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ORIGINAL ARTICLE

Usability, acceptability, and implementation strategies for the Exercise in Cancer Evaluation and Decision Support (EXCEEDS) algorithm: a Delphi study

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Abstract

Introduction Oncology guidelines recommend participation in cancer rehabilitation or exercise services (CR/ES) to optimize survivorship. Yet, connecting the right survivor, with the right CR/ES, at the right time remains a challenge**.** The Exercise in Cancer Evaluation and Decision Support (EXCEEDS) algorithm was developed to enhance CR/ES clinical decision-making and facilitate access to CR/ES. We used Delphi methodology to evaluate usability, acceptability, and determine pragmatic implementation priorities.

Methods Participants completed three online questionnaires including (1) simulated case vignettes, (2) 4-item acceptability questionnaire (0–5 pts), and (3) series of items to rank algorithm implementation priorities (potential users, platforms, strategies). To evaluate usability, we used Chi-squared test to compare frequency of accurate pre-exercise medical clearance and CR/ES triage recommendations for case vignettes when using EXCEEDS vs. without. We calculated mean acceptability and inter-rater agreement overall and in 4 domains. We used the Eisenhower Prioritization Method to evaluate implementation priorities.

Results Participants ($N = 133$) mostly represented the fields of rehabilitation (69%), oncology (25%), or exercise science (17%). When using EXCEEDS (vs. without), their recommendations were more likely to be guideline concordant for medical clearance (83.4% vs. 66.5%, $X^2 = 26.61$, $p < .0001$) and CR/ES triage (60.9% vs. 51.1%, $X^2 = 73.79$, $p < .0001$). Mean acceptability was $M = 3.90 \pm 0.47$; inter-rater agreement was high for 3 of 4 domains. Implementation priorities include 1 potential user group, 2 platform types, and 9 implementation strategies.

Conclusion This study demonstrates the EXCEEDS algorithm can be a pragmatic and acceptable clinical decision support tool for CR/ES recommendations. Future research is needed to evaluate algorithm usability and acceptability in real-world clinical pathways.

Keywords Cancer · Exercise · Rehabilitation · Survivorship · Algorithm

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Participation in exercise during and following cancer treatment is associated with enhanced quality of life and 40–50% reduced relative risk of all-cause and cancer-specific mortality [1]. Still, as few as 12% of individuals living with and beyond cancer (i.e., survivors) participate in recommended levels of exercise (i.e., 90 to 150 min per week) [2, 3]. *Cancer rehabilitation* and *exercise services* (CR/ES) exist on a wide continuum to address exercise-related needs — from highly specialized outpatient physical and occupational therapy to community-based exercise prescription and/or counseling services [4]. Systematic review evidence demonstrates participation in CR/ES can reduce barriers to exercise participation (e.g., functional limitations, treatment side-effect burden, exercise self-efficacy) [5, 6]. Yet, for survivors, researchers show participation in CR/ES is often dependent on recommendation or referral from an oncology clinician or other healthcare provider [3, 7, 8].

An individual survivor's medical status, functional level, exercise self-efficacy, and goals dictate the most appropriate (that is, safest and most efficacious) type of CR/ES [4, 9–12]. At least 69 oncology clinical practice guidelines recommend referral to CR/ES in general, when receiving specific treatments (e.g., hematopoietic stem cell transplantation, immunotherapy) or in the presence of common side effects (e.g., fatigue, lymphedema, pain) [13]. However, existing guidelines have limited applicability for providing appropriate CR/ES recommendations to individual survivors at different stages along the cancer care continuum [14] and are infrequently used by healthcare providers [15]. In one survey study, 80% of oncology clinicians were unaware of the guidelines for CR/ES or how to integrate them into clinical decision-making [15]. As a result, approximately 50–80% of survivors with exercise-related needs is not referred to CR/ES [16, 17].

To enhance clinical recommendations and referrals for appropriate CR/ES, international leaders in oncology, rehabilitation, and exercise oncology call for a multidisciplinary risk-stratified clinical pathway [9, 18]. Clinical decision support tools exist in a variety of formats (e.g., algorithm, clinical pathways, structured reminders) and platforms (e.g., electronic medical record [EMR], web-based, print) to improve patient-centered clinical recommendations during clinical encounters in oncology and other fields [19, 20]. Use of clinical decision support tools is associated with improved adherence to clinical practice guidelines and reduced prescriber error rates [21]. However, no clinical decision support tools currently exist that could be adopted by a variety of clinical users (e.g., oncology, rehabilitation, exercise) or adapted to a variety of platforms (e.g., EMR, web-based, print) to support unified decision-making in a CR/ES clinical pathway.

Recently, Covington et al. (2021) developed the Exercise in Cancer Evaluation and Decision Support (EXCEEDS) algorithm [4]. Successful implementation of EXCEEDS could be an important catalyst to improve clinical recommendations and referrals for CR/ES [22]. However, developing a decision support tool is merely the first step. Strategic selection and utilization of potential users (i.e., those who will adopt and champion the tool), platforms (i.e., media and methods to access/use the tool), and strategies (i.e., techniques to promote integration and adoption) are critical for successful implementation [23–25]. Previous studies of clinical decision support tools have associated low adoption rates and minimal impacts on clinical guideline adherence with poor user-rated usability and acceptability, impractical platform selection, and lack of *a* priori selection of implementation strategies [26, 27].

The aims of this study are to evaluate the usability and acceptability of the EXCEEDS algorithm prior to real-world implementation and to establish consensus for implementation priorities in three domains: potential users, platforms, and implementation strategies.

Procedures

We used modified Delphi methodology [28–30], including three sequential rounds of online questionnaires (referred to hereon as Survey 1, 2, and 3). We selected Delphi methodology because it is ideal to engage a large audience of geographically diverse, expert stakeholders [30], it is appropriate to establish consensus in health research [30], and it has been used previously to validate a variety of clinical support tools [31–33]. Each survey began with consolidated feedback (i.e., preliminary results) from the previous survey. Survey 1 objectives were to determine usability and acceptability. The objective of Survey 2 was to rank implementation priorities. Survey 3 consolidated and ranked priorities drawn from Survey 2. The study was exempt from review by the Institutional Review Board at Colorado State University (20-10145H). Methodology and all findings are reported in accordance with recommendations to improve the rigor and transparency of Delphi studies [34].

Instrument: the EXCEEDS algorithm

The EXCEEDS algorithm (Fig. 1 and Supplement 1) consists of 11 dichotomous (yes/no) questions, organized into 2 sections. Section 1 can be used to decide needs for pre-exercise medical clearance; Section 2 can be used to decide the appropriate level of CR/ES [4]. Algorithm logic is based on extensive literature review and synthesis conducted by a multidisciplinary panel, and is designed to integrate (1) research-based individual characteristics (biomedical, functional, and behavioral) associated with risk of exercise-related adverse event or need for skilled CR/ES intervention,

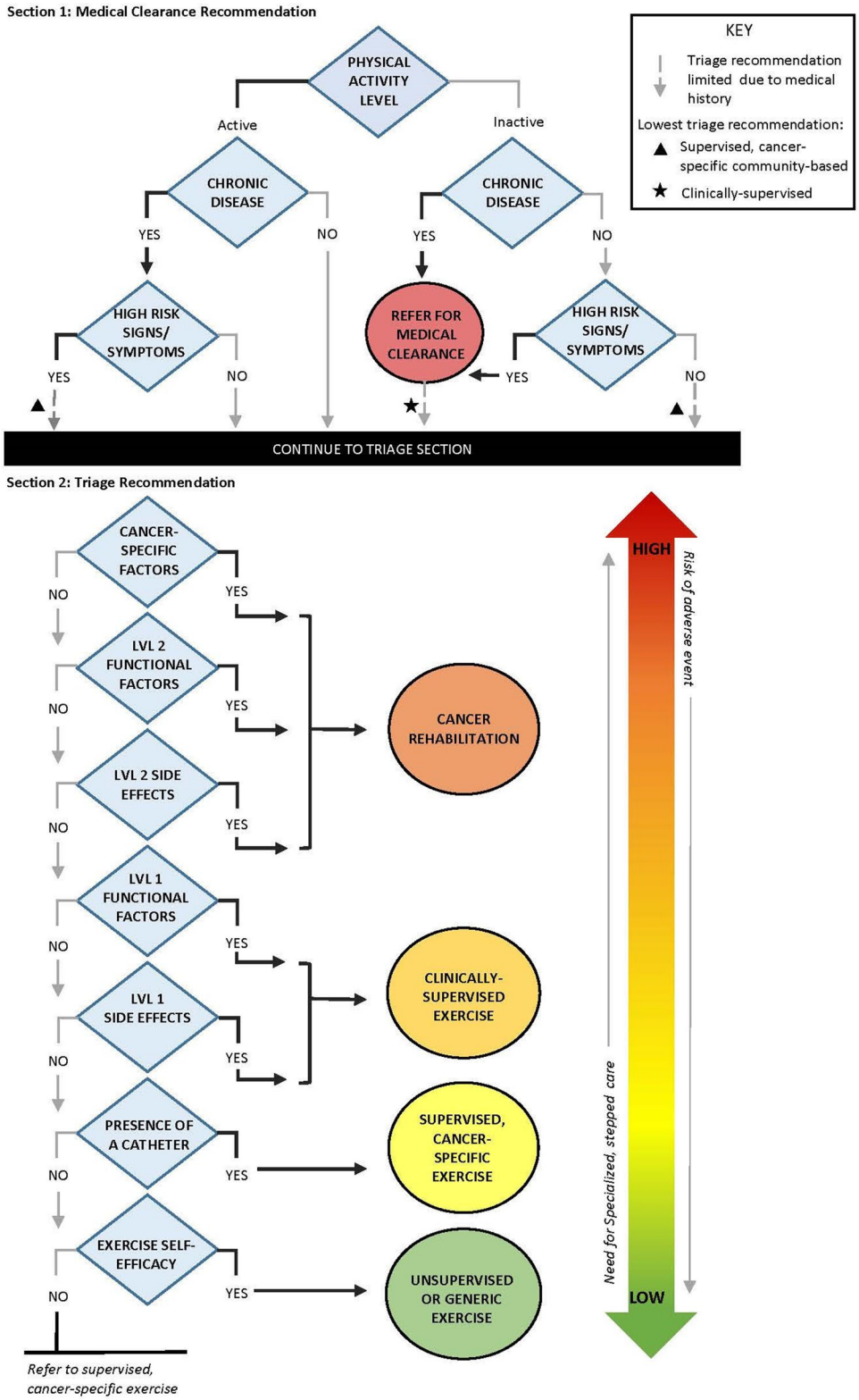

Fig. 1 Exercise in Cancer Evaluation and Decision Support (EXCEEDS) algorithm flow chart diagram. Re-printed with permission from Covington et al., (2020) [4]

with (2) existing oncology clinical practice guidelines' recommendations for CR/ES [4]. EXCEEDS is designed for a range of users (e.g., oncology clinicians, rehabilitation clinicians, exercise clinicians and professionals, survivors) to facilitate bi-directional decision-making and recommendations between oncology and CR/ES. As an example, oncology clinicians could use EXCEEDS to determine the most appropriate level of CR/ES to refer a patient receiving

chemotherapy. A community-based exercise professional could use EXCEEDS to screen clients for medical clearance and/or rehabilitation needs prior to the client initiating a community-based or unsupervised exercise program.

Recruitment and enrollment

We recruited experts in the fields of oncology, cancer rehabilitation, and exercise oncology using an online study advertisement (e.g., posted on social media or blog), listserv emails to members of related clinical organizations (e.g., American College of Sports Medicine, American Physical Therapy Association, and Oncology Nursing Society), and word of mouth (e.g., encouraged participants to share with colleagues). Inclusion criteria were self-identification as a clinician, researcher, or administrator with a Bachelor of Science degree or greater and relevant experience with cancer survivors. There we no exclusions based on geographic region alone. Participants provided consent online using Qualtrics Software, Version XM [35] and then were provided 3 weeks to complete each survey. Only participants who completed the prior survey (e.g., Survey 1) were invited to complete the next survey (e.g., Survey 2). Two reminder emails were sent in the case of incomplete surveys. Incomplete surveys were considered lost to follow-up, and incomplete data were excluded from analysis.

Participants

Two hundred and six individuals consented to participate in the study. Of those, 133 (64.6%) completed Survey 1, 76 (57.1%) completed Survey 2, and 55 (72.4%) completed Survey 3. Participant characteristics are described in Table 1.

Survey 1: Algorithm usability and acceptability

We defined usability and acceptability *a* priori as "the degree to which EXCEEDS could be used to support CR/ES decision-making" and "the degree to which using EXCEEDS is agreeable to support CR/ES decision-making." In Survey 1, participants were randomized to review two of four possible case studies (Supplement 2) and then answered two questions for each case study: (1) "Is pre-exercise medical clearance necessary?" (yes/no), and (2) "What is the most appropriate level of intervention for triage?" Participants chose one of four CR/ES levels for triage: cancer rehabilitation, clinically supervised exercise, cancer-specific community-based exercise, or generic/unsupervised community-based exercise (described previously [4]). Next, participants were provided the EXCEEDS algorithm (Fig. 1 and Supplement 1) as a downloadable PDF. Participants repeated each case study in randomized order but used EXCEEDS to guide their recommendations.

Participants rated algorithm acceptability using the validated, 4-item Acceptability of Intervention Measure (AIM) [36]. Test–retest reliability of the AIM has been established previously [36]. The AIM includes four acceptability domains ("meets approval," "appealing," "like using," and "welcome in practice/discipline"), each rated on a 5-point Likert scale (1 = completely disagree, 5 = completely agree). See Table 2 for each domain [37]. Participants could provide open-ended feedback to enhance algorithm usability and acceptability; however, this feedback was analyzed for algorithm development purposes and not included in this study.

Survey 2 and Survey 3: Potential users, platforms, and strategies

In Survey 2, participants were provided lists of potential algorithm users ($n = 7$ groups), platforms ($n = 6$ types), and implementation strategies ($n = 15$) with instructions to review each list and then perform a series of rankings. Each list with descriptions is provided in Supplement 3. To ensure the potential user groups, platforms, and implementation strategies were relevant to real-world CR/ES decision-making, we drew from existing systematic reviews of clinical decision support systems in cancer care [21, 38] and barriers to CR/ES decision-making [15, 39, 40]. Potential user groups included oncology clinicians or administrators; specialized and non-cancer specialized rehabilitation clinicians; specialized and non-cancer specialized exercise clinicians; cancer survivors; and researchers in related fields. Platform types included open-access websites; restricted-access websites; EMR networks; handheld device applications; clinical print materials; and patient-facing print materials. Platform types and implementation strategies were selected by the lead authors *a* priori from literature review of decision support research in oncology (see Supplement 3) [21, 38] and seminal implementation science literature [24].

Starting with potential algorithm users, participants ranked the ability of each group to benefit from use of the EXCEEDS algorithm, from 1 (most likely to benefit) to 7 (least likely to benefit). Next, participants ranked platform types, from 1 (most important) to 6 (least important) for implementation of the EXCEEDS algorithm. Finally, participants ranked the importance of each implementation strategy (see Supplement 3) from 1 (most important for successful implementation) to 15 (least important for successful implementation).

In Survey 3, participants were provided the 10 highest-ranked implementation strategies from Survey 2 and the following supplementary materials: (1) a brief paragraph about the Eisenhower Prioritization Method [41, 42] and (2) the definition of "successful implementation" established *a* priori by the lead authors. Successful implementation was

Table 1 Characteristics of participants included in analysis ($n=133$)

	Survey 1, $N=133$	Survey 2, $N=76$	Survey 3, $N=55$
Characteristic	*n* (%)	%	
Sex			
Male	30 (22.6)	21 (27.6)	14 (25.5)
Female	102 (76.7)	55 (72.4)	41 (74.5)
Prefer not to answer	1 (0.8)	0 (0.0)	0 (0.0)
Age group			
21–34 years old	38 (28.6)	21 (27.6)	15 (27.3)
35–44	48 (36.1)	25 (32.9)	17 (30.9)
45–54	47 (35.3)	30 (39.5)	23 (41.8)
Race[a]			
White	112 (84.8)	66 (88.0)	47 (87.0)
Asian	14 (10.6)	5 (6.70)	5 (9.09)
Black or African American	3 (2.3)	2 (2.63)	1 (1.82)
Native Hawaiian or other Pacific Islander	3 (2.3)	2 (2.63)	1 (1.82)
Hispanic/Latinx ethnicity (yes)	8 (6.0)	1 (1.3)	1 (1.3)
Country			
USA	97 (72.9)	49 (64.5)	33 (60.0)
Canada	23 (17.3)	18 (23.7)	14 (25.5)
Australia	3 (2.3)	2 (2.63)	2 (3.64)
Israel	3 (2.3)	2 (2.63)	1 (1.82)
Japan	2 (1.5)	2 (2.63)	2 (3.64)
Others (Italy, Costa Rica, Denmark)	6 (4.5)	3 (3.95)	3 (5.45)
Highest degree			
B.S	26 (19.5)	16 (21.1)	11 (20.0)
Masters level	27 (20.3)	13 (17.1)	10 (18.2)
Clinical doctorate	33 (24.8)	18 (23.7)	12 (21.8)
PhD or ScD	22 (16.5)	14 (18.4)	12 (21.8)
MD	23 (17.3)	13 (17.1)	10 (18.2)
Others	2 (1.5)	2 (2.63)	11 (20.0)
Primary discipline[b]			
Physical therapy	58 (43.6)	33 (43.4)	11 (20.0)
Oncology	33 (24.8)	23 (30.3)	26 (47.3)
Exercise science	23 (17.3)	18 (23.7)	7 (12.7)
Research	15 (11.3)	11 (14.5)	4 (7.27)
Occupational therapy	18 (13.5)	8 (10.5)	4 (7.27)
Physiatry	10 (7.5)	6 (7.89)	8 (14.5)
Nursing	6 (4.5)	4 (5.26)	15 (27.3)
Others[c]	4 (3.0)	1 (1.32)	0 (0.0)
Has cancer rehabilitation or exercise clinical certification (yes)	73 (54.9)	41 (53.6)	30 (54.5)
Years of experience			
1–3 years	10 (7.5)	5 (6.60)	4 (7.27)
4–10 years	41 (30.8)	23 (30.3)	15 (27.3)
11–20 years	41 (30.8)	23 (30.3)	17 (30.9)
More than 20 years	41 (30.8)	25 (32.9)	19 (34.5)
Stakeholder group[b]			
Healthcare admin	19 (14.3)	8 (10.5)	6 (10.9)
Licensed rehab professional	72 (54.1)	41 (53.9)	31 (56.4)
Certified exercise professional	17 (12.8)	15 (19.7)	9 (16.4)
Other healthcare providers	62 (46.6)	33 (43.4)	23 (41.8)
Policy maker	1 (0.8)	1 (1.3)	1 (1.82)

Table 1 (continued)

	Survey 1, $N=133$	Survey 2, $N=76$	Survey 3, $N=55$
Research	41 (30.8)	27 (35.5)	21 (38.2)
Others[d]	6 (4.5)	6 (7.90)	5 (9.09)
Current role			
Clinician	83 (62.4)	43 (56.6)	28 (50.9)
Researcher	24 (18.0)	16 (21.1)	13 (23.6)
Admin	16 (12.0)	10 (13.2)	7 (12.7)
Educator	5 (3.8)	5 (6.60)	5 (9.09)
Others	4 (3.0)	2 (2.60)	2 (3.64)
Missing	1 (0.8)	0 (0.0)	0 (0.0)

[a]Race not reported by 1 participant

[b]Could select multiple. Do not add to 100%

[c]Other disciplines included: psychology, internal medicine, speech language pathologist

[d]Other stakeholder groups included: consultant, survivor advocate, healthcare education professional, cancer previvor, business development, nonprofit director

[e]Other current roles included: advocate, mentor, non-profit founder, program development

Table 2 Expert-rated acceptability of the EXCEEDS algorithm and inter-rater agreement by domain

AIM domain item[a]	Average rating, *Mean* ± *SD*	Inter-rater agreement,[b] n (%)
"The EXCEEDS algorithm meets my approval."	3.79 ± 0.79	96 (72.2%)
"The EXCEEDS algorithm is appealing to me."	4.05 ± 0.81	113 (85.5%)
"I like using the EXCEEDS algorithm."	3.76 ± 0.92	90 (67.7%)
"I welcome the EXCEEDS algorithm in my discipline or practice."	4.02 ± 0.78	103 (77.5%)

Note: *AIM* Acceptability of Intervention Measure. Average rating reflects individual level agreement with each domain

[a]Domain rating scale: 1 (completely disagree) to 5 (completely agree)

[b]Proportion of participants who rated the domain ≥ 4 (agree)

defined as "the degree to which the EXCEEDS algorithm is established in a practical, sustainable process (or interface) that is efficient, promotes equitable access to all potential users, and minimizes barriers to care coordination." Following the Eisenhower Prioritization Method (i.e., the "Urgent-Important Matrix" [41, 42]), participants rated each implementation strategy in terms of *effort* associated with using the strategy (1 "low effort" to 4 "high effort") and potential *impact* the strategy could have on successful implementation of the EXCEEDS algorithm (1 "low impact" to 4 "high impact").

Statistical analysis

Usability and acceptability

To determine usability, we coded the medical clearance decision and triage decision for each case vignette as correct (matches EXCEEDS recommendation) or incorrect (does not match EXCEEDS recommendation) and then used Chi-squared (X^2) test to compare the proportion of correct responses when using EXCEEDS vs. without (i.e., independent decision-making). To determine acceptability in each of the four domains of the AIM, we calculated descriptive statistics (mean and standard deviation) and then calculated the proportion of participants who responded "agree" (4 on the Likert scale) or "strongly agree" (5 on the Likert scale) in each domain. For overall acceptability, we averaged all items following AIM scoring instructions [36]. Higher average scores indicate greater acceptability [36]. Cut-off scores indicating high acceptability have not yet been validated; therefore, we established an a priori mean of 4 out of 5 points on the Likert scale (i.e., "agree") as a benchmark. We defined consensus as 70% inter-rater agreement for each domain based on the definition of consensus used in previous Delphi studies [43, 44].

User, platform, and implementation strategy priorities

We calculated central tendency (median and IQR) for all participant rankings collected in Survey 2 (users, platform types, and implementation strategies) and then sorted (high to low) by median rank. To determine inter-rater agreement, we calculated the proportion of participants who ranked each item as a priority. Priority was defined as "top 3" rank (i.e., 1–3) for potential users or platform types, or "top 10" rank (i.e., 1–10) for strategies. We established an a priori benchmark of 70% agreement to indicate consensus [43, 44]. Implementation strategies that did not reach "top 10" rank (i.e., the a priori benchmark) or 70% agreement in Survey 2 were considered low priority and were removed from evaluation in Survey 3.

Following the Eisenhower Prioritization Method [23, 41], we used Survey 3 data to prioritize the "top 10" implementation strategies that resulted from Survey 2. We calculated central tendency (mean and standard deviation) of *effort* ratings and *impact* ratings for each strategy. Using mean *effort* (x) and mean *impact* (y) ratings as coordinates, we plotted each of the top 10 strategies onto the Eisenhower Matrix [23]. Using the matrix plot and corresponding 2.50 median cut-offs, we categorized each strategy in terms of urgency and importance using previously established prioritization categories (ordered from greatest to least priority): "Do now" (low effort, high importance), "Decide" (high effort, high importance), "Delegate" (low effort, low importance), and "Delete" (high effort, low importance) [23, 42].

Results

Usability and acceptability

When using EXCEEDS vs. without, participants were more likely to make the appropriate medical clearance recommendation (83.4% vs. 66.5%, $X^2 = 26.61$, $p < 0.0001$) and CR/ES triage recommendations (60.9% vs. 51.1%, $X^2 = 73.79$, $p < 0.0001$). Mean overall acceptability score was 3.90 ± 0.47 (range = 1.0–5.0). Consensus was achieved in three of four acceptability domains: "meets approval" (72%), "is appealing" (86%), and "welcomed in practice/discipline" (78%). Mean score and inter-rater agreement for each domain are provided in Table 2. Most participants ($n = 111$, 82.7%) provided additional open-ended feedback, which will be used to inform algorithm adaptations and implementation.

Consensus for key potential user, platforms, and implementation strategies

Oncology clinicians were ranked the highest priority user group and were the only group to achieve consensus (median rank = 2.0, IQR = 1.0–3.75, inter-rater agreement = 75.0%). Cancer-specialized rehabilitation clinicians were the second highest priority user group but did not achieve consensus (median rank = 3.0, IQR = 2.0–5.0, inter-rater agreement = 56.6%). The remaining user groups were below 70% inter-rater agreement: specialized and non-specialized rehabilitation clinicians, specialized and non-specialized exercise clinicians, cancer survivors, and researchers (Fig. 2).

Open-access websites (median rank = 2.0, IQR = 1.0–3.5, inter-rater agreement = 72.4%) and EMR networks (median rank = 2.5, IQR = 1.0 – 3.5, inter-rater agreement = 69.7%) were the highest and second-highest ranked platforms and achieved consensus. Each of the remaining platforms had less than 70% inter-rater agreement (from highest to lowest): handheld device applications, clinical print materials, restricted-access websites, and patient-facing print materials (Fig. 3).

Consensus was achieved for nine of the 10 highest-ranked implementation strategies (inter-rater agreement range = 93.4–69.7%). The three highest-ranked implementation strategies were (1) "Identify and prepare champions" (median rank = 4.0, IQR = 1.25–9.25, 78.9% inter-rater agreement), "Capture and share local knowledge"

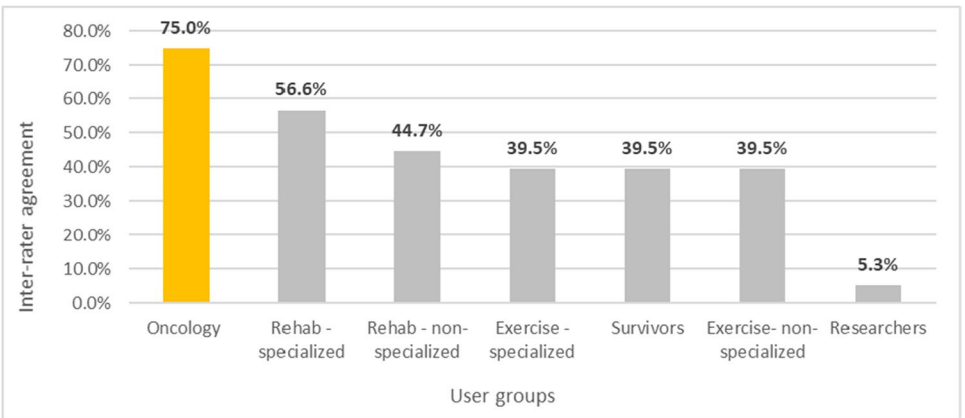

Fig. 2 User priotitizes for implementation of the EXCEEDS algorithm, ordered by rank (1–7). Note: User groups are ordered highest (e.g., 1) to lowest priority (e.g., 7) along the x-axis according to median rank. Yellow shading indicates consensus (70% inter-rater agreement) was achieved

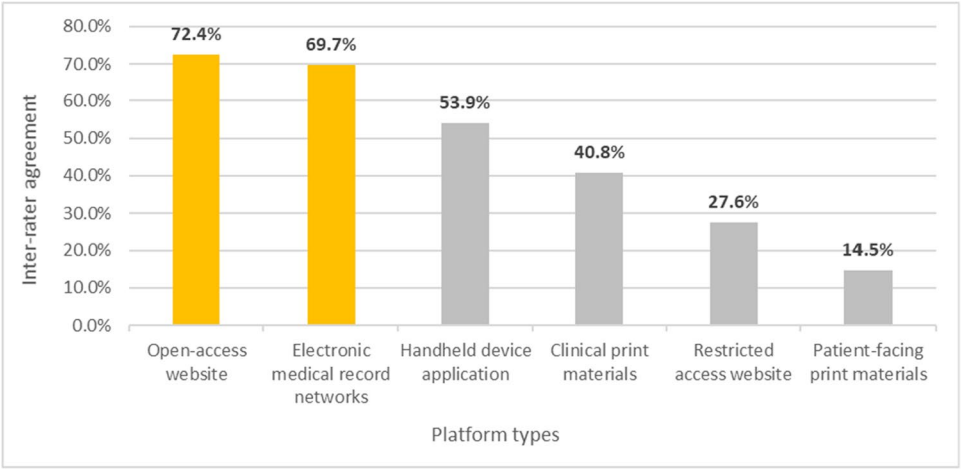

Fig. 3 Platform priotitizes for implementation of the EXCEEDS algorithm, ordered by rank (1–6). Note: Platforms are ordered highest (e.g., 1) to lowest priority (e.g., 6) along the x-axis according to median rank. Yellow shading indicates consensus (70% inter-rater agreement) was achieved

(median = 5.0, IQR = 2.0–7.0, 93.4% inter-rater agreement), and "Develop educational materials" (median = 6.0, IQR = 4.0–11.0, 72.4% inter-rater agreement). The seven remaining top 10 strategies were (from highest to lowest rank): "Stage implementation scale up and tailor strategies" (78.9% inter-rater agreement); "Model and stimulate change" (78.9% inter-rater agreement); "Develop educational materials" (71.2% inter-rater agreement); "Adapt physical structure" (72.4% inter-rater agreement); "Conduct ongoing training" (71.1% inter-rater agreement); "Use advisory boards and workgroups" (69.7% inter-rater agreement); and "Remind clinicians" (67.1% inter-rater agreement).

Mean *effort* and *impact* ratings for each implementation strategy are presented in Table 3. Two strategies were categorized as highest priority (i.e., urgent/important or "Do now"): "Develop educational materials" and "Remind clinicians." Seven strategies were categorized as moderate priority (i.e., important/not urgent or "Decide"). One strategy was categorized as a non-priority (i.e., important/not urgent or "Delete"); no strategies were categorized as low priority (i.e., urgent/not important or "Delegate").

Discussion

In this study, we used Delphi methodology to demonstrate preliminary efficacy of the EXCEEDS algorithm as a useful and acceptable clinical decision support tool to identify the need for clinical pre-exercise medical clearance and to provide CR/ES triage recommendations and

Table 3 Implementation strategy prioritizes for the EXCEEDS algorithm as categorized by the Eisenhower matrix (1)

Eisenhower matrix category	Implementation strategy	Effort rating $M \pm SD$	Impact rating $M \pm SD$
"Do now" (urgent, important)	Develop educational materials	2.51 ± 0.94	2.87 ± 0.88
	Remind clinicians	1.93 ± 0.90	2.76 ± 0.90
"Decide" (important, not urgent)	Identify and prepare champions	2.78 ± 0.88	3.42 ± 0.69
	Capture and share local knowledge	3.05 ± 0.76	3.44 ± 0.69
	Conduct ongoing training	2.82 ± 0.70	3.04 ± 0.82
	Stage implementation scale up and tailor strategies	3.38 ± 0.76	3.38 ± 0.71
	Use advisory boards and workgroups	2.65 ± 0.89	2.62 ± 0.81
	Conduct cyclical small tests of adaptations to physical structure	3.05 ± 0.76	2.71 ± 0.76
	Adapt physical structure	3.07 ± 0.98	2.75 ± 0.78
"Delegate" (urgent, not important)	N/A	N/A	N/A
"Delete" (not important, not urgent)	Model and simulate change	2.62 ± 0.83	2.49 ± 0.79

Note. All ratings based on 4-point Likert scales effort, 1 (low effort) to 4 (high effort) and impact, 1 (least impact) to 4 (most impact). All rankings determined by ordering mean rating #1 (low effort or high impact) to #10 (high effort or low impact)

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referrals. We established consensus for 12 priorities to guide real-world implementation of the EXCEEDS algorithm: one user group (oncology clinicians), two platform types (open-access websites and EMR networks), and nine implementation strategies. EXCEEDS is the first CR/ES clinical decision support tool to be systematically evaluated by potential users prior to implementation.

Oncology clinicians and administrators were the highest-ranked potential user group in this study and the only one to achieve consensus. These results are consistent with CR/ES clinical practice guidelines [11, 13] and previously developed decision support tools [11, 37, 45], most of which place oncology clinicians at the helm of CR/ES decision-making. By testing EXCEEDS with oncology clinicians prior to implementation, this study provides important evidence that EXCEEDS may be especially acceptable and useful for oncology clinicians. By comparison, a recent study by Knoerl and colleagues (2020) concluded that the lack of pre-implementation testing with potential users to understand usability and inform a strategic implementation plan was barriers to clinical adoption and acceptability of a chemotherapy-induced peripheral neuropathy screening algorithm implemented in an EMR [26]. In the study by Knoerl and colleagues (2020), user-rated acceptability was lower than user-rated acceptability of the EXCEEDS algorithm (Knoerl et al., [2020]: mean score = 3.21, domain range = 2.89–3.95, $N = 19$; EXCEEDS [2021]: mean score = 3.90 ± 0.47, domain range = 3.76–4.05, $n = 133$). Furthermore, the implementation strategies categorized as highest priority ("Develop educational materials" and "Remind clinicians") by participants in this study align closely with the barriers reported by Knoerl and colleagues and in other studies of clinical decision support tools [21, 27, 38].

The highest-ranked platforms in this study (open-access websites and EMR networks) align closely with previous calls to use digital platforms to develop clinical decision support repositories. The primacy of these platforms reflects the well-documented growth in engagement and consumer demand for digital patient health information due to technology advances over the past 10 years [46, 47]. While EMR networks are the most frequently cited platform in the oncology clinical decision support literature, cross-discipline communication is a prominent barrier to CR/ES coordination, and reliance on EMR may contribute to communication barriers among disciplines (e.g., oncology and cancer rehabilitation). Alternately, implementation of the EXCEEDS algorithm using open-access digital platforms appears ideal to capitalize on strong growth in technology capabilities and consumerism as indicated by study participants. Currently, plans are underway to integrate the EXCEEDS algorithm with an international directory of active CR/ES programs located on the Moving Through Cancer Taskforce – Exercise is Medicine webpage (https://www.exerciseismedicine.org/eim-in-action/moving-through-cancer/).

Limitations

Our findings represent the opinions of the 133 experts who participated in this study and may not reflect the opinions of all potential CR/ES users. Experts who participated in this study were mostly located in North America (USA or Canada), but other continents were represented (Australia, Europe, Asia). Because healthcare systems and cultural norms or values related to cancer and exercise vary significantly between and among each country, geographic differences may have influenced participant responses. Guided by the findings of this study, future studies and need assessments are needed to understand regional and healthcare system-specific needs regarding CR/ES decision support and elucidate the EXCEEDS algorithm's aptitude to meet those needs.

Although the EXCEEDS algorithm is designed for use in real-world clinical encounters (i.e., point of care or point of need), this study simulates only use at point of care. Additional research is needed to validate the algorithm with key potential user groups and platform types, and to gain survivors' perspectives of algorithm acceptability and usability. In addition, lack of purposeful sampling due to online enrollment methods, could have contributed to variability in participant responses and survey completion rates. For example, approximately one-third of those who consented to participate (35%) did not complete Survey 1. Because Survey 1 was long, participants were not required to complete the entire survey in one sitting (i.e., there was no time limit and participants could start/stop). Non-completion could be partially attributed to survey format and length. Loss to follow-up for each survey was 43% and 28%, respectively, which is similar to previous Delphi studies, including studies with clinical experts in which there was no compensation for participation.

Finally, we want to highlight the reality that cancer survivors' decisions and capacities to participate in CR/ES reflect complex, constantly changing circumstances that are often beyond the control of survivors and their healthcare providers. A myriad of factors influence survivors' access to, and participation in, CR/ES including limited CR/ES program options, survivors' psycho-social challenges, finite resources of time and money, conflicting priorities, and unanticipated or overwhelming negative impacts of treatment. Our intention with the EXCEEDS algorithm is to support clinicians and survivors' ability to make confident and appropriate decisions regarding participation in CR/ES along the cancer care continuum.

Future directions

The algorithm development team [4] will use the results of this study to inform a strategic plan for implementation of EXCEEDS algorithm. Specifically, our implementation strategy will focus on integration into existing open-access websites and oncology EMR platforms. The two highest-ranked implementation strategies will become the priorities for algorithm implementation. Moderate priority strategies will be reviewed and vetted by the algorithm development team to determine appropriate use. Future studies are needed to evaluate usability and acceptability after EXCEEDS is implemented on open-access websites and oncology EMR platforms. In addition, hybrid implementation-effectiveness study designs will be used to evaluate how each of the platforms and strategy priorities in this study may or may not contribute to successful algorithm implementation. We encourage everyone interested in adopting or studying the EXCEEDS algorithm to contact the first author.

Conclusion

In this study we demonstrate preliminary efficacy that the EXCEEDS algorithm can be a useful and acceptable clinical decision support tool for pre-exercise medical clearance and CR/ES triage decision-making. Our results will guide strategic clinical implementation and future research. Thus, the EXCEEDS algorithm can be a pragmatic clinical decision support tool to facilitate improved CR/ES referrals and recommendations.

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Author contribution Dr. Wood led all aspects of the study as PhD dissertation. Drs. Pergolotti, Sharp, Leach, and Bundy served as dissertation committee members and reviewed and advised the study at each stage. The remaining authors participated in algorithm development or assisted with recruitment and aspects of study design.

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Availability of data and coding Data and coding available upon request.

Declarations

Ethics approval The Colorado State University Institutional Review Board has declared the study as exempt from review (protocol #: 20-10145H).

Consent to participate Informed consent was obtained from all individual participants included in the study.

Consent for publication N/A

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