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Original Article

A Randomized Trial of a Nurse-Led Symptom Monitoring App for Reducing Unplanned Hospital Admissions in Older Adults Receiving Chemotherapy

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ABSTRACT

Background: Older adults receiving chemotherapy are vulnerable to treatment-related toxicities that may progress rapidly when symptoms are reported late, increasing emergency department visits, unplanned hospital admissions, and treatment disruption. Objective: To evaluate whether a nurse-led mobile symptom-monitoring application improves timely symptom reporting, reduces acute healthcare utilization, and enhances chemotherapy completion among older adults undergoing outpatient chemotherapy. Methods: A parallel-group randomized controlled trial was conducted in the Islamabad–Rawalpindi region over five months. Eighty-four adults aged ≥60 years receiving outpatient chemotherapy for solid malignancies were randomized equally to a nurse-led symptom-monitoring intervention or standard oncology care. The intervention group used a PRO-CTCAE-based mobile application for daily symptom reporting, with nurse review, telephone follow-up within 24 hours for moderate-to-severe symptoms, standardized guidance, escalation when required, and weekly virtual check-ins. The control group received routine oncology care without structured digital monitoring. Outcomes included unplanned hospital admissions, emergency department visits, symptom-reporting delay, ESAS symptom burden, and chemotherapy completion over six weeks. Results: Seventy-five participants completed follow-up, including 38 in the intervention group and 37 in the control group. The intervention group had fewer unplanned hospital admissions than controls (1.21 ± 0.74 vs 2.08 ± 0.91, p<0.001) and fewer emergency department visits (0.89 ± 0.63 vs 1.67 ± 0.88, p<0.001). Symptom-reporting delay decreased from 3.6 ± 1.2 to 1.4 ± 0.6 days in the intervention group, compared with 3.5 ± 1.1 to 3.2 ± 1.0 days in controls. ESAS scores improved more substantially in the intervention group, and chemotherapy completion was higher with nurse-led monitoring (86.8% vs 70.3%, p=0.04). Conclusion: Nurse-led digital symptom monitoring improved early symptom communication, reduced acute healthcare utilization, lowered symptom burden, and supported chemotherapy completion among older adults receiving chemotherapy. Keywords: Older adults; chemotherapy; nurse-led intervention; symptom monitoring; mobile application; PRO-CTCAE; emergency department visits; hospital admissions.

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INTRODUCTION

The increasing number of older adults receiving chemotherapy has created a major supportive-care challenge for oncology services, as this population frequently presents with multimorbidity, frailty, reduced physiological reserve, and greater vulnerability to treatment-related toxicity. Although advances in cancer therapy have improved survival, chemotherapy-induced symptoms such as fatigue, nausea, dehydration, infection-related complications, anorexia, pain, and functional decline may progress rapidly in older patients when early warning signs are missed or reported late. These complications can disrupt planned chemotherapy schedules, reduce treatment tolerance, impair quality of life, and increase reliance on emergency department visits and unplanned hospital admissions, particularly when symptom management depends mainly on periodic clinic review rather than continuous surveillance (1). In older adults, the clinical consequences of delayed symptom recognition are especially important because apparently mild chemotherapy-related symptoms may overlap with pre-existing chronic illness, geriatric syndromes, or medication-related adverse effects, making early clinical interpretation more difficult and increasing the risk of preventable escalation (2).

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Timely symptom reporting remains a persistent weakness in routine chemotherapy care. Many older patients delay contacting healthcare providers because of limited health literacy, uncertainty about whether symptoms are serious, reluctance to burden clinical staff, reduced confidence in self-management, transportation barriers, or difficulty distinguishing treatment toxicity from baseline comorbid conditions. Conventional oncology follow-up models, which commonly rely on scheduled visits and patient-initiated reporting between appointments, may therefore fail to capture the dynamic and fluctuating pattern of chemotherapy-related adverse events. As a result, symptoms that could potentially be managed through early outpatient advice, medication adjustment, hydration support, infection screening, or escalation to the oncology team may instead present later as urgent clinical events requiring acute care utilization (3). This gap highlights the need for proactive monitoring strategies that can identify symptom deterioration closer to the time of onset and provide a structured route for timely clinical response (4).

Digital health interventions, particularly mobile symptom-monitoring applications, offer a practical mechanism for strengthening real-time communication between patients and oncology teams. Patient-reported outcome systems can standardize symptom capture, improve visibility of treatment-related adverse effects, and support earlier recognition of clinically significant toxicity outside routine clinic encounters. In chemotherapy care, such systems are most likely to be effective when they are not limited to passive data collection but are integrated into a responsive clinical workflow in which symptom alerts lead to timely assessment, triage, counselling, and escalation where required (5). The Patient-Reported Outcomes version of the Common Terminology Criteria for Adverse Events provides a structured approach for capturing symptomatic toxicities from the patient perspective and is particularly relevant for monitoring chemotherapy-related burden in outpatient settings (6).

Nurse-led models are well suited to this form of supportive oncology care because nurses routinely perform symptom assessment, patient education, toxicity counselling, care coordination, and referral escalation across chemotherapy pathways. A nurse-led digital monitoring strategy may therefore combine the advantages of frequent patient-reported symptom capture with professional clinical interpretation and follow-up. In older adults, this combination is especially important because digital tools alone may be limited by variations in digital literacy, confidence, adherence, caregiver support, and symptom interpretation. When supported by structured nursing oversight, mobile symptom reporting may improve patient engagement, reduce delays in clinical contact, and promote earlier intervention before symptoms progress to acute complications (7). Such an approach may also support treatment continuity by reducing unmanaged toxicity, improving patient reassurance, and enabling clinical teams to respond before chemotherapy interruption becomes necessary (8).

Despite growing interest in digital symptom surveillance and nurse-led supportive care, evidence remains limited regarding their combined effect on clinically meaningful outcomes among older adults receiving chemotherapy. Existing literature has often emphasized symptom control, patient satisfaction, general telehealth feasibility, or broader chronic disease management, while fewer randomized studies have directly examined whether a nurse-led mobile monitoring pathway can reduce unplanned hospital admissions and emergency department visits in older chemotherapy patients. This gap is important because older adults are frequently underrepresented in oncology trials and may experience distinct barriers to timely symptom reporting, including frailty, comorbidity, functional limitations, and dependence on caregivers. Generating randomized evidence in this population is therefore necessary to determine whether a structured, nurse-supported digital intervention can improve outcomes beyond standard oncology care (9).

The present randomized controlled trial was designed using a PICO framework in which the population comprised adults aged 60 years and above receiving outpatient chemotherapy for solid malignancies, the intervention was a nurse-led mobile symptom-monitoring application with daily symptom reporting and structured follow-up, the comparator was standard oncology care without structured digital

monitoring, and the primary outcomes were unplanned hospital admissions and emergency department visits during the intervention period. Secondary outcomes included timeliness of symptom reporting and chemotherapy completion, reflecting both acute healthcare utilization and treatment-continuity dimensions of supportive oncology care. This study therefore aimed to evaluate whether a nurse-led symptom-monitoring mobile application improves timely symptom reporting, reduces emergency healthcare utilization, and enhances chemotherapy completion among older adults undergoing chemotherapy. We hypothesized that older adults receiving nurse-led digital symptom monitoring would experience fewer unplanned hospital admissions and emergency department visits, shorter symptom-reporting delays, and higher chemotherapy completion rates than those receiving standard oncology care alone (10).

MATERIALS AND METHODS

The study details used here include the parallel-group randomized controlled design, Islamabad–Rawalpindi setting, 84 randomized participants, 1:1 allocation, PRO-CTCAE-based mobile symptom reporting, nurse follow-up, standard-care comparator, six-week intervention period, and predefined clinical outcomes.

A parallel-group randomized controlled trial was conducted in the Islamabad–Rawalpindi region to evaluate the effectiveness of a nurse-led mobile symptom-monitoring application among older adults receiving outpatient chemotherapy. The randomized design was selected to compare a structured nurse-supported digital monitoring pathway with standard oncology care while minimizing selection bias and allowing direct estimation of intervention effects on acute healthcare utilization and treatment-continuity outcomes. The study was conducted over five months, from November 2025 to March 2026, including participant recruitment, baseline assessment, random allocation, six-week intervention exposure for each participant, and post-intervention outcome assessment. The intervention period was aligned with active chemotherapy cycles so that symptom reporting, nurse response, emergency healthcare utilization, and treatment completion could be assessed during a clinically relevant period of chemotherapy-related toxicity risk.

Participants were recruited from outpatient oncology services serving older adults undergoing chemotherapy for solid malignancies. Eligible participants were adults aged 60 years or above who had a confirmed diagnosis of a solid tumor, were receiving outpatient chemotherapy, had an Eastern Cooperative Oncology Group performance status of 0–2, and were able to use a smartphone application independently or with assistance from a caregiver or family member. Patients were excluded if they had cognitive impairment that prevented reliable symptom reporting, severe psychiatric illness that could interfere with study participation, concurrent enrollment in another interventional study, or receipt of exclusively palliative care. Potential participants were screened against the eligibility criteria during oncology visits, and those meeting the criteria were invited to participate after receiving information about the study procedures, intervention requirements, follow-up schedule, confidentiality safeguards, and voluntary nature of participation.

A total of 112 older adults were assessed for eligibility, of whom 84 met the inclusion criteria and were enrolled. Participants were randomized in a 1:1 ratio to either the intervention group or the control group, with 42 participants assigned to each arm. Randomization was performed using a computer-generated allocation sequence. Allocation concealment was maintained through sequentially numbered, sealed opaque envelopes prepared by an independent researcher who was not involved in recruitment, intervention delivery, or outcome assessment. Because of the nature of the mobile application and nurse-led follow-up, blinding of participants and care providers was not feasible; however, outcome assessors and data analysts were blinded to group allocation to reduce detection and analytical bias.

Participants allocated to the intervention group received access to a nurse-led mobile symptom-monitoring application designed for daily reporting of chemotherapy-related symptoms. The symptom

checklist was based on the Patient-Reported Outcomes version of the Common Terminology Criteria for Adverse Events and included structured reporting of common chemotherapy-related toxicities such as nausea, fatigue, pain, appetite disturbance, dehydration-related symptoms, infection-related warning signs, and other clinically relevant adverse effects. Participants were prompted to submit daily symptom reports during the six-week intervention period. Moderate or severe symptom entries generated alerts for nurse review, and a trained nurse contacted the participant by telephone within 24 hours. During follow-up calls, nurses confirmed symptom severity, assessed associated risk features, provided standardized self-care guidance, reinforced medication and hydration advice where appropriate, triaged patients requiring urgent review, and coordinated escalation to the oncology team when clinically indicated. Weekly virtual check-ins were also conducted to reinforce adherence, address technical or clinical concerns, and support continuity of symptom monitoring.

Participants in the control group received standard oncology care, consisting of routine clinic visits, usual chemotherapy-related counselling, and access to hospital services as needed. They did not receive structured daily digital symptom monitoring, automated symptom alerts, or scheduled nurse-led app-based follow-up. Both groups continued to receive routine oncology management according to clinical need, including chemotherapy administration, physician review, supportive medications, and referral for urgent care when required.

The primary outcomes were the frequency of unplanned hospital admissions and emergency department visits during the six-week intervention period. Unplanned hospital admission was operationally defined as any non-elective inpatient admission occurring after randomization and during the intervention window for chemotherapy-related symptoms, treatment toxicity, acute deterioration, or other clinically indicated urgent reasons.

Emergency department visit was defined as any unscheduled visit to an emergency service during the same period, whether or not it resulted in hospital admission. Secondary outcomes included symptom reporting delay, chemotherapy completion rate, and symptom burden. Symptom reporting delay was defined as the interval, in days, between participant-recognized symptom onset and first clinical contact with the oncology or nursing team. Chemotherapy completion was defined as completion of the planned chemotherapy schedule during the six-week observation period without discontinuation due to unmanaged toxicity or clinical deterioration. Symptom burden was assessed using the Edmonton Symptom Assessment System at baseline and after completion of the intervention period.

Baseline demographic and clinical data were collected before randomization, including age, sex, cancer type category, ECOG performance status, baseline symptom burden, treatment status, and ability to use or be assisted in using the mobile application.

For intervention participants, application usage logs and nurse documentation were used to monitor adherence, frequency of symptom reporting, alert generation, nurse response, and escalation actions. Clinical outcome data were collected from participant follow-up records, nurse documentation, oncology service records, emergency visit records, and hospital admission records. Data collection was standardized across both groups using predefined case-record forms to ensure consistency in variable definitions and timing of assessment.

Several steps were incorporated to reduce bias and confounding. Random allocation and concealed assignment were used to limit selection bias. Baseline comparability between groups was assessed using demographic and clinical variables, including age, sex, ECOG performance status, tumor type category, and baseline ESAS score.

Outcome assessors and data analysts were blinded to treatment assignment. Standardized symptom reporting criteria, predefined outcome definitions, structured nurse follow-up procedures, and uniform post-intervention assessment timing were used to reduce measurement variability. Potential

confounding from baseline clinical status was addressed through eligibility restriction to ECOG 0–2, exclusion of patients unable to provide reliable symptom data, and comparative baseline analysis between randomized groups.

The sample size of 84 participants was based on anticipated moderate intervention effects in reducing acute healthcare utilization among oncology patients using digital symptom-monitoring approaches. The target enrollment allowed equal allocation of 42 participants per arm and incorporated expected attrition during chemotherapy follow-up. The final analyzed sample included participants who completed the six-week assessment period, while participant flow and reasons for loss to follow-up were recorded by group to support transparent interpretation of outcome estimates.

Data were analyzed using a predefined statistical plan. Continuous variables were summarized as mean and standard deviation when normally distributed, while categorical variables were summarized as frequencies and percentages. Normality was assessed using the Shapiro–Wilk test. Baseline between-group comparisons were performed using independent-samples t-tests for continuous variables and chi-square or Fisher's exact tests for categorical variables, as appropriate. Post-intervention comparisons of hospital admissions, emergency department visits, symptom reporting delay, and ESAS scores were performed using independent-samples t-tests for between-group differences and paired-samples t-tests for within-group changes.

Repeated measures analysis of variance was used to evaluate time-by-group interaction effects for longitudinal symptom burden and change in symptom reporting delay across assessment points. Chemotherapy completion rates were compared between groups using categorical analysis, with statistical significance determined at a two-sided p-value of less than 0.05.

Pearson correlation analysis was used to explore associations between symptom reporting delay and acute healthcare utilization. Missing outcome data resulting from withdrawal, disease progression, or loss to follow-up were documented, and available-case analysis was performed for participants completing the post-intervention assessment.

All study data were recorded using standardized data collection forms and checked for completeness before analysis. Application-generated data and nurse follow-up records were cross-checked against clinical documentation to improve data accuracy. Identifiable participant information was kept separate from analytical datasets, and coded study identifiers were used during statistical analysis. Access to study data was limited to authorized research personnel. The study was conducted in accordance with ethical principles for human participant research, and written informed consent was obtained before enrollment. Participants retained the right to withdraw from the study at any point without affecting their ongoing oncology care.

RESULTS

A total of 112 older adults receiving outpatient chemotherapy were assessed for eligibility. Of these, 84 participants met the eligibility criteria and were randomized equally into the nurse-led symptom monitoring group and the standard oncology care group, with 42 participants allocated to each arm. During the six-week follow-up period, 9 participants were lost to follow-up, including 4 in the intervention group and 5 in the control group, leaving 75 participants in the final analyzed sample: 38 in the intervention group and 37 in the control group. The intervention exposure period remained six weeks for each participant and corresponded to active chemotherapy cycles.

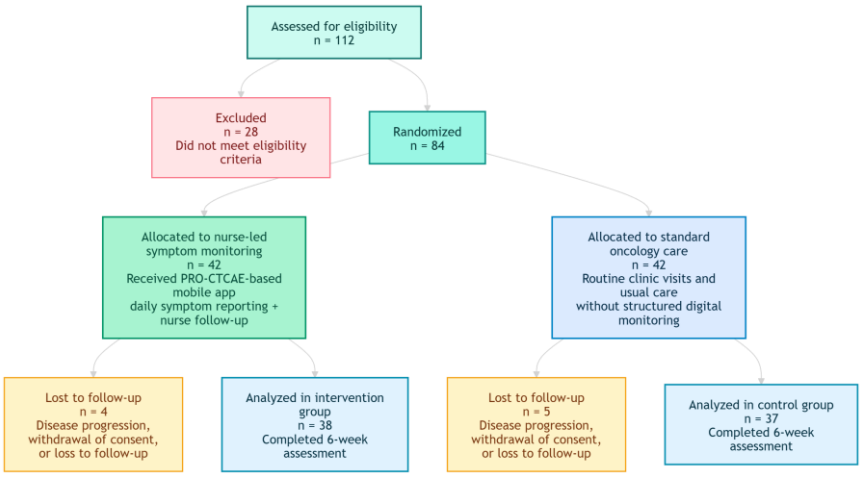

Figure 1. CONSORT Flow Diagram of Participant Recruitment, Randomization, Follow-Up, and Analysis

The CONSORT flow diagram summarizes participant progression through the randomized trial. Of 112 older adults assessed for eligibility, 84 were randomized equally into the nurse-led symptom-monitoring group and standard oncology care group, with 42 participants in each arm. During follow-up, 4 participants in the intervention group and 5 in the control group were lost because of disease progression, withdrawal of consent, or loss to follow-up. The final analyzed sample included 75 participants: 38 in the intervention group and 37 in the control group, each completing the six-week assessment period.

Table 1. Participant Flow and Baseline Demographic and Clinical Characteristics

Variable	Total Sample	Intervention Group	Control Group	Between-Group Difference / Effect	p-value
Assessed for eligibility	112				
Randomized	84	42	42	1:1 allocation	
Lost to follow-up	9	4/42 (9.5%)	5/42 (11.9%)	Risk difference: -2.4 percentage points	
Final analyzed sample	75	38	37		
Age, years, mean ± SD	66.4 ± 4.8	66.1 ± 4.6	66.7 ± 5.0	Mean difference: -0.6 years	0.62
Male sex, n (%)	44 (52.4%)	22 (52.4%)	22 (52.4%)	Risk difference: 0.0 percentage points	1.00
ECOG performance status 0–1, n (%)	51 (60.7%)	25 (59.5%)	26 (61.9%)	Risk difference: -2.4 percentage points	0.82
Solid tumor, n (%)	84 (100%)	42 (100%)	42 (100%)	No between-group variation	
Baseline ESAS score, mean ± SD	28.6 ± 6.3	28.9 ± 6.1	28.3 ± 6.5	Mean difference: 0.6 points	0.71

Baseline characteristics were well balanced between groups. The mean age differed by only 0.6 years between the intervention and control groups, and the proportion of male participants was identical at 52.4% in both arms. ECOG performance status 0–1 was present in 59.5% of intervention participants and 61.9% of controls, while all randomized participants had solid tumors. Baseline symptom burden was also similar, with mean ESAS scores of 28.9 ± 6.1 in the intervention group and 28.3 ± 6.5 in the control group, indicating comparable symptom burden before intervention exposure.

Table 2. Post-Intervention Primary Outcomes: Acute Healthcare Utilization

Outcome	Intervention Group (n=38), mean ± SD	Control Group (n=37), mean ± SD	Mean Difference (95% CI)	Relative Reduction	Test Statistic / Effect	p-value
Unplanned hospital admissions	1.21 ± 0.74	2.08 ± 0.91	-0.87 (-1.23 to -0.51)	41.8% lower mean admissions	Between-group comparison	<0.001
Emergency department visits	0.89 ± 0.63	1.67 ± 0.88	-0.78 (-1.15 to -0.41)	46.7% lower mean ED visits	Between-group comparison	<0.001
Acute care utilization over time					Time × group interaction: F=11.42	<0.001

The intervention group experienced substantially lower acute healthcare utilization over six weeks. Mean unplanned hospital admissions were 1.21 ± 0.74 in the intervention arm compared with 2.08 ± 0.91 in the control arm, giving a mean difference of -0.87 admissions per participant and a relative reduction of approximately 41.8%. Emergency department visits followed the same pattern, with a mean of 0.89 ± 0.63 visits in the intervention group compared with 1.67 ± 0.88 visits in the control group, corresponding to a mean difference of -0.78 visits and an estimated 46.7% lower mean ED-visit burden. The repeated-measures analysis showed a significant time-by-group interaction for acute healthcare utilization, supporting a sustained between-group separation during the intervention period.

Table 3. Symptom Reporting Delay and Symptom Burden Before and After Intervention

Outcome	Intervention Pre, mean ± SD	Intervention Post, mean ± SD	Intervention Change	Control Pre, mean ± SD	Control Post, mean ± SD	Control Change	Between-Group Post-Intervention Difference (95% CI)	Interaction p-value
Symptom reporting delay, days	3.6 ± 1.2	1.4 ± 0.6	-2.2 days	3.5 ± 1.1	3.2 ± 1.0	-0.3 days	-1.8 days (-2.18 to -1.42)	<0.001
ESAS score	28.9 ± 6.1	20.2 ± 5.4	-8.7 points	28.3 ± 6.5	25.1 ± 6.0	-3.2 points	-4.9 points (-7.53 to -2.27)	<0.01

Symptom reporting became markedly faster in the intervention group. Mean reporting delay decreased from 3.6 ± 1.2 days at baseline to 1.4 ± 0.6 days after the intervention, representing a 2.2-day reduction. In contrast, the control group showed only a 0.3-day reduction, from 3.5 ± 1.1 to 3.2 ± 1.0 days. At post-intervention assessment, symptom reporting occurred 1.8 days earlier in the intervention group than in the control group. Symptom burden also improved more strongly in the intervention arm, with ESAS scores decreasing by 8.7 points compared with a 3.2-point reduction in controls. The post-intervention ESAS score was 4.9 points lower in the intervention group, and repeated-measures analysis confirmed a significant time-by-group interaction for symptom burden reduction.

Table 4. Chemotherapy Completion Rate by Study Group

Outcome	Intervention Group (n=38)	Control Group (n=37)	Absolute Difference	Relative Measure	p-value
Completed chemotherapy during follow-up, n (%)	33/38 (86.8%)	26/37 (70.3%)	+16.5 percentage points	Relative completion ratio: 1.24	0.04
Did not complete chemotherapy during follow-up, n (%)	5/38 (13.2%)	11/37 (29.7%)	-16.5 percentage points		

Chemotherapy completion was higher among participants receiving nurse-led symptom monitoring. In the intervention group, 33 of 38 participants completed chemotherapy during follow-up, yielding a completion rate of 86.8%. In the control group, 26 of 37 participants completed chemotherapy, corresponding to 70.3%. The absolute difference between groups was 16.5 percentage points, and the relative completion ratio was 1.24, indicating that chemotherapy completion was approximately 24% higher in the intervention arm.

Overall, the results showed consistent benefit across acute healthcare utilization, symptom-reporting timeliness, symptom burden, and treatment completion. The largest absolute improvements were observed in symptom reporting delay, which decreased by 2.2 days in the intervention group compared with 0.3 days in controls, and ESAS symptom burden, which declined by 8.7 points compared with 3.2 points in controls. These findings indicate that the nurse-led digital monitoring pathway was associated with earlier symptom communication, lower emergency care use, fewer unplanned admissions, and improved chemotherapy continuity over the six-week intervention period.

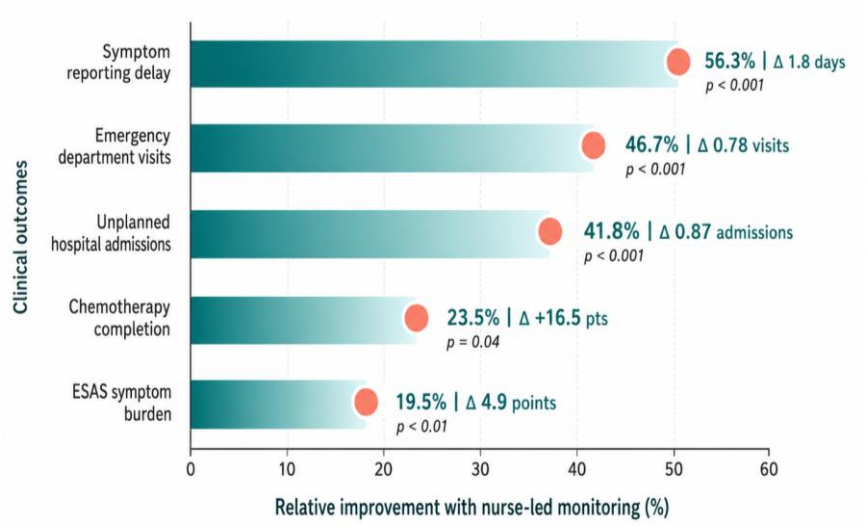

Figure 2. Outcome Benefit Gradient with Nurse-Led Monitoring Versus Standard Care

This figure summarizes the relative clinical benefit of nurse-led symptom monitoring compared with standard oncology care across five key outcomes during the six-week follow-up period. The greatest improvement was observed in symptom reporting delay, with a 56.3% relative reduction and symptoms reported 1.8 days earlier in the intervention group. Emergency department visits decreased by 46.7%, corresponding to 0.78 fewer visits, while unplanned hospital admissions decreased by 41.8%, corresponding to 0.87 fewer admissions. Chemotherapy completion improved by 23.5%, with a 16.5-percentage-point absolute increase in the intervention group, and ESAS symptom burden was 19.5% lower, representing a 4.9-point difference. Overall, the outcome gradient demonstrates consistent benefit favoring nurse-led monitoring, with the strongest effects observed for timely symptom reporting and acute healthcare utilization.

DISCUSSION

This randomized trial demonstrated that a nurse-led mobile symptom-monitoring application was associated with clinically meaningful improvements in acute healthcare utilization, symptom-reporting timeliness, symptom burden, and chemotherapy completion among older adults receiving outpatient chemotherapy. The intervention group had fewer unplanned hospital admissions than the standard-care group, with mean admissions of 1.21 ± 0.74 versus 2.08 ± 0.91, and fewer emergency department visits, with mean visits of 0.89 ± 0.63 versus 1.67 ± 0.88. These differences suggest that daily symptom reporting combined with nurse-led review may improve early identification of chemotherapy-related deterioration before symptoms progress to events requiring urgent hospital-based care. The observed reduction in symptom-reporting delay from 3.6 ± 1.2 to 1.4 ± 0.6 days in the intervention group further supports the role of proactive digital surveillance in shortening the interval between symptom onset and clinical response, which is particularly important in older adults whose chemotherapy toxicities may evolve rapidly and coexist with frailty, multimorbidity, and reduced physiological reserve (11). The results are based on the study's randomized comparison, six-week intervention period, and final analyzed sample of 75 participants.

The reduction in unplanned admissions and emergency department visits is clinically important because acute healthcare utilization during chemotherapy often reflects delayed recognition of toxicity, insufficient outpatient symptom control, or late escalation of complications that could have been managed earlier. Older adults are especially vulnerable to this pattern because symptoms such as fatigue, anorexia, nausea, dehydration, fever, pain, or functional decline may be normalized by patients or attributed to aging or pre-existing disease rather than chemotherapy-related adverse effects. In this context, structured symptom monitoring appears to have shifted care from a reactive model, in which patients seek help after symptoms become severe, toward a more anticipatory model, in which daily

reporting and nurse review create opportunities for earlier counselling, supportive medication adjustment, hydration advice, infection screening, and escalation to oncology services when needed (12). The significant time-by-group interaction for acute care utilization supports the interpretation that benefits were not limited to an isolated post-intervention difference but reflected a consistent separation between groups across the intervention period.

The improvement in symptom-reporting timeliness provides a plausible pathway through which the intervention reduced acute care use. Participants in the intervention group reported symptoms approximately 1.8 days earlier than controls at post-intervention assessment, and this earlier communication likely allowed nurses to intervene before toxicity became clinically destabilizing. This finding is important because the effectiveness of digital monitoring in oncology depends not only on the patient entering data but also on whether reported symptoms are converted into timely clinical action. A mobile application without clinical oversight may increase data availability without necessarily changing outcomes; however, the nurse-led structure used in this study linked symptom entries to alert review, telephone follow-up within 24 hours for moderate or severe symptoms, standardized guidance, triage, and escalation when required. This integrated workflow helps explain why improvements were observed across both process outcomes, such as reporting delay, and clinical outcomes, such as admissions and emergency visits (13).

The reduction in ESAS symptom burden further indicates that the intervention may have improved symptom control rather than merely changing patterns of healthcare use. The intervention group showed a mean ESAS reduction of 8.7 points compared with 3.2 points in the control group, with a significant time-by-group interaction, suggesting a stronger longitudinal improvement in patient-reported symptom burden among participants receiving nurse-led monitoring. This finding is clinically relevant because symptom burden is closely linked to functional status, treatment tolerance, psychological distress, and care-seeking behavior during chemotherapy. By enabling repeated symptom assessment and timely nurse contact, the intervention may have improved patients' ability to recognize toxicity, follow supportive-care advice, and seek appropriate help before symptom escalation. The magnitude of ESAS improvement also supports the interpretation that reduced acute care utilization did not occur at the expense of untreated symptoms; rather, it coincided with better reported symptom control (14).

The higher chemotherapy completion rate in the intervention group, 86.8% compared with 70.3% in the control group, suggests that nurse-led digital monitoring may support treatment continuity in older adults undergoing chemotherapy. Treatment interruption in this population is often driven by poorly controlled toxicity, delayed reporting, functional decline, or acute complications requiring hospitalization. Earlier identification and management of symptoms may therefore reduce preventable treatment disruption and help patients complete planned chemotherapy cycles. This finding is particularly meaningful because chemotherapy completion is not only a service-utilization outcome but also a marker of treatment feasibility, adherence, and supportive-care adequacy in a population at increased risk of toxicity-related discontinuation (15).

A key strength of the intervention was the combination of digital symptom capture with nursing oversight. The app provided a structured mechanism for daily patient-reported symptom entry, while nurses translated symptom alerts into clinical assessment, education, triage, and coordination with oncologists when needed. This hybrid model is likely more clinically effective than a purely automated monitoring system because it preserves human interpretation, contextual judgment, and patient reassurance. In older adults, this is especially relevant because digital literacy, symptom interpretation, caregiver involvement, and confidence in self-management may vary substantially. Nurse-led follow-up may have increased trust in the monitoring process, encouraged continued reporting, and reduced reluctance to contact healthcare providers. The intervention therefore functioned not simply as a technology platform but as a care-coordination pathway embedded within chemotherapy support (16).

The findings also have implications for supportive oncology practice in resource-constrained settings. Unplanned admissions and emergency department visits increase healthcare costs, disrupt chemotherapy schedules, and place pressure on hospital services. A nurse-led monitoring model that identifies symptom deterioration earlier may reduce avoidable acute care use while improving patient experience and treatment continuity. Because the intervention relied on daily symptom reporting, alert-based nurse review, telephone follow-up, and weekly virtual check-ins, it may be adaptable to outpatient oncology settings where specialist physician availability is limited but trained nursing teams can provide structured surveillance and triage. However, implementation would require adequate nurse staffing, clear escalation protocols, app usability support, data privacy safeguards, and mechanisms to prevent alert fatigue (17).

Several limitations should be considered when interpreting these findings. The study was conducted in an urban healthcare setting where access to oncology services, smartphones, and digital support may be better than in rural or lower-resource environments. This may limit generalizability to populations with lower digital literacy, limited internet access, or reduced caregiver support. The six-week follow-up period was appropriate for assessing short-term chemotherapy-related symptom monitoring but did not capture long-term outcomes such as sustained symptom control, cumulative treatment completion, survival, cost-effectiveness, or repeated hospital utilization over multiple chemotherapy cycles. Participant and care-provider blinding was not feasible because of the nature of the intervention, which may have introduced performance effects, although blinded outcome assessment and data analysis helped reduce measurement bias (18).

The moderate sample size should also be acknowledged. Although the study detected statistically significant differences in major clinical outcomes, smaller differences in secondary outcomes or subgroup effects may not have been fully captured. Variation in tumor type, chemotherapy regimen, toxicity profile, caregiver involvement, and individual comfort with mobile technology may have influenced symptom trajectories and intervention responsiveness. In addition, app adherence and frequency of symptom entry could affect the intensity of exposure to the intervention, and differential engagement may partly explain variation in benefit among participants. These considerations are important because digital health interventions depend on both clinical design and user behavior; therefore, future analyses should examine app-use patterns, alert frequency, nurse response time, escalation rates, and patient satisfaction as mediators of clinical effectiveness (19).

Future research should build on these findings through larger multicenter trials involving more diverse oncology settings, including rural populations and patients with varying levels of digital literacy. Longer follow-up would help determine whether reductions in emergency visits and unplanned admissions persist beyond the initial chemotherapy cycles and whether improved symptom management translates into better treatment completion, quality of life, survival, or healthcare cost outcomes. Additional studies should also evaluate caregiver-assisted reporting, language-adapted interfaces, predictive analytics for high-risk symptom patterns, and integration of symptom-monitoring platforms into electronic health records. Such work would clarify how nurse-led digital monitoring can be scaled while preserving timely clinical response, minimizing alert burden, and maintaining patient-centered care for older adults receiving chemotherapy (20).

CONCLUSION

The nurse-led symptom-monitoring mobile application significantly improved supportive oncology outcomes among older adults receiving outpatient chemotherapy by reducing unplanned hospital admissions and emergency department visits, shortening symptom-reporting delays, lowering overall symptom burden, and improving chemotherapy completion over the six-week follow-up period. The findings indicate that daily digital symptom reporting, when combined with structured nurse review, timely telephone follow-up, patient guidance, and escalation to oncology care when required, can shift

chemotherapy support from a reactive model to a more proactive and clinically responsive approach. This integrated nurse-led digital pathway appears particularly valuable for older patients, who are at higher risk of delayed symptom recognition, treatment-related toxicity, and avoidable acute healthcare use. Overall, the intervention offers a practical and patient-centered strategy to strengthen early symptom detection, improve treatment continuity, and reduce preventable healthcare utilization during chemotherapy.

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