Effectiveness of a Digital Therapeutics-Based Personalized Rehabilitation in Patients with Colorectal Cancer After Surgery for 1 Year

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Introduction

- After colorectal cancer surgery, personalized and comprehensive rehabilitation plays a crucial role in enhancing physical function, alleviating treatment-related symptoms, and improving quality of life (QoL) for patients.
- To facilitate health management according to the treatment phase and patient condition, mobile applications-based digital therapeutics can be a promising approach for patients.
- This clinical trial aims to examine the impact of a one-year personalized rehabilitation program delivered through a mobile application and smart bands immediately following surgery.
- This poster is the result of the 6-month interim analysis.

Methods

Participants

- The inclusion criteria were as follows: (a) aged 19–85 years, (b) diagnosed with colorectal cancer and undergone colorectal cancer resection surgery, (c) uses an Android- or iOS-based smartphone, (d) able to use mobile application and have regular follow-up assessment as outpatient, (e) voluntary participation. The exclusion criteria were as follows: (a) unable to perform exercise and diet management because of severe underlying disease, neuromusculoskeletal disease, or cognitive or visual impairment, (b) communication difficulties.

Study design

- This trial has been conducted at three territorial hospitals in South Korea since May 2021. Eligible participants were randomly assigned to either the digital therapeutics (intervention) group or the conventional education-based rehabilitation (control) group in a ratio of 2:1 (Figure 1).
- Outcome measures included body composition, health-related QoL with EORTC-QLQ-C30, EORTC-QLQ-CR29, physical fitness (grip strength, 30-sec chair stand test, 2-min walk test), pain (NRS), physical activity (IPAQ-SF), and nutrition status (Mini Nutrition Assessment). The intervention group completed a usability questionnaire on digital therapeutics at 6 months after the intervention.

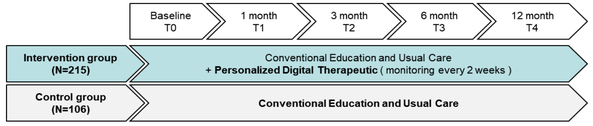

Figure. 1 Study flow according to Group Allocation

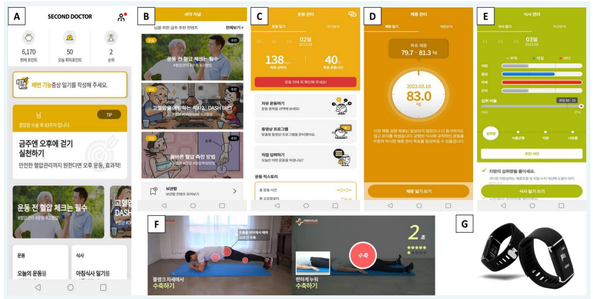

Figure 2. Screenshots of the Representative Function and Smart-Band: (A) home (today's to do list), (B) second doctor journal, (C) exercise management, (D) weight management, (E) diet management, (F) exercise video (pelvic floor muscle training), and (G) DoFit. Reproduced with permission of Medi Plus Solution. Co., Ltd

Personalized digital therapeutic (intervention group)

- The key app functions are indicated in Figure 2. User information for the algorithms of personalized content includes treatment type (chemotherapy), hypertension, initial weight, age, perceived rating of exertion, and comorbid diseases. After the primary analysis using these factors, the user life log data is repeatedly analyzed to provide a tailored guide. Functions of the mobile application and key characteristics are shown in Table 1.

Table 1. Functions of the mobile application and key characteristics

Functions	Key characteristics
Exercise	• Depending on the user's treatment type, it provides an aerobic exercise program that sets a target heart rate and exercise time. In addition, provided by combination of stretching and muscle strengthening exercises and pelvic floor muscle training. Difficulty is adjusted by rating the perceived exertion after the exercise. • The contents of exercise are personalized according to the user information (surgery and treatment type)
Diet	• If a user inputs their daily diet, it provides feedback of the intake, food balance, and protein and fat, with the marking as insufficient, dequate, or excessive. • The weight information entered at the time of membership registration becomes the standard for the initial recommended calorie intake. • It simply recommends foods and its amount for breakfast, lunch, dinner, and snacks. Moreover, it recommends nutritional intake according to comorbid diseases from the 13th week.
Physical activity	• It recommends the target stepping intensity, burning of calories, and heart rate (e.g., 5,000 steps, 200 kcal, etc.).
Comorbidity & Weight	• It indicates target blood pressure and blood glucose level based on the clinical practice guidelines. • It informs the user whether their weight is within the normal weight range.

Results

- In characteristics, the intervention group was younger than the control group, while all other variables were homogeneous at the baseline (Figure 3).

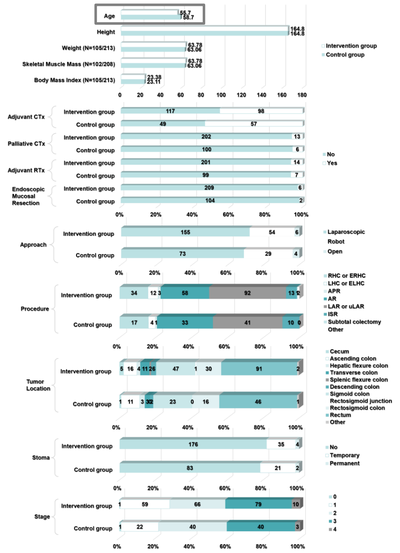

Figure 3. Characteristics of Participants at Baseline (N=321)

- **As a result of interim analysis, the intervention group (n=215) had significant improvement to the control group (n=106) in global health status and QOL scores from the QLQ-C30 at the initial 1 month and 6 months after surgery (Table 2).**

Table 2. Generalized Estimating Equation Analysis for the Comparison of Outcome (EORTC-QLQ-C30) [a]

Outcome	Mean (SE)		Group Effect [b]		Time Effect [c]		Group x Time Effect [d]	
	Intervention	Control	β (95% CI)	*P* value	β (95% CI)	*P* value	β (95% CI)	*P* value
C30 Summary								
T0	82.86 (31.94)	80.40 (31.65)			NA	NA	NA	NA
T1	83.67 (31.90)	80.16 (31.72)	132.10	.000	-0.24 (-2.82 to 2.34)	.856	1.04 (-2.04 to 4.13)	.508
T2	86.84 (31.88)	83.83 (31.83)	(68.38 to 82.12)		3.44 (0.96 to 5.91)	.006	0.54 (-2.45 to 3.53)	.723
T3	88.69 (31.93)	86.18 (31.78)			5.78 (3.23 to 8.32)	.000	0.05 (-2.95 to 3.05)	.973
C30_Quality of Life								
T0	54.66 (52.80)	54.88 (52.75)			NA	NA	NA	NA
T1	61.40 (52.94)	54.07 (52.84)	434.38	.000	-0.81 (-5.71 to 4.10)	.747	7.55 (1.60 to 13.49)	.013
T2	66.84 (52.91)	62.49 (52.76)	(49.25 to 71.11)		7.61 (3.10 to 12.13)	.001	4.57 (-1.21 to 10.35)	.121
T3	69.67 (52.93)	62.14 (52.69)			7.27 (2.53 to 12.00)	.003	7.74 (1.94 to 13.54)	.009

Abbreviations: SE, Standard error; CI, Confidence interval; T0, baseline; T1, 1 month after surgery; T2, 3 month after surgery; T3, 6 months after surgery; NA, not applicable.

[a] The control group (group=0) and baseline measurement (time=0) were the reference categories in the generalized estimating model, adjusting for age.

[b] Group effect was defined as group differences at baseline between groups.

[c] TIme effect at T1, T2, and T3 is defined as each change of scores for the control group at T1, T2, and T3 compared with T0 (baseline).

[d] Group x time effect at T1, T2, and T3 is defined as an addional change of scores for the intervention group compared with the control group at T1, T2, and T3 respectively.

[*] $p<.016$.

- **The intervention group showed good levels of usability (mean 74.8 [SD 12.0] score out of 100). 65.7% of participants showed that this tool was useful for disease management and improving lifestyle and about 70% of participants had willing to recommend it aggressively to other patients.**

Discussion & Conclusions

- To the best of our knowledge, this is the first randomized clinical trial performing digital therapeutics for personalized postoperative rehabilitation in patients with colorectal cancer. The study has several differentiated strong points. First, it starts immediately after the operation for one year. Second, a large number of colorectal cancer patients will be enrolled. Third, the program will be composed of a tailored digital health intervention, modified according to the treatment phase and patient condition.
- This research will be the foundation for supporting the long-term effectiveness of digital therapeutics-based personalized rehabilitation among patients with colorectal cancer. It can provide benefits in subjective health status and the QoL. It could be used for patients to check out their health status more continuously and conduce healthier lifestyles. Further subgroup analysis is needed to explore a differential benefit.

Ethics approval & Publishing

- All study procedures were approved by the Institute Review Board of Samsung Medical Center, Korea University Anam Hospital and Seoul St. Mary's Hospital (approval numbers: SMC-2021-01-090, 2021AN0104 and KC21FNSI0177) respectively.
- The study protocol had published: Kim, I., Lim, J.Y., Kim, S.W. et al. Effectiveness of personalized treatment stage-adjusted digital therapeutics in colorectal cancer: a randomized controlled trial. BMC Cancer 23, 304 (2023). https://doi.org/10.1186/s12885-023-10728-2