

Using Serious Games to Increase Prevention and Self-Management of Chemotherapy-Induced Nausea and Vomiting in Older Adults With Cancer

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OBJECTIVES: To examine the frequency and types of preventive and self-management behaviors reported by participants, as well as report acceptability and usability data for the electronic Symptom Self-Management Training–Chemotherapy-Induced Nausea and Vomiting (CINV) serious game.

SAMPLE & SETTING: 80 adults who were aged 60 years or older and newly diagnosed with cancer were recruited from a community cancer center.

METHODS & VARIABLES: Participants were randomized to an intervention or control group. A symptom management checklist was used to record preventive and self-management behaviors used after each chemotherapy treatment at home. Acceptability and usability were assessed using a brief survey.

RESULTS: The intervention group reported using more preventive behaviors, and the control group reported using more self-management behaviors. Antiemetics were the most common strategy used, followed by dietary strategies. Participants rated all aspects of the serious game highly for usability and acceptability.

IMPLICATIONS FOR NURSING: Oncology providers can help older adults plan for self-managing treatment-related side effects at home. Recording self-management behaviors may reinforce the importance of active prevention and management of CINV.

KEYWORDS serious game; self-management; older adults; chemotherapy-induced nausea and vomiting
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Chemotherapy-induced nausea and vomiting (CINV) is a common side effect of cancer treatment (Loerzel, 2015; Nyrop et al., 2019; O’Neill et al., 2015; Uysal et al., 2018). Older adults undergoing cancer treatment are at serious risk for CINV and associated complications, such as dehydration, fluid and electrolyte imbalances, generalized fatigue, and muscle weakness (Naeim et al., 2014). Severe CINV occurs in as many as 80% of older adults receiving treatment for cancer (Massa et al., 2009), leading to poor quality of life and reduced functioning (Cohen et al., 2007). CINV is one of the most common reasons why patients call their oncologist (Flannery et al., 2014) and can lead to increased use of resources, unplanned emergency department visits, and hospital admissions (Geddie et al., 2016).

Standard practice toward patient education includes providing all patients with basic information about cancer treatment and potential side effects, usually in the form of take-home written materials; however, older adults have reported being overwhelmed by this information (Loerzel et al., 2018). Fitch et al. (2015) reported that, although older adults are satisfied with the information they receive, they believe answers to their questions can be hard to find. Older adults have identified fast-talking providers who use medical jargon and complex written materials as a barrier to educational processes. In addition, previous studies have found that older adults do little to self-manage side effects at home, despite being educated about side effect self-management (Loerzel, 2018), and they do not believe the self-management strategies they are taught are effective at managing side effects (Loerzel, 2016). This lack of self-management or waiting too

long to try to self-manage side effects can lead to increased side effect severity, as well as an increased risk for unplanned emergency department visits, hospital admissions, and costs (Carlotto et al., 2013). Therefore, this study sought to find new ways to educate older adults with cancer on the use and effectiveness of common self-management strategies for CINV. CINV was selected because its pharmacologic and nonpharmacologic treatment strategies are well known (National Cancer Institute, 2014).

Serious gaming is a well-established method designed to support learning and change health-related behaviors by engaging individuals in an entertaining experience. Some of the core tenets of serious gaming are that knowledge sets the stage for behavioral change, practicing skills leads to self-mastery, and modeling is an effective way to learn new skills. Serious gaming provides a safe environment for individuals to learn by doing and then use that new knowledge and skills to self-manage CINV at home.

The electronic Symptom Self-Management Training–CINV (eSSET-CINV) is a serious game that was developed to show older adults the positive impact that preventive and self-management activities could have on side effects and quality of life. At the time that the eSSET-CINV intervention originated, there was a paucity of technology-based interventions for older adults. The few studies that used technology were limited to Wii Fit™ games (Chao et al., 2013) and mobile applications to improve physical activity (Malliot et al., 2012). Avatars and interactive touchscreen technology were also being used to educate older adults about diabetes (Finkelstein & Bedra, 2014). Studies that have used technology including avatars report that they are well liked by older adults (Finkelstein & Bedra, 2014; Green-Hamann et al., 2011). The eSSET-CINV intervention was the first serious game designed for use with older adults with cancer. It was developed using a community advisory board of older patients, caregivers, and oncology nurses (Loerzel et al., 2018) and tested in a two-group, longitudinal, randomized clinical trial (NCT03143829).

This study aimed to examine group differences in the frequency and types of preventive and self-management behaviors used at home by older adults and to report acceptability and usability statistics for the eSSET-CINV serious game.

Methods

Sample and Setting

Older adults receiving treatment for cancer were recruited from the Orlando Health UF Health Cancer

Center in Florida. Eligible participants were aged 60 years or older, newly diagnosed with any cancer, on a three-week treatment cycle, receiving any chemotherapy agent with moderate-to-severe emetic potential, and proficient in English, and had a telephone. Potential participants were excluded if they had a previous diagnosis of cancer, received prior treatment with chemotherapy, had advanced or end-stage disease, were being treated with palliative intent, or were visually or hearing impaired. A power analysis indicated that 66 participants were needed for the study, and 80 participants were recruited.

Procedures

Following institutional review board approval, new patients at the community cancer center's outpatient treatment center were screened for eligibility by a research nurse using the hospital's electronic health record and scheduling system. Eligible participants were approached by the research nurse at the start of their first chemotherapy treatment appointment before receiving premedications. In this cancer center, all patients receive standard education about chemotherapy and potential side effects, including educational handouts, from clinic nurses prior to being scheduled for chemotherapy. Therefore, all participants were aware that they might be at risk for CINV. Potential participants were educated on the requirements of the study. If participants were interested, informed consent was obtained, and baseline data were collected. Participants were randomized to either the intervention or control group by selecting a sealed envelope from a manila envelope. The intervention began immediately for those randomized to the intervention group. Both groups received follow-up telephone calls between treatment appointments to remind them to complete a self-management checklist, describing what they were doing at home to prevent and self-manage CINV.

The intervention consisted of two parts: playing the serious game on an iPad in the treatment room before receiving the first chemotherapy treatment and discussing the outcomes with the research nurse. The serious game focused on making preventive and self-management decisions for avatars who, like the participants, were receiving their first chemotherapy treatment and going to self-manage side effects at home. Within the game, participants chose an avatar, watched a tutorial, and began to make self-management decisions for their avatar once the avatar left the treatment center. Choices included decisions related to antiemetic medication, food and

beverages, and other nonpharmacologic strategies. All choices were based on typical and common strategies taught at the cancer center and available from other resources (Basch et al., 2012; National Cancer Institute, 2014; Tipton et al., 2007). Participants' decisions triggered an algorithm that would cause the avatar to experience some level of nausea or no nausea throughout the game. Participants played through a simulated three-day scenario with various opportunities to make decisions for their avatar. On average, the game took 12–15 minutes to complete. The research nurse was present while participants played the game if there were any technology issues with the iPad or if the participant had any questions. After the game, participants discussed the outcomes with the research nurse. In cases where CINV was minimal or the participant was able to make decisions that moved the avatar from moderate or severe CINV to low or no CINV, the nurse reinforced making frequent positive choices to prevent or self-manage CINV at home. In cases where the avatar experienced moderate or severe CINV, the nurse provided additional education and reinforced the teaching the participant had already received as part of standard treatment. This was done through discussion and reintroducing standard written patient education materials. Intervention fidelity was maintained by having one research nurse provide the intervention to all participants.

Data were collected from both groups through four chemotherapy cycles (about 12 weeks). This interval was chosen to provide time for side effects to develop and to understand more about what participants were doing to prevent and self-manage symptoms of CINV at home. Structured follow-up telephone calls occurred each week. Data were collected at each chemotherapy visit in the treatment center. At the end of the study, participants in the control group were given the opportunity to play the serious game.

Measures

Demographic information and experiential characteristics were collected from all participants. Demographic variables included age, gender, comorbidities, education, and income level. Experiential characteristics included cancer diagnosis and stage, chemotherapy regimen with antiemetics, and antiemetics prescribed for use at home.

The symptom management checklist was an investigator-developed written form that participants took home to record fluid intake per day (number of glasses) and preventive and self-management

behaviors for CINV. The form was reviewed by oncology-certified nurses with experience in managing CINV. Recommendations for managing CINV were based on common evidence-based self-management strategies and were listed on the form, including antiemetic medication, dietary changes, relaxation/distraction techniques, and other strategies for preventing and self-managing CINV. Participants completed one form for each cycle and week of treatment (the study period ended after the fourth treatment cycle). All participants were called weekly to remind them to complete the form and bring it with them to their next appointment at the treatment center.

Usability and acceptability data were collected from the intervention group after the second treatment cycle and from the control group at the fourth treatment cycle after participants were able to play the game using an intervention evaluation form. Six questions related to ease of game play, likability, usefulness, realism, and self-management choices were evaluated on a five-point, Likert-type scale ranging from 1 (strongly disagree) to 5 (strongly agree). These questions were developed after a review of the gaming and technology-based intervention literature.

Data Analysis

Descriptive statistics, including means, frequencies, and percentages, were used to characterize demographic information, experiential variables of study participants at baseline, and usability. Means, medians, and sums were used to examine the frequency and types of preventive and self-management behaviors reported by each participant. Data were analyzed using IBM SPSS Statistics, version 25.0.

Findings

Patient Characteristics

Eighty participants enrolled in the study and completed the baseline data collection. The intervention group had 38 participants, and the control group had 42 participants. The average age of participants was 69.71 years old (range = 60–84 years), and most were female ($n = 59$), White ($n = 69$), and non-Hispanic ($n = 77$). The primary language of participants was English ($n = 78$), and the majority had completed some college education or higher ($n = 46$). Forty-eight participants were either married or living with a partner, and most were retired ($n = 64$). Clinically, most participants had lung ($n = 27$), breast ($n = 18$), or uterine/endometrial ($n = 15$) cancer. Most participants received at least two chemotherapy agents ($n = 59$), with one or more

TABLE 1. Sample Characteristics by Group

Characteristic	Intervention (N = 38)	Control (N = 42)
	n	n
Gender		
Female	29	30
Male	9	12
Education		
High school	12	15
Trade school	1	6
College/graduate school	25	21
Employment		
Retired	28	36
Part-time	6	3
Full-time	2	2
Medical leave	2	1
Hispanic		
No	38	39
Yes	-	3
Marital status		
Living with partner/ married	21	27
Divorced/separated	8	4
Never married	3	2
Widowed	4	8
Did not answer	2	1
Primary language		
English	37	41
Spanish	1	1
Race		
White	35	34
Asian	2	2
Black/African American	1	4
Middle Eastern	-	1
Spanish Indian	-	1
Cancer stage		
I	8	9
II	12	7
III	8	11
IV	7	14
Unknown	3	1
Cancer type		
Lung	10	17
Breast	9	9
Uterine/endometrial	7	8

Continued in the next column

**TABLE 1. Sample Characteristics by Group
(Continued)**

Characteristic	Intervention (N = 38)	Control (N = 42)
	n	n
Cancer type (continued)		
Lymphoma	5	3
Ovarian	3	3
Bladder	2	-
Other	2	2
Chemotherapy agents		
2	28	31
3	1	3
4	8	5
Did not answer	1	3
Moderate-to-high emetic agents		
1	31	33
2	6	6
Unknown	1	3
Premedications		
1	-	1
2	17	15
3	18	22
4	3	4
Prescribed medications		
1	1	2
2	8	11
3	22	25
4	7	4

Note. The average age of all participants was 69.71 years (range = 60–84).

of those agents having moderate-to-high emetic potential. There were no significant differences in demographic information between groups at baseline (see Table 1).

Symptom Prevention and Self-Management

Participation in and recording of preventive and self-management behaviors on the symptom management checklist varied at each time point and in each group. The most common self-management strategy reported was fluid intake. Seventy-five percent of participants (n = 60) reported drinking fluids at the first time point. More than 55% of participants (n = 44) continued to track and record fluid intake over time.

On average, the intervention group reported drinking more fluids at all time points as compared to the control group. Fluid intake ranged from six to seven 8 oz glasses per day (see Table 2).

Prevention behaviors were reported by 49% of participants ($n = 39$), and self-management behaviors were reported by 64% of participants ($n = 51$). Overall, the intervention group reported using almost twice the number of preventive strategies compared to the control group (1,486 versus 768), whereas the control group reported using almost twice as many CINV self-management strategies compared to the intervention group (1,311 versus 681) (see Table 3).

Participants reported using antiemetics 410 times as a preventive measure and 549 times as a self-management strategy. The most frequently reported dietary intervention was eating small meals, followed by eating bland or dry foods. Relaxation was reported as both a preventive strategy (344 times) and a self-management strategy (285 times). Distraction and deep breathing were also used to a lesser degree (see Table 4).

Overall, more participants in the intervention group engaged in reporting or keeping track of preventive strategies they used at home during each cycle than in the control group. The intervention group reported using more medications, dietary strategies, and relaxation/distraction techniques for CINV prevention as compared to the control group. The control group reported using more dietary strategies for prevention

as compared to medication or relaxation/distraction techniques at home during each cycle (see Table 5).

For self-management of CINV, the control group reported using more medication, dietary strategies, and relaxation/distraction techniques to self-manage CINV when it occurred at home as compared to the intervention group. They also reported using more self-management behaviors than preventive behaviors for CINV overall (see Table 6).

Acceptability

The eSSET-CINV serious game was well received by participants. Fifty-two participants completed the intervention evaluation form and agreed or strongly agreed ($\bar{X} = 4$) that the game was easy to play and useful in helping them to manage CINV at home and that choices in the game were clear and consistent with the standard teaching they had received. Slightly fewer participants rated the game as “realistic” ($\bar{X} = 3.923$) and reported that they liked it ($\bar{X} = 3.872$).

Some participants wrote comments about the serious game on the evaluation form. Many offered suggestions for improving the game and making it clearer. Suggestions included adding in a greater variety of self-care choices related to food and drinks, as well as making action choices clearer. For example, players could choose medicine as a self-care option, and several players suggested it be changed to nausea medicine to avoid confusion with other medications. Participants in the control group suggested playing

TABLE 2. Fluid Intake Trends Over Time by Group

Time	Intervention (N = 38)			Control (N = 42)		
	n	\bar{X}	SD	n	\bar{X}	SD
Cycle 1 (week 1)	28	7.06	1.07	32	6.98	2.6
Cycle 1 (week 2)	23	7.18	2.1	27	6.78	2.8
Cycle 1 (week 3)	21	7.16	1.85	26	6.81	2.74
Cycle 2 (week 1)	25	6.93	2.21	28	6.89	2.52
Cycle 2 (week 2)	22	7.07	2.32	27	6.7	2.92
Cycle 2 (week 3)	20	6.7	2.4	25	6.25	2.83
Cycle 3 (week 1)	26	7.46	2.14	28	6.88	2.34
Cycle 3 (week 2)	24	7.27	2.1	25	6.9	2.32
Cycle 3 (week 3)	25	7.21	2.23	23	6.77	2.27

Note. Data were collected during a 12-week period, each treatment cycle lasted 3 weeks, and the study period ended following the fourth treatment cycle. Fluid intake was measured by the number of 8 oz glasses of fluid drank per day each week.

TABLE 3. Total Number of Preventive and Self-Management Behaviors by Group

Behavior	Intervention (N = 38)						Control (N = 42)					
	n	\bar{X}	SD	M	Range	Total	n	\bar{X}	SD	M	Range	Total
Preventive	22	67.55	69	38	2-290	1,486	17	40.06	79.83	8	1-328	681
Self-management	22	34.91	43.15	23	1-160	768	29	45.21	78.54	16	1-394	1,311

M—median
Note. Data were collected during a 12-week period using a symptom management checklist.

the game earlier in the treatment cycle instead of at the fourth cycle because of fatigue. One participant reported that playing the game was more helpful than speaking with the nurse.

Discussion

The eSSET-CINV serious game is a novel intervention that was designed to promote CINV prevention and self-management behaviors at home among older adults receiving cancer treatment. It is one of the first avatar-based simulation interventions that

allows older adults with cancer the opportunity to practice making self-care decisions and visualizing the consequences of those decisions. Participants in the eSSET-CINV intervention engaged in more preventive behaviors as compared to the control group. Participants in the control group typically started engaging in self-management behaviors once they experienced symptoms of CINV. It is possible that participants in the intervention group avoided CINV through their use of preventive strategies, which led to requiring fewer self-management strategies for symptoms of CINV.

Older adults have been found to experience high numbers of side effects from treatment and engage in few self-management strategies because of beliefs that common self-management strategies are ineffective (Loerzel, 2015, 2016, 2018). According to Salgado et al. (2017), higher levels of confidence in ability to self-manage symptoms, such as nausea, are associated with active symptom management. In this study, seeing the outcomes of making self-care decisions for their avatar may have led to more confidence in using prevention and self-management strategies among participants and prompted them to actively increase management of CINV at home. In addition, participants had the opportunity to review their decisions from the serious game with the research nurse, which could have also reinforced positive self-care choices.

The most common self-care strategy reported by participants in this study was using antiemetics to prevent and self-manage nausea, which is consistent with a previous study that found that patients with CINV use antiemetics 47% of the time (Ökten & Bedük, 2017). Dietary changes and relaxation techniques have also been reported to be used by patients to a lesser degree (Ökten & Bedük, 2017; Williams et al., 2014), which was also the case in the current study.

Few serious games have been developed for or tested in older adults; however, those that have been developed were associated with behavior changes and increased motivation to self-manage

TABLE 4. Frequency of Use of Self-Care Strategies

Strategy	Preventive Behaviors (N = 2,167)	Self-Management Behaviors (N = 2,079)
	n	n
Eating small meals	495	351
Taking antiemetics	410	549
Relaxing	344	285
Eating bland foods	269	284
Eating dry foods	186	161
Sitting up after eating	176	110
Distraction	43	56
Controlled/deep breathing	41	52
Guided imagery	22	6
Listening to music	16	35
Avoiding odors	7	14
Acupuncture/acupressure	-	-
Other	158	176

Note. Data were collected during a 12-week period using a symptom management checklist.

symptoms. In a study that used serious gaming to help older adults learn how to identify fall hazards in a simulated home, Money et al. (2019) reported that participants became aware of changes that they needed to make in their own homes to reduce the risk of falls, and some took measures to actively reduce hazards in the home. In another study that used serious gaming for self-management in patients with heart failure, Radhakrishnan et al. (2016) found that self-management knowledge improved, and participants stated they became more motivated to engage in self-management behaviors for heart failure.

The results of this study indicate that the eSSET-CINV serious game is acceptable and liked by older adults, which is consistent with the evaluation of other technology-based interventions and serious games. Using web-based technology to support and encourage self-care has been found to be acceptable and feasible in older adults with hip fractures (Jensen et al., 2019), patients with cancer-related fatigue (Foster et al., 2016), and breast cancer survivors living in rural settings (Lally et al., 2018). Serious games are relatively new, but they are also demonstrating feasibility and acceptability. For example, serious games to detect frailty (Lunardini et al., 2020), promote quality of life through active lifestyles (Santos

KNOWLEDGE TRANSLATION

- It is important to assess older adults' decision making and assist them in planning which symptom prevention and self-management behaviors to use for chemotherapy-induced nausea and vomiting before actual symptom experience in the home setting.
- Nonpharmacologic options for self-care, such as fluid intake, dietary choices, and relaxation/distraction techniques, should be recommended as self-care options for older adults.
- Technology-based simulated learning opportunities are acceptable to older adults receiving treatment for cancer and should be considered as part of standard side effect self-management education.

et al., 2019), and learn about managing pain after surgery (Ingadottir et al., 2017) have all reported good scores for usefulness, acceptability, and ease of use, supporting the use of serious gaming as a potential educational tool for older adults.

Limitations

This study reflects the experience of a small number of mostly White, educated older adults in central Florida, and the results may not be generalizable to more

TABLE 5. Preventive Behaviors for Chemotherapy-Induced Nausea and Vomiting by Group

Behavior	Intervention (N = 38)					Control (N = 42)				
	n	\bar{X}	Median	Range	Total	n	\bar{X}	Median	Range	Total
Antiemetics										
Cycle 1	16	5.68	4	1-16	91	12	5	4	1-17	60
Cycle 2	11	6.73	5	2-19	74	9	4.89	3	1-17	44
Cycle 3	13	5.34	8	1-17	108	5	8.14	5	1-21	34
Dietary choices										
Cycle 1	15	20.67	12	2-74	310	4	26.94	12.5	5-62	92
Cycle 2	11	21.09	9	1-84	232	5	26.14	28	2-67	134
Cycle 3	11	21.09	12	1-63	232	4	21.78	36	1-52	125
Relaxation/distractions										
Cycle 1	13	9.3	9	1-26	121	3	11.33	11	0-23	34
Cycle 2	8	11.5	10.5	4-21	90	3	18	18	17-19	54
Cycle 3	9	14.33	20	3-21	129	3	14.33	18	6-19	43

Note. Data were collected during a 12-week period using a symptom management checklist; each treatment cycle lasted for 3 weeks.

TABLE 6. Self-Management Behaviors for Chemotherapy-Induced Nausea and Vomiting by Group

Behavior	Intervention (N = 38)					Control (N = 42)				
	n	\bar{X}	Median	Range	Total	n	\bar{X}	Median	Range	Total
Antiemetics										
Cycle 1	20	5.6	4	1-14	112	18	5.61	4	1-30	213
Cycle 2	10	6	5	1-14	60	18	5.61	4	0-15	161
Cycle 3	8	10.62	10	5-20	85	15	6.27	4	0-20	179
Dietary choices										
Cycle 1	13	10.77	9.5	0-27	140	13	18.92	11	1-87	246
Cycle 2	6	11.5	5	2-32	69	11	18.9	10	0-78	208
Cycle 3	5	14.8	14	1-29	74	9	18.78	20	1-62	169
Relaxation/distractions										
Cycle 1	10	6	4	1-19	60	6	15.83	14.5	2-30	95
Cycle 2	5	12.2	11	2-23	61	8	12	7.5	1-33	96
Cycle 3	5	8.8	9	2-16	44	6	15.33	15	1-30	92

Note. Data were collected during a 12-week period using a symptom management checklist; each treatment cycle lasted for 3 weeks.

diverse groups. Other groups, such as non-English speakers, should be considered during the development and testing of future serious games. Serious gaming has the potential to provide culturally specific and appropriate information and can be adapted for different cultures and in different languages in the future.

Another limitation was that CINV prevention and self-management behaviors were not reported by all participants; therefore, the frequency and types of self-management strategies used by other participants is unknown. It is possible that remembering to record all daily self-care behaviors on paper was overwhelming for some participants. More convenient methods of recording and documenting this information should be investigated and tested.

Implications for Nursing

Providing patient symptom management education is a part of oncology nurses' usual practice. However, tailoring patient education to fit the unique needs of older adults is not a common competency for all nurses. This study's results, which indicate that teaching older adults to anticipate and practice how they will self-manage side effects at home is effective, should prompt nurses to rethink how they deliver

education to patients. Most cancer-related symptom management education is generic in content, and delivery of such education may be overwhelming for older adults to process and apply effectively. Using a discussion format or asking patients to apply what they have learned from general educational materials to a potential scenario may prompt them to be more proactive about symptom self-management at home. In addition, a nurse-led serious game debriefing (i.e., reviewing and discussing symptom strategy outcomes) may increase knowledge retention of self-management strategies. Nurses should also consider asking older adults to track or record the self-management strategies they use at home. Tracking or recording behaviors may reinforce the value and importance of symptom self-management when at home. Gathering information about older adults' self-management strategies can help nurses to personalize education, plans of care, and interventions. Additional research is needed to determine the effectiveness of this serious game intervention in other ethnic and cultural groups.

Conclusion

The eSSET-CINV serious game was effective at increasing the number of CINV preventive

self-management behaviors among older adults with cancer who received the intervention. In addition, serious gaming was shown to be acceptable and useful to older adults. Using a technology-based simulation as an educational tool reinforces standard education and allows older adults to see the potential positive and negative consequences of their self-management actions in a safe environment, which may translate into more active symptom management at home.

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