Asia-Pacific Journal of Oncology Nursing 11 (2024) 100610

Contents lists available at ScienceDirect

Asia-Pacific Journal of Oncology Nursing

journal homepage: www.apjon.org

Review

Time toxicity in cancer care: A concept analysis using Walker and Avant's method

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ARTICLE INFO

Keywords:
Time toxicity
Cancer care
Quality of life

ABSTRACT

Objective: The purpose of this concept analysis was to explore and clarify the concept of time toxicity in the context of cancer care using Walker and Avant's method, identify its defining attributes, antecedents, and consequences, and explore its implications for cancer care.

Methods: Walker and Avant's eight-step method was employed to analyze time toxicity. The literature was reviewed, focusing on peer-reviewed articles, grey literature, and cancer care policy documents to identify the defining attributes, antecedents, consequences, and empirical referents of time toxicity. Contextual factors, such as health care infrastructure and socioeconomic status, shape the manifestation of time toxicity in different patient populations. Model, borderline, and contrary cases were developed to clarify the concept further.

Results: Time toxicity is characterized by its defining attributes of temporal burden, disruption of daily life, cumulative effect, opportunity cost, and emotional strain. Antecedents include cancer diagnosis, complex treatment regimens, and health care inefficiencies, while consequences involve reduced quality of life, non-adherence to treatment, and economic strain. Empirical referents include time logs, patient-reported outcomes, and health care utilization data.

Conclusions: Our findings underscore the multidimensional nature of time toxicity and its significant implications for cancer patients' well-being. Importantly, we highlight the vital role of oncology nurses in mitigating its effects through care coordination and patient support, thereby making our research directly applicable to clinical practice.

Introduction

Cancer treatments might impact patient's time and quality of life negatively due to the significant time commitment required for the treatment process, especially as cancer treatments have become more complex and longer in duration, particularly with the rise of immunotherapies and targeted therapies. In oncology care, treatment has traditionally been assessed with its physical, financial, and emotional burdens on patients. However, an underexplored dimension is the impact of treatment on patients' time—a factor increasingly referred to as time toxicity. Over the years, adjuvant and immunotherapies and targeted therapies have been widely adopted in cancer treatment. However, these treatments also bring unintended consequences to routine practices, such as time toxicity.[1] Time toxicity is a concept that describes the significant time patients spend attending appointments, undergoing treatment, and managing side effects, which disrupts daily life and affects overall well-being, unlike traditional forms of toxicity, which focus on the physical side effects of treatment (e.g., nausea, fatigue, or organ damage), time toxicity addresses explicitly the burden that frequent clinic visits, treatment delays, lengthy infusions, follow-up appointments, monitoring, and recovery periods impose on patients.[2–4] This can significantly affect their personal, professional, and social lives.

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https://doi.org/10.1016/j.apjon.2024.100610
Received 18 September 2024; Accepted 20 October 2024

For many cancer patients, especially those receiving adjuvant (post-surgical) or palliative care (to relieve symptoms), the time spent on treatment can detract from their quality of life, as it reduces the time available for meaningful activities, family interactions, and personal well-being. There is a higher degree of time toxicity among older adults with metastatic cancer, especially those receiving radiotherapy or chemotherapy, as they experience approximately one in 5 days with health care workers during their treatment with potential frailty.[5] In recent years, as cancer treatments have become more complex and prolonged, time toxicity has emerged as a critical factor that oncology professionals must consider. Cancer treatment regimens, especially for advanced-stage cancer patients, can be highly time-consuming, sometimes requiring multiple weekly visits for infusions, monitoring, or follow-up appointments. These time-consuming care schedules can negatively impact a patient's ability to engage in meaningful personal and professional activities when not accounted for. The increased focus on time toxicity emphasizes that prolonging survival may come at a cost, with much of the additional time spent in a health care setting rather than at home or with loved ones.[1,4]

A recent study highlighted that health care contact days, or the number of days patients physically interact with the health care system, can be an effective metric for measuring time toxicity.[6] It was found that certain cancer therapies impose a significant burden, as patients spend a considerable portion of their remaining life expectancy in hospitals or clinics. This is particularly relevant in palliative care settings, where improving quality of life is often prioritized over the extension of life, yet treatments may still impose time burdens on patients.[2]

Furthermore, this time burden is exacerbated by factors such as traveling to appointments, waiting times, and dealing with insurance paperwork, all of which contribute to time spent away from normal activities. These additional stressors have been referred to as hidden aspects of time toxicity, which can erode a patient's psychological and emotional well-being.[3,7] Additionally, new technologies, such as digital geotracking and smartphone apps, are being explored to help patients record their time spent on cancer-related activities to quantify time toxicity more accurately.[8]

Several initiatives have been developed to promote the advancement of reporting and reducing time toxicity among cancer patients, by providing treatment tolerability and informed clinical decisions to patients.[9] However, the concept of Time toxicity is a relatively new term in oncology that lacks a standardized definition. Conducting a concept analysis will clarify what is meant by time toxicity, particularly in relation to its impact on patients' quality of life, clinical outcomes, and the health care system. This is essential for consistency in understanding and addressing it in both research and practice. Conducting a concept analysis on time toxicity will further deepen understanding of this emerging issue, enabling better integration into oncology care models for improved patient outcomes and care efficiency. Using Walker and Avant's[10] concept analysis method, this paper aims to clarify and analyze time toxicity, exploring its defining attributes, antecedents, consequences, and empirical referents.

Methods

Walker and Avant's method of concept analysis consists of eight steps: selecting the concept, determining the purpose, identifying uses of the concept, defining attributes, identifying antecedents and consequences, constructing model and contrary cases, defining empirical referents, and generating a formal definition. This method was chosen for its systematic approach to concept clarification.

Data sources

A comprehensive literature search was conducted in PubMed, CINAHL, Scopus, and Google Scholar using key terms such as “time toxicity,” “temporal burden,” “cancer care,” “treatment burden,” and “patient time in oncology” (Table 1). The search focused on peer-reviewed articles published between 2000 and 2023. Grey literature, including reports from cancer organizations and health policy papers, was also reviewed. Nursing and oncology textbooks were consulted to provide a theoretical framework for the analysis (Table 2).

Data analysis

Throughout the concept analysis, data were managed using NVivo software (Version 12) for qualitative data analysis. This allowed for efficient coding of the extracted data, thematic analysis, and cross-referencing of relevant literature. Themes and sub-themes related to attributes, antecedents, and consequences were derived.

Results

A comprehensive literature search was conducted to identify relevant studies exploring the concept of time toxicity in cancer care. Using Walker and Avant's concept analysis method, 18 studies were ultimately included in this analysis, as shown in Table 2. These studies provided valuable insights into the attributes, antecedents, and consequences of time toxicity among cancer patients.

Step 1: Select a concept

The concept of time toxicity was selected due to its increasing relevance in oncology, as modern cancer treatments often require significant time investment, potentially impacting patients' quality of life and treatment adherence.

Step 2: Determine the purpose of the analysis

The purpose of this analysis was to clarify the meaning of time toxicity in cancer care and to provide a clearer understanding of its defining characteristics, antecedents, consequences, and measurable outcomes. This will help oncology nurses and health care providers identify time toxicity and develop strategies to reduce its impact on patients.

Step 3: Identify all uses of the concept

Time toxicity is a relatively new concept in oncology but has been used to describe the negative impact of time spent on treatment and care-related activities. Other relevant uses include:

Health care Utilization: Time toxicity directly influences health care utilization. Patients facing significant time burdens may experience challenges in accessing necessary care, attending appointments, and adhering to treatment regimens. This is significantly impacted by cancer diagnosis, type and prognosis – which determines the treatment schedule and intensity for cancer patients. The unpredictable nature of cancer can lead to increased morbidity and unplanned health care utilization,[11] leading to the introduction of unexpected burdens such as time toxicity. Furthermore, health care utilization is influenced by patients’ perceptions of their health, susceptibility to cancer, sense of mastery, and social support.[12] In this regard, time toxicity increases health care utilization while at the same time, health care utilization exacerbates time toxicity, representing a cyclical relationship and creating a feedback loop that can affect both patient outcomes and health care systems.

Table 1
Search terms.

“Time Toxicity”
“Temporal burden”
“Cancer care”
“Treatment burden”
“Patient time in oncology”

Table 2
Evidence appraisal of time toxicity.

Reference discipline	Purpose/research question (s)/ hypothesis	Design, sample, and instruments used	Variable analysis of data	Findings
Baltussen et al.[5] Cancer care	Quantify time toxicity among older patients with cancer receiving palliative systemic treatment.	All patients aged ≥ 65 years with metastatic cancer receiving cytotoxic chemotherapy, immunotherapy, or targeted therapy at a single center in Mexico were selected from a prospective patient navigation cohort. Patients completed a baseline assessment, including the G8 screening and quality of life measures. Physical health care contact days within the first 6 months were extracted from medical records and divided by days alive during the same period. Beta regression models were used to identify predictors of time toxicity.	DV: Time toxicity IV: G8 screening, quality of life measures, age, time of treatment, co-morbidities, and baseline health status. Beta regression models were used.	158 older patients (median age 71 years); 86% received cytotoxic chemotherapy. Seventy-three percent had an impaired G8 score and were considered vulnerable/ frail. Six-month overall survival was 74%. Within the first 6 months, patients spent a mean of 21% (95% confidence interval (CI): 19%–23%) of days with health care contact. Concurrent radiotherapy (odds ratio (OR) = 1.55; 95% CI: 1.21–1.97), cytotoxic chemotherapy versus targeted therapy (OR = 1.64; 95% CI: 1.13–2.37), and an impaired G8 (OR = 1.27; 95% CI: 1.01–1.60) were associated with increased time toxicity.
Bateni et al.[1] Cancer treatment	How have health care costs, survival, and time toxicity changed after the adoption of adjuvant and palliative immunotherapies and targeted therapies for melanoma?	Cohort study of 731 patients with melanoma.	DV: Health care costs, survival, time toxicity. IV: Era. This is the primary independent variable, categorizing patients into two groups based on the time period of their treatment: 2007–2012 (before the widespread adoption of adjuvant and palliative immunotherapies and targeted therapies) and 2018–2019 (after the adoption of these therapies).	731 patients with melanoma were study participants. Found a substantial increase in systemic therapy costs in 2018–2019 compared with 2007–2012. Survival improved for all stages in 2018–2019 compared with 2007–2012, and time toxicity was similar between eras.
Gupta et al.[46] Clinical oncology	Journal article on oncology care with time toxicity as main subject	Sample and instrument not specified.	Data drawn from literature and analysed in the form of commentary.	This study argues that oncology clinical trials should report a measure of "time toxicity" to help patients make informed decisions about treatment options. While traditional focus has been on improving survival rates, understanding the time spent on treatment is equally important. It highlights that the pursuit of cancer treatment can sometimes paradoxically reduce meaningful survival time. Therefore, providing information about time toxicity can help patients weigh the benefits and burdens of different treatments.
Gupta et al.[6] Cancer treatment	To assess time toxicity in a completed randomized controlled trial (RCT).	Secondary analysis of the Canadian cancer trials group CO.17 RCT that evaluated weekly cetuximab infusions versus supportive care alone in 572 patients with advanced colorectal cancer. Subsequent analyses reported that benefit was restricted to patients with K-ras wild-type tumors. Calculated patient-level time toxicity by analyzing trial forms. Days without health care contact as home days was considered. Medians of time measures across arms and stratified results by K-ras status were compared.	DV: Time toxicity IV: Treatment arm, k-ras value. The study hypothesized that Cetuximab treatment would be associated with lower time toxicity compared to supportive care. Also, the effect of cetuximab on time toxicity would differ based on K-ras status.	In the overall population, median time toxic days were higher in the cetuximab arm (28 vs 10, $P < 0.001$) although median home days were not statistically different between arms (140 vs 121, $P = 0.09$). In patients with K-ras–mutated tumors, cetuximab was associated with almost numerically equal home days (114 days vs 112 days, $P = 0.571$) and higher time toxicity (23 days vs 11 days, $P < 0.001$). In patients with K-ras wild-type tumors, cetuximab was associated with more home days (186 vs 132, $P < 0.001$).
Johnson et al.[41] Clinical Trends	Journal article on oncology care with time toxicity as main subject	Sample and instrument not specified.	Data drawn from literature and analysed in the form of commentary.	To ensure equitable health care, future research on time toxicity must consider the impact of factors such as access to care, leisure time, and cultural perspectives. Findings should be interpreted cautiously, recognizing that these factors can influence the true burden of time toxicity. Qualitative research that incorporates patient and cultural perspectives is essential for developing a comprehensive understanding of time toxicity and identifying effective solutions

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Table 2 (*continued*)

Reference discipline	Purpose/research question (s)/ hypothesis	Design, sample, and instruments used	Variable analysis of data	Findings
Quinn et al.[48] Oncology clinical trials	To assess the measurement and reporting of time toxicity (i.e., time spent receiving care) within prospective oncologic studies.	On July 23, 2023, PubMed, Scopus, and Embase were queried for prospective or RCT from 1984 to 2023 that reported time toxicity as a primary or secondary outcome for oncologic treatments or interventions. Secondary analyses of RCTs were included if they reported time toxicity. The included studies were then evaluated for how they reported and defined time toxicity.	DV: Time toxicity IV: Study design, oncologic treatment or intervention, method of reporting time toxicity, definition of time toxicity. Other study characteristics such as study size, patient population, and follow-up duration could also be considered as independent variables.	The initial query identified 883 records, with 10 studies (3 RCTs, 2 prospective cohort studies, and 5 secondary analyses of RCTs) meeting the final inclusion criteria. Treatment interventions included surgery ($n = 5$), systemic therapies ($n = 4$), and specialized palliative care ($n = 1$). The metric "days alive and out of the hospital" was used by 80% ($n = 4$) of the surgical studies. Three of the surgical studies did not include time spent receiving ambulatory care within the calculation of time toxicity. "Time spent at home" was assessed by three studies (30%), each using different definitions. The five secondary analyses from RCTs used more comprehensive metrics that included time spent receiving both inpatient and ambulatory care.
Nindra et al.[45] Clinical trials	To quantify the amount of patient time consumed through early phase cancer treatments (EPCT) participation.	A retrospective audit of patients treated in the EPCT unit at Liverpool hospital, Sydney was carried out from 2013 to 2023. We defined 'time toxicity' (TT) as a composite measure where time-toxic days were considered days with any health care system contact, including clinic visits, infusions, procedures or blood work	DV: Time toxicity IV: Patient characteristics, treatment factors, time period. The analysis involved calculating the proportion of time-toxic days for each patient by comparing the mean or median time toxicity across different patient groups based on the independent variables.	219 patients across 36 EPCTs were included. The median age was 65 years (range 31–81 years). Patients spent a median of 29% (range 4%–100%) of their days in direct contact with the health care system during their study. Protocol-specified visits accounted for the greatest contribution to total TT in 101 (46%) patients. In 7% ($n = 16$) of patients, unscheduled visits due to either adverse events or cancer-related symptoms accounted for the greatest TT. TT reduced as patients completed additional cycles of treatment. No statistically significant difference in TT was noted between dose-expansion and dose-escalation studies or trials focusing on immune-oncology versus targeted therapy.
Durbin et al.[29] Cancer clinical trial	To assess the time that patients spend interacting with the health care system (e.g., time toxicity) while participating in these studies.	Retrospectively reviewed the electronic health records of consecutive patients enrolled in EP-CTs from 2017 to 2019 to obtain baseline characteristics and number of health care–associated days, defined as all inpatient and outpatient visits while on trial. We used univariable and multivariable analyses to identify predictors of increased time toxicity, defined as the proportion of health care–associated days among total days on trial. For ease of interpretation, we created a dichotomous variable, with high time toxicity defined as $\geq$ 20% health care–associated days during time on trial and used regression models to evaluate relationships between time toxicity and clinical outcomes.	DV: Time toxicity IV: Baseline characteristics, EP-CT characteristics, treatment related factors. Using regression models (e.g., logistic regression for dichotomous time toxicity, linear regression for continuous time toxicity) to evaluate the relationship between time toxicity and the independent variables.	Among 408 EP-CT participants (mean age, 60.5 years [standard deviation, SD, 12.6]; 56.5% female; 88.2% White; 96.0% non-Hispanic), patients had an average of 22.5% health care–associated days while on trial (SD, 13.8%). Those with GI ($B = 0.07$; $P = 0.002$), head/neck ($B = 0.09$; $P = 0.004$), and breast ($B = 0.06$; $P = 0.015$) cancers and those with worse performance status ($B = 0.04$; $P = 0.017$) and those receiving targeted therapies ($B = 0.04$; $P = 0.014$) experienced higher time toxicity. High time toxicity was associated with decreased disease response rates (OR = 0.07; $P < 0.001$), progression-free survival (hazard ratio [HR] = 2.10; $P < 0.001$), and overall survival (HR = 2.16; $P < 0.001$).
Atre et al.[34] Breast cancer research	Investigates the association between age at diagnosis and time toxicity for patients with metastatic breast cancer (MBC) and identifies major components of care that confer the greatest time toxicity.	Retrospective cohort study among patients with MBC aged 67 or older using the SEER-Medicare database. We assessed time toxicity using the number of encounter days patients interacted with the health care system per 100 days, within the first year of starting cancer treatment. We used a Poisson model to analyze the association between age and encounter days, adjusting for clinical and sociodemographic factors. We stratified the mean encounter days for each age cohort by treatment types.	DV: Encounter days IV: Age, clinical factors, sociodemographic factors, treatment types. Using a regression model to analyze the association between age and encounter days, adjusting for the independent variables.	2949 patients; 51.4% were between 70 and 79 years old, and 81.3% were white. Although unadjusted analysis showed an association between older age and more encounter days (Rate Ratio (RR) = 1.12; 95% CI: 1.02, 1.22), there was no significant association after adjusting for comorbidities and treatment type. Patients with more than three comorbidities had significantly higher encounter days compared to those without comorbidities [RR = 1.36 (95% CI: 1.26, 1.46)]. Receipt of radiotherapy [RR = 1.45 (95% CI: 1.37, 1.54)] was associated with more encounter days compared to not receiving radiotherapy, while receipt of bone-

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Table 2 (*continued*)

Reference discipline	Purpose/research question (s)/ hypothesis	Design, sample, and instruments used	Variable analysis of data	Findings
				modifying agents was associated with fewer encounter days compared to not using Bone modifying agents [RR = 0.75, 95% CI: 0.70, 0.79)].
Agrawal et al.[26] Advanced esophageal and gastric cancer	To evaluate the time toxicity, or time spent in health care, of immunotherapy- versus chemotherapy-based regimens for metastatic esophageal and gastric cancers.	A literature search was conducted, and 18 phase III clinical trials of immune checkpoint inhibitors were selected for analysis. Health care days were calculated based on the number of days associated with receiving therapy and the adverse events reported in the clinical trials. Both the number of health care days and the median overall survival were compared among chemotherapy-only, immunotherapy-only, and chemo-immunotherapy regimens across this cohort of drug registration trials.	DV: Number of health care days, median overall survival IV: Treatment regimen. The analysis involved calculating the number of health care days for each patient based on the reported therapy and adverse events by comparing the mean or median number of health care days and median overall survival across the three treatment regimens.	Estimated median number of health care days was 37 (range of 7–52) days, or 1.2 (range of 0.2–1.7) months, compared to a median survival of 10.2 months across these 18 studies. For the chemotherapy-only regimens, the median number of health care days was 39 (range of 21–51) days, and for chemo-immunotherapy, it was 39 (range of 30–52) days. The immunotherapy-only regimens had fewer days, a median of 28 (range of 24–41), $P < 0.05$, compared to the other two arms.
Cronin et al.[30] Palliative cancer care	To assess time toxicity of palliative chemotherapy in a geriatric oncology population, also to assess time toxicity of palliative chemotherapy in a geriatric oncology population	Retrospective review of patients attending the multidisciplinary Geriatric oncology Assessment and Liaison (GOAL) clinic of University hospital Waterford, Ireland over a 3.5-year period. We included patients for whom an initial or subsequent line of palliative CTx was commenced in the last 6 months of life. We recorded ambulatory physical health care contact days related to the delivery of CTx as well as treatment-related inpatient admissions as a measure of time toxicity.	DV: Time toxicity IV: Patient characteristics, treatment factors, and time to death. A total of 26 patients met inclusion criteria for the study. The median age of patients was 78 (67–86) at initial GOAL.	A total of 26 patients met inclusion criteria for the study. The median age of patients was 78 (67–86). At initial GOAL clinic review, 15 patients (58%) had an ECOG performance status of 1, and 10 patients (38%) had a performance status of 2. Most patients received single agent cytotoxic CTx (17/26; 65%) and 85% of patients received only 1 line of treatment. 23 patients (88%) required hospital admission during treatment and 11 patients (42%) required more than one admission. 5 patients (19%) were admitted due to treatment-associated toxicity. The median number of physical health care contact days related to CTx (including hospital admissions directly due to treatment toxicity) was 14 (5–37). Median survival from initiation of CTx was 119 days (15–170). 9 patients (35%) received treatment in the last month of life.
Banergee et al.[16] Cancer	To assess financial toxicity, time toxicity, and quality of life in multiple myeloma	Single-center cross-sectional survey of patients with MM who had undergone transplantation. FinTox+ was defined as a COST-FACIT score < 23, TimeTox + as MM-related interactions (including phone calls) ≥ 1x weekly or ≥ 1x monthly in-person among far-residing patients, QOL using PROMIS Global health, and functional status using patient-reported Karnofsky performance status (KPS).	DV: Financial toxicity, time toxicity, quality of life, functional status. IV: Patient characteristics, disease characteristics and treatment factors. The analysis involved identifying patients with financial toxicity (FinTox+) and time toxicity (TimeTox+) based on the defined criteria. Also, comparing the mean or median QOL and KPS scores between patients with and without financial toxicity and time toxicity.	Of 252 patients, 22% and 40% met FinTox+ and TimeTox + criteria respectively. Respective FinTox+ and TimeTox + proportions were 22%/37% for patients on maintenance, 22%/82% with active therapy, and 20%/14% with observation. FinTox + predictors included annual income ($P < 0.01$) and out-of-pocket costs ($P < 0.01$). TimeTox + predictors included disease status ($P < 0.001$), caregiver status ($P = 0.01$), far-residing status ($P < 0.001$), and out-of-pocket costs ($P = 0.03$). FinTox+ was associated with a clinically meaningful decrease in mental QOL, while TimeTox + patients were more likely to have KPS ≤ 80.
Cavanna et al.[44] Cancer Treament	To assess how barriers to oncologic diagnosis and treatment, and travel burden may cause time and financial toxicity.	A program to deliver oncologic treatment closer to the patient was initiated in the district of Piacenza (Northern Italy) several years ago. The oncologic activities are performed by oncologists and by nurses who travel from the oncologic ward of the city hospital to territorial centres to provide cancer patient management. This model is called Territorial oncology care (TOC): Patients are managed near their home, in three territorial hospitals and in a health centre, named "Casa della Salute" (CDS). A retrospective study was	DV: Travel burden, time toxicity, patient satisfaction IV: Treatment location. The analysis involved comparing the travel burden, time toxicity, and patient satisfaction between patients managed in the city hospital and those managed in the TOC program.	546 cancer patients managed in the TOC program from 2 January 2021 to 30 June 2022 were included in this study. Primary endpoints: Median km to reach the city hospital: 26 (range 11–79 km), median time: 44 min (range 32–116); median km to reach the territorial clinicians in the TOC program: 7 (range 1–35 km), median time: 16 minutes (range 6–54), $P < 0.001$. Secondary endpoints: 64.8% of patients who needed a caregiver for the city hospital could travel alone in the TOC program and 99.63% of patients were satisfied.

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Table 2 (*continued*)

Reference discipline	Purpose/research question (s)/ hypothesis	Design, sample, and instruments used	Variable analysis of data	Findings
		performed and the records of patients with cancer managed in the TOC program were analysed.		
Anggondowati et al.[22] Cancer treatment	Evaluated the effect of time-to-treatment on the overall 5-year survival of patients with non-small cell lung cancer (NSCLC) with cancer stage at diagnosis.	We analyzed data in the national cancer data base for adult patients newly diagnosed with NSCLC in 2003–2011 ($N = 693,554$). Extended *Cox* regression with counting process was used to model the effect of time-to-treatment on survival, adjusted for demographic and clinical factors. Multivariable analyses were performed separately for the groups with different stages at diagnosis. Time-to-treatment was defined as the interval between diagnosis and treatment initiation, with the categories of (I) 0 day, (II) 1 day–4 weeks, (III) 4.1–6.0 weeks, and (IV) > 6 weeks (the 1 day–4 weeks group was considered the reference group).	DV: Overall survival IV: Time-to-treatment, demographic factors, clinical factors. Using an extended Cox regression model with counting process to analyze the relationship between time-to-treatment and overall survival, adjusting for the independent variables.	Compared to treatment initiated between 1 day and 4 weeks after diagnosis, time-to-treatment at 4.1–6.0 weeks was associated with a lower risk of death for patients with early-stage cancer [adjusted HR (aHR) = 0.84 (95% CI: 0.82–0.85)], with locally advanced cancer [aHR = 0.82 (95% CI: 0.80–0.83)], and with metastatic cancer [aHR = 0.75 (95% CI: 0.74–0.76)]. Similarly, a lower risk of death was associated with time-to-treatment longer than 6 weeks for patients with any cancer stage at diagnosis. However, a subset analysis for early-stage patients who received surgery only showed that extended time-to-surgery was associated a higher risk of death [aHR 4.1–6.0 weeks, 1.06 (95% CI: 1.03–1.09); aHR > 6 weeks 1.17 (95% CI: 1.14–1.20)].
Wong et al.[33] Cancer treatment	To determine the current real world duration of curative treatments for the four common cancers.	A retrospective review was completed of patients referred to BC cancer from 2010 to 2016, ≤ 65 years old, newly diagnosed with stage I-III breast, colorectal, NSCLC or prostate cancer who received curative intent treatment. Information was collected on baseline characteristics, date of diagnosis, surgery, type, duration and intent of both radiotherapy and chemotherapy	DV: Duration of curative intent treatment IV: Cancer type, stage of cancer, type of treatment, duration of surgery, intent of treatment, patient characteristics. The analysis involved calculating the total duration of curative intent treatment for each patient based on surgery, radiotherapy, and chemotherapy duration.	22,275 patients were included: 55.7% breast, 22.4% colorectal, 9.2% NSCLC, 12.7% prostate cancer. Stage I/II/III at diagnosis: Breast 47.2%/38.7%/14.1%, colorectal 26.5%/30.1%/43.5%, NSCLC 46.5%/18.1%/35.4%, prostate 7.7%/ 62.9%/29.4%. Patients treated with definitive surgery only: breast 35.9%, colorectal 58%, NSCLC 52.2%, prostate 40.1%. The median duration of multimodality treatment was breast 24.6 weeks, colorectal 26.7 weeks, NSCLC 9.1 weeks, and prostate 6.0 weeks
Patel et al.[20] Cancer treatment	To analyze the time interval between diagnosis and either hormonal or radiotherapy treatment for prostate cancer patients in Nigeria and Tanzania.	Data were extracted from electronic patient records at the NSIA-LUTH Cancer Center (NLCC) in Lagos, Nigeria and at the Ocean Road Cancer Institute (ORCI) in Dar Es Salaam, Tanzania. Included patients were prostate cancer patients who received hypofractionated radiotherapy (HFRT) at ORCI between January 6 – June 16, 2022, and either HFRT or conventionally fractionated radiotherapy (CFRT) at NLCC between February 1 – July 27, 2022. Simple descriptive statistics were used to calculate the mean time interval between the patient's date of diagnosis of prostate cancer and the start of hormonal or radiotherapy treatment.	DV: Time interval IV: Treatment centre, type of radiotherapy. The analysis involved calculating the mean time interval for each treatment center and for each type of radiotherapy. DV: Time interval.	Time to hormonal therapy was collected for 23 ORCI patients and 28 NLCC patients. The mean time interval from date of diagnosis to start of hormonal therapy was 19.3 weeks for patients in Tanzania and 8.0 weeks for patients in Nigeria. Time to radiotherapy was collected for 23 ORCI patients and 50 NLCC patients. The mean time interval from date of diagnosis to start of radiotherapy was 59.13 weeks for patients in Tanzania and 48.5 weeks for patients in Nigeria.
Kagawalla et al.[24] Oncology	To quantify the time patients with cancer spend attending ambulatory appointments. To quantify the time patients with cancer spend attending ambulatory appointments.	Retrospective study of patients scheduled for oncology-related ambulatory care (e.g., labs, imaging, procedures, infusions, and clinician visits) at an academic cancer center over 1 week. The primary exposure was the ambulatory service type(s) (e.g., clinician visit only, labs and infusion, etc.). We used Real-time location system badge data to calculate clinic times and estimated round-trip travel times and parking times. We calculated and summarized clinic and total (clinic + travel + parking) times for ambulatory service types.	DV: Clinic time, total time. IV: Ambulatory service time. The study hypothesized that; different ambulatory service types would be associated with varying amounts of clinic time and total time. Also, patients receiving multiple services would experience longer total times compared to those receiving a single service.	$n = 435$ patients. Across all service day type(s), the median (IQR) clinic time was 119 (78–202) minutes. The estimated median (IQR) round-trip driving distance and travel time was 34 (17–49) miles and 50 (36–68) minutes. The median (IQR) parking time was 14 (12–15) minutes. Overall, the median (IQR) total time was 197 (143–287) minutes. The median total times for specific service type(s) included: 99 minutes for lab-only, 144 minutes for clinician visit only, and 278 minutes for labs, clinician visit, and infusion.

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Table 2 (*continued*)

Reference discipline	Purpose/research question (s)/ hypothesis	Design, sample, and instruments used	Variable analysis of data	Findings
Wieringa et al.[49] Cancer care	To describe the role of time in patient involvement, and identify strategies to overcome time-related barriers.	Seven databases were searched for any publications on patient involvement in cancer treatment decisions, focusing on how time is used to involve patients, the association between time and patient involvement, and/or strategies to overcome time-related barriers. Reviewers worked independently and in duplicate to select publications and extract data. One coder thematically analyzed data, a second coder checked these analyses.	DV: Patient Involvement in treatment decision making, time spent on decision making IV: Strategies to Overcome time-related barriers, health care provider characteristics, health care system factors. The analysis involved extracting data on the methods used to measure patient involvement and time, as well as the strategies employed to overcome time-related barriers.	Analysis revealed that time was a resource to process the diagnosis, to obtain/process/ consider information, for patients and clinicians to spend together, and for patient involvement in making decisions.

DV, dependent variable; IV, independent variable.

Workplace Burden: The temporal demands of cancer treatment can have a profound impact on patients' ability to maintain employment and fulfill professional responsibilities. Employment plays a crucial role in providing financial and psychological support for cancer patients.[13] Interestingly, the financial distress associated with out-of-pocket costs (OOP), exacerbated by employment loss or disruption,[14] further exacerbates the challenges faced by cancer patients in the presence of time toxicity.

Psychosocial Impact: Time toxicity can have a significant psychological impact on cancer patients and survivors. The emotional and psychological burden stemming from the time demands of treatment can contribute to reduced self-concept, body image disturbance, sexual inadequacies, and difficulties in social relationships.[15] These psychosocial challenges can further compound the overall impact of cancer on patients' lives.

- **Financial Toxicity:** the concept of time toxicity is closely linked to financial toxicity, as financial toxicity is a predictor for time toxicity and can significantly impact patients' wellbeing.[16] The financial burden of cancer treatment, which includes direct out-of-pocket costs and indirect costs such as travel and time away from work, can be overwhelming for patients and their families. Financial toxicity can affect a significant proportion of individuals with cancer, highlighting the importance of addressing this critical issue.[17] Financial toxicity affects approximately one-half of individuals with cancer due to the economic burdens associated with cancer treatment with associated temporal impacts.[18]

Generally, time toxicity increases health care utilization, leading to more time spent in treatment and recovery, which burdens patients' workplaces and reduces productivity. It also exacerbates psychosocial stress by isolating patients from their personal lives, while contributing to financial toxicity through lost income and increased medical costs. These factors together compound the overall burden of cancer care on patients.

Step 4: Determine the defining attributes

The defining attributes of time toxicity are characteristics consistently associated with the concept. From the literature, seven primary attributes of time toxicity were identified:

Temporal Burden: Time toxicity significantly burdens patients with treatment-related activities, including travel, waiting, receiving therapy, and recovering from side effects. Patients with high travel burden experience a more tedious process of cancer treatment, which ultimately increases the time spent in the hospital following cancer diagnosis.[3,19] Cancer patients in sub-Saharan countries experience a travel burden to access specific cancer services, which increases the level of time toxicity among these patients.[19,20] This excessive time expenditure can lead to a sense of exhaustion and overwhelm.

Disruption of Daily Life: The temporal demands of cancer treatment can disrupt patients' personal and professional lives, preventing them from engaging in normal activities. This disruption can lead to feelings of isolation and a diminished sense of control. Due to the high level of unmet needs experienced by patients diagnosed with cancer, they experience significant psychological disturbances associated with hopelessness, loss of control, and anxiety.[21]

Cumulative Impact: The cumulative effect of repeated appointments and extended treatment regimens can exacerbate the burden of time toxicity. Time-to-treatment is related to time toxicity, which can be described as the interval between cancer diagnosis and treatment initiation.[22] Long treatment regimens for cancer, unlike other chronic diseases, requires self-management support in routine from patients and caregivers, thus without this– cancer patients may experience declining health outcomes and poorer survival over long treatment durations.[23] Over time, this ongoing strain can contribute to increased stress and fatigue.

Opportunity Cost: The time dedicated to cancer treatment represents a significant opportunity cost. Several times, cancer patients exhaust several hours to obtain cancer care, especially ambulatory cancer care; which results in opportunity time costs and the coordination of social activities around ambulatory care.[24] Patients may miss out on valuable time with loved ones, career advancements, or personal pursuits.

Emotional and Psychological Strain: The ongoing demands of treatment-related time can contribute to increased stress, frustration, and feelings of isolation. Cancer accounts for an increase in emotional, and psychological problems, and every cancer stage increases the risk of cancer patients reporting moderate/severe emotional distress.[25] These emotional and psychological burdens can have a significant impact on patients' overall well-being.

Quantifiable and Qualitative Burden: While time toxicity can be measured quantitatively (e.g., number of hours or days spent in treatment), its true impact is qualitative. Time toxicity, which includes the days spent in health care facilities due to cancer diagnosis and treatment, increases the economic burden and reduces the quality of life of patients and their caregivers.[26] It affects patients' quality of life, autonomy, and psychosocial well-being.

Patient-Centered: The experience of time toxicity varies between individuals, influenced by their personal life circumstances, including employment, family responsibilities, geographic location, and access to

care and the availability of family or specialist oncology nurses. These factors make time toxicity a deeply personal experience, with each patient navigating unique challenges depending on their circumstances. A patient-centered tool designed to quantify time toxicity among cancer patients can significantly enhance the quality of care by providing a precise measure of the impact of treatment on patients' daily lives and well-being.[27] Understanding the individual experiences of time toxicity is essential for tailoring interventions and providing effective support.

Step 5: Identify antecedents and consequences

Antecedents

Antecedents are events or conditions that must be present before toxicity occurs. This implies certain factors must be present for time toxicity to manifest. The most common antecedents identified were:

Timing of Cancer Diagnosis: The timing of cancer diagnosis plays a crucial role. Early diagnosis can lead to better outcomes and reduce the overall time burden of treatment.[28] However, advanced or aggressive cancers often require more complex and prolonged treatment regimens, increasing the time demands on patients. In addition, individuals experiencing higher time toxicity may have poorer clinical outcomes, as related to the stage, type and severity of cancer diagnosis and intervention.[29]

Complex and Prolonged Treatment Regimens: Even for those with early-stage cancer, treatment regimens can be complex and time-consuming. Older adults with cancer facing cytotoxic chemotherapy treatments may experience heightened risks of treatment-related side effects, underscoring the complexities of managing cancer in the elderly population.[30] Advanced or aggressive cancers often require frequent appointments, long infusions, diagnostic tests, and follow-up care, further contributing to the time burden. Additionally, not all patients with cancer will achieve a cure, and some may face chronic or incurable cancers, extending the duration of treatment.[31]

Chronicity of Cancer: The chronicity of cancer, characterized by ongoing episodes of acute treatment and long-term disease management, is a significant contributor to time toxicity. Cancer chronicity is increasingly prevalent, requiring ongoing care for both the disease itself and its associated symptoms and side effects.[32] The prolonged nature of multimodality curative treatments for certain cancers, including the time spent on adjuvant chemotherapy, radiotherapy, and recovery periods between treatments, can contribute to increased time toxicity for patients.[33]

Health care System Inefficiencies: Inefficiencies within health care systems can exacerbate the time burden of cancer care. Time toxicity, defined as the amount of time patients spend seeking health care, can significantly impact the burden of illness for cancer patients; which highlights the importance of efficient and accessible health care systems in minimizing the negative effects of time-consuming treatments.[34] Fragmented care, long waiting times, and inadequate coordination among health care providers can lead to delays and unnecessary appointments. These inefficiencies can act as significant barriers to timely and efficient health care delivery for cancer patients.[35]

Consequences

Consequences are the outcomes of time toxicity. These include:

Decreased Quality of Life: The significant time burden detracts from patients' ability to engage in enjoyable or meaningful activities. Cancer has a negative impact on the quality of life of patients, associated with the disease process, the treatment type, and the chronicity of the disease.[36]

Non-Adherence to Treatment: The overwhelming time burden can lead to non-adherence to treatment, as some patients may skip or abandon treatment regimens. Factors influencing medication non-adherence include younger age, low education, low income, high medication cost, side effects, patient beliefs/perceptions, comorbidities, and poor patient–provider communication.[37]

Economic Burden: Time away from work or other obligations may lead to lost income and financial strain, compounding the overall burden of cancer treatment. Cancer is associated with high out-of-pocket costs, which poses a significant burden to patients and their families.[38]

Caregiver Strain: Time toxicity also extends to caregivers, who may need to take time off work or sacrifice personal activities to support the patient. Caregivers of patients with cancer experience high levels of caregiver-related strain and burden, which ultimately leads to poor health outcomes for the caregiver.[39]

Step 6: Construct model and contrary cases

Model case

Sarah, a 55-year-old woman with metastatic breast cancer, has been undergoing chemotherapy for over six months. Her treatment regimen requires weekly appointments for infusions, regular diagnostic tests, and follow-up consultations. Each visit to the hospital takes hours, including travel time, waiting, and the treatment itself. Sarah is struggling to keep up with her job and feels disconnected from her family. She is emotionally drained by the time demands of her treatment, and her quality of life has diminished. Sarah's case is a model example of time toxicity, encompassing all of its defining attributes—temporal burden, disruption of life, cumulative impact, opportunity cost, and emotional strain.

Borderline case

Tom, a 65-year-old man with early-stage colon cancer, undergoes surgery followed by a short course of radiation therapy. While he experiences some disruption in his daily life due to frequent appointments, his treatment is relatively brief, and he can resume his normal activities within a few weeks. Though Tom experiences some time-related stress, it does not meet the full criteria for time toxicity due to the limited duration and impact of his treatment.

Contrary case

Lisa, a 40-year-old woman, is diagnosed with a benign skin condition that requires a single outpatient procedure. The treatment is completed in one visit, with minimal time spent in the health care system and minimal disruption to her daily life. Lisa's case does not reflect time toxicity, as her treatment does not impose any significant time burden on her life and treatment requires minimal time investment.

Step 7: Identify empirical referents

Empirical referents are measurable indicators that demonstrate the presence of the concept. For time toxicity, the following empirical referents are commonly used:

Time Logs: Documentation of time spent in appointments, receiving treatments, or recovering from side effects.

Patient-Reported Outcomes: Surveys and interviews where patients describe how time spent in treatment affects their daily life and overall well-being.

Time toxicity index: A metric used to quantify cancer treatments' cumulative time burden on patients.

Health care Utilization Data: Data on the frequency and duration of medical appointments and treatments can provide insight into patients' time burdens.

Step 8: Definition of time toxicity

Based on the analysis, time toxicity is defined as:

… the cumulative burden of time spent on treatment-related activities

by cancer patients, characterized by disruption of daily life, loss of opportunity for meaningful activities, and increased emotional strain. It often results from complex and prolonged treatment regimens and can negatively impact patients' quality of life and adherence to treatment. Time toxicity is a significant concern in cancer care, as it can have a substantial impact on patients' overall well-being and their ability to cope with the challenges of their illness.

Discussion

The concept of time toxicity, as explored in this analysis using Walker and Avant's method,[10] is a pivotal consideration in the broader context of cancer care. It underscores the significant impact that the temporal demands of treatment can have on patients' lives, extending beyond the immediate medical consequences. The increasing complexity and duration of cancer treatments, coupled with factors like geographical distance to oncology facilities, contribute to the escalating burden of time toxicity. In clinical practice, time toxicity becomes a particularly relevant factor in decision-making when assessing the balance between the potential benefits of a treatment and its impact on the patient's daily life. While certain therapies may prolong survival or reduce cancer progression, the extensive time commitment they require may offset some of these benefits, especially in palliative care settings, where maintaining a good quality of life is paramount.

Time toxicity, a significant burden for cancer patients, encompasses various dimensions. It involves the substantial time spent on treatment-related activities, including travel, waiting, receiving therapy, and recovering from side effects. This temporal burden can disrupt patients' daily lives, interfering with personal and professional activities and leading to feelings of isolation and a diminished sense of control. The cumulative impact of repeated appointments and extended treatment regimens can exacerbate the strain, contributing to increased stress and fatigue.

Several factors contribute to the development of time toxicity in cancer care. The timing of cancer diagnosis plays a crucial role. Early diagnosis can lead to better outcomes and reduce the overall time burden of treatment.[28] However, advanced or aggressive cancers often require more complex and prolonged treatment regimens, increasing the time demands on patients. Additionally, in line with existing research,[31] not all patients with cancer will achieve a cure, and some may face chronic or incurable cancers, further extending the duration of treatment.

The chronicity of cancer, characterized by ongoing episodes of acute treatment and long-term disease management, is another significant contributor to time toxicity. Cancer chronicity is increasingly prevalent, requiring ongoing care for both the disease itself and its associated symptoms and side effects.[39] Furthermore, inefficiencies within health care systems can exacerbate the time burden of cancer care. Fragmented care, long waiting times, and inadequate coordination among health care providers can lead to delays and unnecessary appointments, as significant barriers to timely and efficient health care delivery for cancer patients.[35]

Time toxicity can have a profound impact on cancer patients' overall well-being. It can lead to a decreased quality of life, as patients may find it difficult to engage in enjoyable or meaningful activities. Time toxicity also has significant implications for patient-centered cancer care. For instance, a study[40] found that certain anti-cancer drugs approved based on their ability to extend progression-free survival may result in high time costs for patients, raising questions about the true benefit of these treatments. The overwhelming time burden can also contribute to non-adherence to treatment, ultimately leading to cancer patients abandoning treatment regimens with huge negative consequences on their treatment and survival.

Additionally, time toxicity can have economic consequences, as patients may experience lost income and financial strain due to time away from work or other obligations. Cancer is associated with high out-of-pocket costs, which can pose a significant burden to patients and their families.[38] Moreover, time toxicity can extend to caregivers, who may need to take time off work or sacrifice personal activities to support the patient. Caregivers of patients with cancer often experience high levels of caregiver-related strain and burden, which can ultimately lead to poor health outcomes for the caregiver.[39]

The emotional, social, and economic toll of time toxicity cannot be overstated. The financial strain of frequent medical appointments, the disruption of personal and professional relationships, and the psychological stress associated with the uncertainty of treatment can all contribute to a diminished overall well-being. Therefore, it is imperative that researchers and clinicians prioritize strategies to mitigate time toxicity. This includes efforts to enhance accessibility to oncology care, optimize scheduling practices, and explore innovative approaches such as telemedicine. Therefore, a comprehensive understanding of the patterns of time toxicity and their associated burdens is essential for developing effective interventions.[41]

Implications for oncology nursing

The concept of time toxicity has significant implications for clinical practice and research. Understanding the attributes, antecedents, and consequences of time toxicity can inform the development of more patient-centered and effective approaches to cancer care. In clinical decision-making, time toxicity should be considered when assessing the balance between the potential benefits of a treatment and its impact on the patient's daily life. While certain therapies may prolong survival or reduce cancer progression, the extensive time commitment they require may offset some of these benefits, especially in palliative care settings.

One of the most important implications is the need for patient-centered care coordination. Oncology nurses are uniquely positioned to facilitate the coordination of care across various disciplines, reducing the time patients spend on logistical tasks. As cancer care becomes more patient-centered, there is a growing call to include time toxicity as an essential endpoint in clinical trials, alongside traditional metrics such as overall survival and progression-free survival.[42,43] In addition, by addressing delays in care and minimizing the frequency of unnecessary visits, oncology nurses help improve the patient experience and reduce the emotional toll associated with prolonged treatment schedules.

By incorporating the concept of time toxicity into cancer care decision-making, patients can make more informed treatment choices based on the time commitment required, enabling a more nuanced understanding of the trade-offs between prolonging life and maintaining quality of life. For example, telemedicine consultations can reduce the need for travel, while connecting patients to community resources and social services might ease some of the logistical challenges they face. Furthermore, oncology nurses can advocate for workplace accommodations that allow patients to balance treatment and employment, thus reducing the economic strain associated with time toxicity.

Another key implication is the nurse's role in advocating for health care system improvements. Nurses, being on the frontline of care, often witness firsthand the inefficiencies within health care systems contributing to time toxicity. These inefficiencies include long wait times, disjointed care pathways, and a lack of patient-centered scheduling practices. Furthermore, the time spent traveling to and from health care facilities can pose substantial barriers to timely diagnosis and treatment, leading to negative consequences such as delayed interventions, increased anxiety, and compromised quality of life.[44] Addressing these barriers requires efforts to enhance accessibility to oncology care and optimize scheduling practices. Efforts to minimize time toxicity include streamlining care processes, using less frequent dosing regimens, employing telemedicine for follow-up visits, and exploring treatments with shorter durations.

Equally important is the emotional support nurses provide, helping patients cope with the psychological burden of time toxicity. By fostering open communication, nurses can encourage patients to express their concerns about the time demands of treatment and work with them to develop individualized solutions that alleviate this burden. Open

communication between clinicians and patients is essential for addressing time toxicity. Clinicians should proactively discuss the potential time-related burdens of cancer care, including the risks and benefits of different treatment options.[45] Moreover, active efforts to streamline care processes and minimize unnecessary appointments can help to alleviate the time toxicity experienced by patients.

A crucial aspect of addressing time toxicity involves ongoing research and patient-centered approaches to ensure that treatment plans align with patients' individual preferences and life goals. The development of a standardized measure of time toxicity[46] is a crucial step in quantifying and addressing this complex issue. Such a measure would enable researchers to compare the time burdens experienced by different patient populations and to evaluate the effectiveness of interventions aimed at reducing time toxicity. Clinical trials,[47] can serve as valuable tools for refining existing measures and identifying areas for improvement. However, time toxicity has been underreported in oncologic clinical trials, lacking a standardized definition, metric, or methodology.[48] Oncology nurses can take a leading role in research and quality improvement initiatives related to time toxicity. By gathering data on patients' experiences, nurses can assess the impact of time toxicity on quality of life and identify areas where care processes can be improved. Nurses are well-positioned to collaborate with interdisciplinary teams on projects aimed at reducing the time burden on patients and improving the efficiency of care delivery. Furthermore, nurse-led research can explore the psychological and emotional consequences of time toxicity, paving the way for evidence-based interventions that address this growing concern.

As oncology treatments evolve, the role of the nurse in mitigating this burden becomes increasingly critical. With their deep understanding of the patient's experience and their role as key health care team members, oncology nurses are well-positioned to play a pivotal role in reducing time toxicity. Health care providers can enhance patient decision-making by collaborating with patients to create personalized treatment timelines, spreading out decisions across multiple consultations, providing written information, and advocating for health care system reforms that allocate sufficient time for patient-centered care.[49–51] By coordinating care, providing education, and offering emotional support, oncology nurses can help patients navigate the complexities of their treatment regimens and minimize the negative impacts of time toxicity.

Conclusions

Time toxicity is a vital, evolving and underexplored concept in cancer care, with significant implications for patient well-being and treatment success. By taking a proactive approach to care coordination, patient education, advocacy, and support, nurses can play a critical role in reducing the time burden experienced by cancer patients. Addressing time toxicity improves the patient's quality of life, enhances treatment adherence, and expands overall outcomes. As health care systems evolve, oncology nurses will remain central in shaping how cancer care is delivered, ensuring that time toxicity is recognized and mitigated as part of comprehensive, patient-centered oncology care. By understanding the defining attributes, antecedents, and consequences of time toxicity, health care providers can better identify its presence, develop strategies to mitigate its impact, and better support patients in navigating their cancer journeys. Future research should focus on interventions to reduce time toxicity and explore its effects across different cancer settings and populations to elucidate its impact on cancer care further.

CRediT authorship contribution statement

Chinomso Nwozichi: Conceptualization, Methodology, Data curation, Formal analysis, Writing – original draft, revision. **Salako Omolabake**: Methodology, Writing – original draft and revisions, manuscript preparation. **Margaret O. Ojewale**: Formal analysis, Writing – revised draft preparation, Data curation. **Funmilola Faremi**: Conceptualization, Methodology, Data collection, Writing – original and revised draft preparation. **Deliverance Brotobor**: Formal analysis, Writing – revised draft preparation, Data collection. **Elizabeth Olaogun**: Data collection, Writing – revised draft preparation. **Mosidat Oshodi-Bakare**: Writing – original and revised draft preparation. **Oluwaseun Martins-Akinlose**: Supervision, Writing – review and editing. All authors had access to the study data, and the corresponding author had final responsibility for submitting the manuscript for publication. The corresponding author confirms that all listed authors meet authorship criteria and that no individuals who qualify for authorship have been omitted.

Ethics statement

Not required.

Funding

This study received no external funding.

Data availability statement

No new data were generated or analyzed in this study. All data supporting the findings of this literature review are based on publicly available research articles, which are cited in the reference section. Any additional information can be requested from the corresponding author, Dr. Chinomso Nwozichi, as needed.

Declaration of generative AI and AI-assisted technologies in the writing process

During the preparation of this work, the author(s) used Grammarly software to edit the grammar presentation. After using this tool/service, the authors reviewed and edited the content as needed and took full responsibility for the content of the publication.

Declaration of competing interest

The authors declare no conflict of interest. However, the corresponding author, Dr. Chinomso Nwozichi, is an editorial board member of *Asia–Pacific Journal of Oncology Nursing*. The article was subject to the journal's standard procedures, with peer review handled independently of Dr. Nwozichi and their research group.

Acknowledgment

The authors would like to thank Mrs Paulina Ahuchuba for her support during this study.

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