bubbles within the round • cylinder lights up green each time it decreases in level to start the next wave • flapping arms causes the avatar to fly • arms at side, and you see the avatar fall to the platform again Auditory: • hear the bubbles popping when you hit them • hear the coins go into the coin counter • hear a ding every time you achieve a medal • hear the cylinder gurgle and bubble when the level is dropping • crowd cheers when you pop all bubbles
Progression	Physical and cognitive difficulty increase subtly within and greatly between levels • more multiple leaks and leaks connected by cracks require simultaneous plugging in the upper levels	None	Each level, need to hit more boxes/more boxes given	Difficulty increases within game-speed player, obstacles are more difficult	No progression within game Difficulty increased by level
Game Score	Score is number of coins achieved for plugging leaks and time bonus; medal	Score relates to number of coins earned by accurately contacting them and time to complete courses; score can be augmented by a time bonus; medal	Score represents number of blocks/targets hit plus bonus points; medal	Score represents number of points earned and time to complete course; can increase with a time bonus; medal	Coins earned by popping the bubbles; medal
Game modifications can be categorized as physical environment, virtual environment, and task. This section of the resource is planned as a wiki so users may add their experience. An example of a physical environment modification is changing the support surface. An example of changing the virtual environment is eliminating the volume. An example of changing the task during Reflex Ridge is telling the player not to jump (makes the game easier) or to attend to every other target (also makes the game easier).					

[a] UE=upper extremity, LE=lower extremity.

Appendix 2.
Focus Group Interview and Written Questions

Interview questions:

1. What did you think about each game description?
   - (Prompt for specifics)
2. What did you think about the breakdown into game choice vs game use?
3. What did you think about the category names?
4. Were there any technical terms that you were not familiar with?
5. What did you think about the videos?
6. Would the resource help your decision making about using these games in clinical practice? Why or why not?
7. What other categories would you like to see included?
8. What information was missing? What could be added?
9. What information could be taken out?
10. Would you use this resource to assist you in selecting video games to be used as part of a patient intervention? Why or why not?
11. Please make any other suggestions or comments or give other feedback about any of these questions or about the content of the resource overall.

Written questions:

1. Have you used any virtual reality system (Nintendo Wii or WiiFit, Microsoft Kinect for Xbox, Sony Move for Playstation) within your rehabilitation interventions? Yes___ No____
2. If yes, please list which system and describe use.

   System:

   Duration of use:

   Specific games most used:
3. With respect to the Kinect, How comfortable/confident are you in choosing the most appropriate games for your clients? (1–7; 1=not at all comfortable, 7=extremely comfortable)
4. Please describe how you currently decide which game(s) to use as part of a patient intervention. In other words, what process or criteria do you use to select a game to be played with a specific patient as part of their intervention? (open answer)
5. Do you use any virtual reality system (Nintendo Wii or WiiFit, Microsoft Kinect for Xbox, Sony Move for Playstation) for recreational purposes outside of work hours? Yes___ No____
6. If yes, please list which system and describe use, including hours used per week?

   System:

   Duration of use:

   Specific games most used: