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Cancer care treatment attrition in adults: Measurement approaches and inequities in patient dropout rates – a rapid review

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Abstract

Background Cancer treatment attrition refers to the discontinuation of prescribed cancer therapies before completion. It can significantly impact patient outcomes and cancer survival rates making it a critical concern. There is growing evidence on inequalities in cancer care, the avoidable systematic differences in the health of different groups of people. Understanding the extent of treatment attrition, why it happens, for whom, and associated inequalities may improve cancer care delivery and patient outcomes.

Methods A rapid review was conducted to identify existing evidence on measures of cancer treatment attrition, definitions, reasons for attrition and potential inequalities. The review followed a systematic approach but with abbreviated processes to facilitate quicker evidence synthesis. Searches were restricted to MEDLINE and Embase databases from their inception dates to May 7, 2024. Additional searches were performed in PubMed, Google Scholar, and key grey literature from relevant organizations. Inclusion criteria were adults with any type of cancer undergoing treatment, with studies reporting quantitative or qualitative data on treatment attrition conducted outside of clinical trials. Exclusion criteria included studies on children or adolescents, clinical trials, non-English publications, and various non-research article types. Data extraction and quality assessment were performed using standardized tools, and studies were synthesized narratively.

Results The search retrieved 1,353 references, with 40 studies meeting inclusion criteria. Most studies were retrospective. Studies covered various cancer types and treatments, reporting measures of attrition and reasons for treatment drop-out. Factors influencing attrition included disease progression, death, clinical deterioration, treatment toxicity, and socioeconomic factors such as lower income or socioeconomic disadvantage.

Conclusions This review highlights significant variability in how treatment attrition is measured and defined, and suggests potential inequalities in who discontinues treatment. Standardized measures of attrition and data collection on reasons for discontinuation are essential to improve cancer care outcomes and equity. Future research should focus on developing these standardized metrics and exploring interventions targeting identified disparities to support cancer patients to complete treatment and improve outcomes.

Keywords Attrition rates, Inequalities in healthcare, Cancer treatment adherence

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Background

Cancer treatment attrition refers to the discontinuation of prescribed cancer therapies before completion. It can significantly impact patient outcomes and cancer survival rates making it a critical concern. There is growing evidence of inequalities in cancer incidence and care globally [1]. These inequalities often result in differences in cancer incidence, stage of disease at diagnosis, treatment access, treatment adherence, and overall survival rates. For instance, minority populations and individuals with lower socioeconomic status frequently experience delayed diagnoses, limited access to advanced treatments, and higher mortality rates compared to those from more affluent areas [2]. These widely observed disparities in access to cancer care may also have manifestations in cancer care treatment and the continuation of treatment for different groups. Cancer treatment attrition may have been overshadowed by the focus on early diagnosis and access to cancer treatment that remain critical to improving survival rates. Understanding the extent of treatment attrition, why it happens and for whom, and associated inequalities may improve cancer care delivery and patient outcomes for all. Addressing potential disparities in attrition first requires effective ways of identifying it.

Within the clinical trial environment treatment attrition measurement can ensure internal and external validity. If there is high attrition, the remaining sample may no longer be representative of the initial population impacting internal validity, it can also affect the generalisability of results if specific subgroups discontinue treatment impacting external validity. If treatment attrition is not accounted for, reported outcomes may reflect the experiences of a subset of participants who tolerated or benefited from the treatment, rather than the whole cohort. Existing literature indicates that treatment attrition can be influenced by various factors, including socioeconomic status, access to healthcare, patient-related factors (e.g., comorbidities, psychological distress), and healthcare system factors (e.g., quality of care, healthcare provider bias) [3]. Despite the recognition of these factors, there is limited comprehensive evidence outside of clinical trial environments on how treatment attrition is measured, the specific reasons for discontinuation, and whether there are inequalities associated with who stops treatment.

This rapid review aims to address these gaps by exploring the current evidence on cancer treatment attrition, focusing on measurement methods, reasons for discontinuation, and evidence of inequalities in treatment attrition.

Methods

To support future work on cancer treatment attrition a rapid review was conducted to identify existing evidence outside of a clinical trial environment on measures of cancer treatment attrition, definitions, reasons for attrition, and inequalities.

Rapid reviews follow a systematic approach, but some processes are abbreviated or omitted to facilitate evidence synthesis in a shorter timeframe [4]. For this review the number of databases that were searched were restricted to MEDLINE and Embase. MEDLINE was searched via Ovid from 1946 to 7th May 2024 and Embase was searched via Ovid from 1974 to 7th May 2024. The search strategy was designed in MEDLINE and adapted for use in Embase. The strategy included index terms and keywords for the population, phenomenon of interest, and study design. Search strategies are available in the supplementary materials.

The database searches were supplemented with reference checking of relevant published systematic reviews, additional targeted searches in PubMed and Google Scholar, and targeted searches for key grey literature from relevant organisations including Macmillan Cancer Support, and the National Cancer Institute (NCI).

Studies were included if they reported on adults with any type of cancer at any stage undergoing cancer treatment (chemotherapy, radiotherapy, and/or surgery). Any quantitative or qualitative study was included if it addressed the research question and was conducted outside of a clinical trial environment. Reports published in English were included. Studies reporting on children or adolescents were excluded. Editorials, commentaries, journal clubs, study protocols, conference abstracts, and reports published in languages other than English were also excluded.

Search results were imported into a reference manager (Zotero) and deduplicated. Study screening was conducted in Rayyan [5] by a single reviewer in two phases: (1) screening based on title and abstract; (2) full-text review. Any uncertainty was discussed with a second reviewer. The final list of studies for inclusion was verified by a second reviewer. The screening process was documented and reported in a PRISMA study flow diagram [6].

Data from each included study were extracted by a single reviewer into a data extraction table in Excel and verified by a second reviewer. The following elements were extracted: country, study objectives, study design, data source, population details, intervention details, measures and definitions of attrition, attrition rates, reasons for attrition, risk factors, inequalities, and study conclusions. Study quality was assessed with the Newcastle-Ottawa Scale (NOS) [7]. Studies were stratified by patient and study characteristics and synthesised narratively.

Results

Results of literature search

The electronic searches retrieved a total of 1,353 references. Duplicates were identified and 291 records removed, leaving 1,062 references for screening. During title and abstract screening 994 records were excluded, leaving 68 references to be assessed based on full text. Following full text review, 40 studies were included, 25 were excluded, and 3 were not retrievable. See Fig. 1 for the study flow diagram.

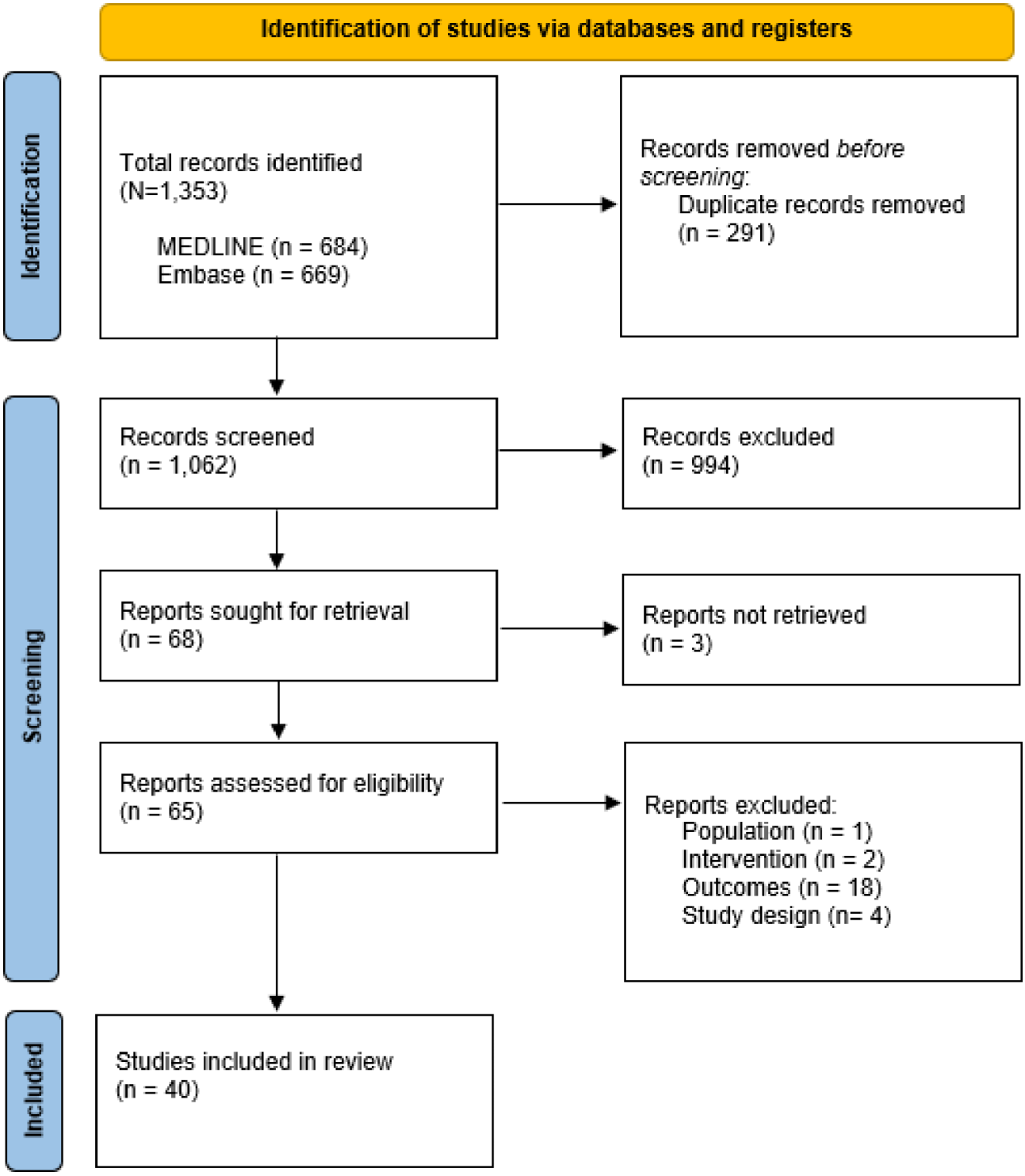

Fig. 1 PRISMA flow diagram

Description of included studies

Most of the included studies (*N*=36) had a retrospective design [8–43]. Two studies [44, 45] were prospective cohorts, one study [46] was ambispective (combines retrospective and prospective data collection), and one study was population-based [47]. Studies came from Canada, (*N*=9), USA (*N*=8), Italy (*N*=4), Europe (*N*=3), China (*N*=2), India (*N*=2), Australia and UK (*N*=1), and one study each from Australia, Austria, Denmark, England, Germany, Greece, Korea, Malaysia, Slovenia, and Spain.

Studies included patients with colorectal cancer (*N*=7), lung cancer (*N*=7), multiple myeloma (*N*=6), oesophageal or gastric cancers (*N*=4), mixed populations [4], urothelial carcinoma (*N*=3), oral cancer (*N*=2), prostate cancer (*N*=2), and one study each for breast cancer, cervical cancer, hepatocellular carcinoma, mantle cell lymphoma, and vulvar cancer. Most studies (*N*=26) included patients with advanced or metastatic disease. Six studies included mixed stages, and the remaining eight studies did not report disease staging. The number of patients in each study ranged widely from 123,943 in a population-based study [47] to 20 patients in a single-centre retrospective study [25].

Treatments included a range of chemotherapies, radiotherapy, surgery, and various combinations. One study [44] also reported referral to psycho-oncology intervention. All included studies reported some measure of attrition. Twenty studies reported reasons for attrition, 19 studies reported on risk factors, and 7 studies reported information on inequalities related to treatment attrition. Included studies are summarised in Table 1. All studies were rated as fair quality or above on the Newcastle Ottawa scale.

Measures and definitions

Measures and definitions found in the included studies are summarized in Table 2. The most common measure of attrition was the rate or proportion of patients initiating or not initiating the next line of therapy. This was reported in 25 of the included studies. Definitions varied where reported. Other identified measures included attrition rate (defined as a ratio), default rate, discontinuation from first line treatment, attendance or non-attendance, proportion of patients experiencing attrition, proportion of patients meeting the study attrition rate criteria, proportion of patients undergoing adjuvant chemo-radiotherapy/radiotherapy following surgery, surgery rates, surgery refusal, treatment completion, and unintended interruption of radiotherapy.

Treatment attrition rates

Rates appeared to differ with cancer types, although attrition from chemotherapy was variously reported with regards to line of therapy (LOT) which makes comparison difficult. The attrition rate from first line (1 L) to second line (2 L) was reported as 9.67% in breast cancer patients [10]. In a study of cervical cancer patients, 12% did not complete their treatment [27]. Attrition rate from 1 L in colorectal cancers ranged from 27 to 53% [18, 19]. In oesophagogastric cancer, 24% of patients experienced attrition [41], and in non-small cell lung cancer, 33–43% of patients did not receive a 2 L treatment [9, 26]. In multiple myeloma, attrition from 1 L ranged from 7 to 45.7% [30, 38] while attrition across all lines of therapy ranged from 43 to 57% in non-transplanted patients, and 21–37% in transplanted patients [16].

Attrition rates tended to increase with increasing lines of therapy [11, 19, 20, 30, 33, 38] regardless of cancer type. Where attrition was reported as a proportion of patients receiving a subsequent line of therapy, the inverse was true, i.e. the proportion of people receiving a subsequent line decreased with increasing lines of therapy [8, 12, 21, 23, 28, 31–35, 37, 39, 41, 42, 46].

Attrition from surgery was found to be marginally lower in a group of patients who received surgery before neoadjuvant chemotherapy for oesophagogastric cancer when compared with a group who received neoadjuvant chemotherapy before surgery [22]. The rate of surgery in the surgery-first arms was 90.1%, compared to 84.4% in the neoadjuvant- firstarm. Non-attendance at follow up visits following surgery for oral cancer was high, with only 1.6% of patients adhering to a monthly follow-up and 12.6% failing to attend any follow-up visits [43].

In a study of radiotherapy for various types of cancer, interrupted treatment was reported in 19.3% of patients [36].

A summary of treatment attrition stratified by cancer type can be found in Table 3.

Reasons for treatment attrition

Information on reasons for cancer treatment discontinuation were reported in eighteen of the included studies [9–11, 13, 15, 17, 20, 22, 25, 31–34, 36, 40, 42, 45, 46]. The most frequently reported reason was disease progression (*N*=9), followed by death (*N*=8), clinical deterioration or progression (*N*=5), toxicity (*N*=3), adverse event (*N*=2), concern about lack of family/social support (*N*=2), radiological progression (*N*=2), and 'unknown' reasons (*N*=2). The following reasons were reported in one study each: complications due to previous therapy, fear of consequences of surgery, loss to follow up, medical reasons, missing data, non-medical reasons, patient refusal, poor overall status/life expectancy, severe concomitant illness, symptoms relieved, technical problems, unwilling to have further treatment, personal preference, worsening health condition, and 'other'.

Table 1 Summary of included studies

Author/Year	Country	Study design	Total *N*	Cancer type	Treatment type
Abdel-Rahman 2021 [8]	Canada	Retrospective	4179	Colon or rectal adenocarcinoma	Chemotherapy
Addeo 2021 [9]	Europe, Israel	Retrospective	899	Lung cancer (NSCLC)	EGFR-TKI treatment (gefitinib, erlotinib, or afatinib, as monotherapy or combination therapy)
Basile 2021 [10]	Italy	Retrospective	717	Breast cancer	Chemotherapy, Endocrine therapy (ET), cyclin-dependent-kinases 4/6 inhibitors (CDK4/6i)
Benda 2023 [11]	Austria	Retrospective	571	Multiple myeloma	proteasome inhibitors, immunomodulators, antibodies, and chemotherapy.
Boyne 2023 [12]	Canada	Retrospective	2721	Colorectal cancer	Systematic therapy
Carruthers 2019 [13]	Australia	Retrospective	807	Mixed	Referral for radiation therapy
Chan 2015 [44]	Malaysia	Prospective	467	Mixed	Definitive oncology treatment (i.e. chemotherapy or radiotherapy)
Dobbs 2018 [14]	USA	Retrospective	576	Prostate cancer	Referred to urologic oncology clinic
Fisch 2021 [15]	Germany	Retrospective	191	Lung cancer (LCNEC)	Systematic therapies, palliative therapies
Fonseca 2020 [16]	USA	Retrospective	•Did not receive ASCT (non-transplant, *n* = 22,062) •Received ASCT (transplant, *n* = 2763)	Multiple myeloma	Chemotherapy
Fu 2021 [17]	China	Retrospective	171	Oral cavity	Neoadjuvant chemotherapy, surgery
Garattini 2021 [18]	Italy	Retrospective	890	Colorectal cancer	Chemotherapy
Germani 2024 [19]	Italy	Retrospective	179	Colorectal cancer	Encorafenib plus cetuximab +/- binimetinib
Groene 2015 [45]	England	Prospective	2313	Oesophagogastric cancer	Palliative chemotherapy
Janzic 2022 [20]	Bulgaria, Poland, Romania, and Slovenia	Retrospective	389	Lung cancer (NSCLC)	EGFR TKI therapy
Jensen 2019 [47]	Denmark	Population-based cross-sectional study	123,943	Mixed	NR
Jimenez-Zepeda 2022 [21]	Canada	Retrospective	1729	Multiple myeloma	Chemotherapy
Kakish 2023 [22]	USA	Retrospective	Clinical trial population: 7650 Database population: 48,187	Gastric or gastroesophageal junction cancers	Neoadjuvant treatment and curative intent surgery
Kennecke 2019 [23]	Canada	Retrospective	200	Colorectal cancer	Systemic treatment
Kronenfeld 2021 [24]	USA	Retrospective	116	Gastric cancer	Neoadjuvant chemotherapy
Kumar 2020 [25]	India	Retrospective	20	Vulvar cancer	Surgery, chemoradiotherapy, radiotherapy
Lampaki 2022 [26]	Greece	Retrospective	160	Lung cancer (NSCLC)	EGFR-TKI therapy
Martinelli 2022 [28]	Austria, Belgium, France, Germany, Italy, Spain, UK	Retrospective	255	Colorectal cancer	Systemic treatment
Mathew 2024 [29]	USA	Retrospective	7260	Urothelial Carcinoma	Chemotherapy
McCurdy 2023 [30]	Canada	Retrospective	5548	Multiple myeloma	anti-MM agent
McLean 2016 [31]	Canada	Retrospective	215	Colorectal cancer	Chemotherapy
Minson 2024 [32]	Australia, UK	Retrospective	389	Mantle cell lymphoma	Chmotherapy
More 2023 [33]	Italy	Retrospective	412	Multiple myeloma	Chemotherapy
Morgans 2022 [46]	USA	Ambispective	300	Urothelial Carcinoma	PD- 1/L1 inhibitor therapy following chemotherapy
Nieva 2022 [34]	USA	Retrospective	1029	Lung cancer (NSCLC)	1 L first-generation or second-generation EGFR-TKIs

Table 1 (continued)

Author/Year	Country	Study design	Total *N*	Cancer type	Treatment type
O'Sullivan 2021 [35]	Canada	Retrospective	1941	Lung cancer (SCLC)	Chemotherapy with/without radiotherapy or supportive care
Paul 2010 [27]	India	Retrospective	784	Cervical cancer	Chemotherapy, radiotherapy
Rim 2018 [36]	Korea (Republic of)	Retrospective	353	Mixed	Radiotherapy
Swami 2023 [37]	USA	Retrospective	4758	Prostate Cancer	Chemotherapy, ADTs
Tang 2023 [38]	China	Retrospective	1255	Multiple Myeloma	Chemotherapy
Tapia 2024 [39]	Spain	Retrospective	206	Urothelial Carcinoma	Systemic therapy
Tsang 2020a [40]	Canada	Retrospective	144	Hepatocellular Carcinoma	1 L sorafenib,
Tsang 2020b [41]	Canada	Retrospective	245	Esophagogastric cancer	systemic therapy
Turnsek 2022 [42]	Slovenia	Retrospective	120	Lung cancer (NSCLC)	1 L first-generation or second-generation EGFR-TKIs
Wang 2023 [43]	China	Retrospective	430	Oral squamous cell carcinoma	Surgery

Nineteen of the included papers included information on the risk factors associated with treatment attrition. There was a diverse array of influences contributing to treatment discontinuation across the different cancer types. Significant risk factors included older age ($N=11$), advanced disease stage ($N=3$), and the presence of multiple comorbidities ($N=5$), which are often associated with increased treatment side effects and reduced tolerability. Socioeconomic factors also play a role, with lower income ($N=3$) and lack of insurance coverage ($N=3$) linked to higher attrition rates. Ethnicity, living in a rural location or with long travel times to treatment, and receiving care in a non-academic health provider were additional factors considered, but were not shown to be significant once adjusting for other factors. These findings underscore the complex interplay of medical, socioeconomic, and psychological elements that need to be addressed to reduce treatment attrition and improve cancer care outcomes.

Discussion

The findings of this rapid review underscore the complexity of cancer treatment attrition and highlight significant inequalities. The variation in definitions and measures of attrition complicates the comparison of rates across studies. However, the identified reasons for attrition and associated inequalities align with existing literature [1, 3], reinforcing the need for targeted interventions to support vulnerable populations.

Measures and definitions of attrition

The review identified considerable variability in the measures and definitions of treatment attrition used across studies. Most commonly, attrition was quantified by the rate or proportion of patients who did not proceed to the next line of therapy (LOT). This measure varied in specificity, with some studies providing detailed definitions that included criteria such as death, loss to follow-up, or patient refusal, while others used broader terms like "discontinuation from treatment" or "non-attendance." The lack of a standardized definition complicates comparisons across studies and highlights the need for a unified approach to measuring treatment attrition. Standardized measures would not only improve the comparability of studies but also enhance the clarity of communication between healthcare providers and patients regarding the implications of treatment discontinuation.

Rates of attrition

The rates of attrition varied significantly across different cancer types and treatments. For example, attrition from first-line to second-line therapy was as low as 9.67% in breast cancer patients receiving chemotherapy, while it ranged from 27 to 53% in colorectal cancer. Multiple myeloma patients exhibited a wide range of attrition rates depending on whether they underwent autologous stem cell transplantation, with non-transplanted patients experiencing higher rates of attrition (43–57%) compared to those who received transplants (21–37%). Attrition tended to increase with each successive line of therapy, indicating that patients often discontinue treatment as the disease progresses or as they experience increasing treatment-related burdens. These differences underscore the influence of both cancer type and treatment regimen on patient adherence.

Reasons for attrition

Several studies provided insights into the reasons for treatment attrition, which include medical complications, treatment toxicity, progression of disease, and patient choice influenced by quality of life considerations.

Table 2 Measures and definitions of cancer treatment attrition

Measure of attrition	Definition (where reported)
Attrition rate	Ratio of patients who did not have record of a subsequent LOT because of death or loss to follow-up (.ie, no subsequent treatment in follow-up) in the database for any reason [16].
Default rate	Patients who refuse, delay or fail to complete treatment or who did not attend three or more consecutive visits after their last clinic attendance [44].
Discontinuation from 1L treatment	Proportion of patients who discontinued 1L treatment [9].
Follow-up attendance after surgery	Number of follow-up visits within the first year after surgery [43].
Non-attendance	Any unexplained non-attendance was recorded for patients in the pre-treatment (pre-RT) period, and during RT, but multiple non-attendances for a single patient were recorded only as a single non-attendance statistic within the treatment stage analyzed (either pre-RT, or during RT). Full attendance was defined as no missed appointments or missed for medical reasons [13].
	Patients were categorised into "non-attenders" (no consultations) and "attenders" (one or more consultations) based on face-to-face consultations with a GP in the period up to 36 months before cancer diagnosis [47]. *Note: this was therefore not specific to cancer treatment completion but used to understand potential correlation with late cancer diagnosis.*
	Proportion of patients who missed appointments [14].
Proportion of patients experiencing attrition	Attrition was defined as the inability to complete the prescribed number of NAC cycles, as determined at the inception of treatment by the medical oncologist, and as documented in the medical record [24].
Proportion of patients meeting the attrition rate criteria	Attrition was defined as being either deceased, progressive without having received another LOT, or lack of follow-up for > = 5 years [11].
Proportion of patients undergoing adjuvant chemoradiotherapy/radiotherapy following surgery	No further definition reported
Rate or proportion of patients initiating or not initiating the next line of therapy	Percentage of patients not achieving/progressing to a further line of treatment (18, 29).
	The attrition rate related to first-line treatment was defined as the proportion of patients who started therapy but who, at the time of disease progression were unable to receive further treatment due to disease progression, death, toxicity, or other clinical conditions [10]. *Note: It is not clear how other reasons such as patient preferences were accounted for.*
	Proportion of patients who received first-line therapy and who went on to receive subsequent lines of systemic therapy [12].
	Ratio of patients who did not have a record of a subsequent LOT owing to death, loss to follow-up, or still stayed at the current LOT (i.e., no subsequent treatment during the study period) [38].
	Ratio between the number of patients treated in each line to the number of patients treated in the previous one [19].
	Failure to receive a subsequent line of therapy due to (1) death or (2) despite progression patients alive at the time of last follow-up [30].
	Line of treatment discontinuation was defined as the last day supply before a gap of > 90 days without treatment or the day before initiation of the next LOT [37].
Surgery rates	No further definition reported
Surgery refusal	No further definition reported
Treatment completion	The study captured treatment completion by adopting the data item from the National Cancer Dataset. The item captured whether treatment was delivered as planned or the reason for a change from this. This information was recorded by local clinicians and was calculated for first-line treatment only [45].
	Completed the primary treatment [27].
Unintended interruption of radiotherapy	Three levels of intolerance were used: The first and second levels "early-phase incompletion" and "mid-phase incompletion" were defined as completion of < = 50 and < = 80% of a planned radiotherapy, respectively. The third level, "total interruption," was defined as completion of < = 90% of a planned radiotherapy or temporary discontinuation of ≥ 5 consecutive practical days or ≥ 10 discontinued practical days. In addition, treatment related mortality within 2 months was included in total interruption (meaning a death without evidence of disease progression as judged by an experienced oncologist under the circumstances) [36].

Abbreviations: 1L, first line; HRQOL, health-related quality of life; LOT, line of treatment; RT, radiotherapy

Table 3 Rates of attrition from cancer treatment

Author/year	Cancer type	Treatment	Attrition rates - summary
Basile 2021 [10]	Breast cancer	Chemotherapy, Endocrine therapy, cyclin-dependent-kinases 4/6 inhibitors	· Attrition rate 1–2 L: 9.67%
Paul 2010 [27]	Cervical cancer	Chemotherapy, radiotherapy	· Did not complete planned treatment: 94 (12%)
Abdel 2021 [8]	Colorectal cancer	Chemotherapy	· Received only 1 L: 42.5% · Received 2 L: 30.5% · Received 3 L: 17.1% · Received 4 L: 7.4% · Received 4 L+: 2.6%
Boyne 2023 [12]		Systematic therapy	· Initiated 2 L: 207 (65%) · Initiated 3 L: 125 (39%)
Garattini 2021 [18]		Chemotherapy	· Attrition rate 1–2 L: 27.62%
Germani 2004 [19]		Encorafenib plus cetuximab +/- binimetinib	· Attrition rate 1 L: 53% · Attrition rate 2 L: 62% · Attrition rate 3 L: 78%
Kennecke 2019 [23]		Systemic treatment	· Initiated 2 L: 139 (70%) · Initiated 3 L: 60 (30%) · Initiated 4 L: 29 (15%)
Martinelli 2022 [28]		Systemic treatment	· Received 2 L: 52.5% · Received 3 L: 30.2%
McLean 2016 [31]		Chemotherapy	· Received 2 L: 160 (74.4%) · Received 3 L: 79 (36%) · Received 4 L: 35 (16.3%) · Received 5 L: 12 (5.6%) · Received 6 L: 2 (0.9%)
Tsang 2020b [41]	Esophagogastric cancer	Systemic therapy	· Received only 1 L: 122 (50%) · Received 2 L: 83 (34%) · Received 3 L: 34 (14%) · Received 4 L: 6 (2%)
Kronenfeld 2021 [24]		Neoadjuvant chemotherapy	· Experienced attrition: 28 (24%)
Kakish 2023 [22]		Neoadjuvant treatment and curative intent surgery	· Rate of surgery, neoadjuvant therapy arms: 5876 (84.6%) · Rate of surgery, surgery-first arms: 1774 (90.1%)
Groene 2015 [45]		Palliative chemotherapy	· Completed chemotherapy: 917 (52.7%) · Died before all treatment received: 244 (14%)
Tsang 2020a [40]	Hepatocellular Carcinoma	1 L sorafenib,	· Received 2 L: 12 (8%)
Fisch 2021 [15]	Lung cancer (LCNEC)	Systematic therapies, palliative therapies	· Died without systemic treatment: 23 (12%) · Received 2 L: 46 (41%) · Attrition 2–3 L: 25 (54%)
Addeo 2021 [9]	Lung cancer (NSCLC)	EGFR-TKI treatment (gefitinib, erlotinib, or afatinib, as monotherapy or combination therapy)	· Discontinued 1 L EGFRTKI treatment: 765 (85%) · Did not receive 2 L therapy: 250 (33%)
Janzic 2022 [20]		EGFR TKI therapy	· Discontinued 1 L EGFR TKI therapy: 320 (82%) · No further treatment: 84 (30%) · No further treatment after 2 L: 54 (47%) · No further treatment after 3 L: 28 (67%) · Received 4 L: 14 (27%) · Received 5 L: $n=5$ · Discontinued 5 L: $n=5$
Lampaki 2022 [26]		EGFR-TKI therapy	· Did not receive 2 L: 59 (43%)
Nieva 2022		1 L first-generation or second-generation EGFR-TKIs	· Initiated 2 L: 539 (65%) · Initiated 3 L: 258 (25%)
Turnsek 2022 [42]		1 L first-generation or second-generation EGFR-TKIs	· Initiated 2 L treatment: 66 (74%) · Received 3 L: 19 (40%) · Received 4 L: 5 (28%) · Received 5 L: $n=4$
O'Sullivan 2021 [35]	Lung cancer (SCLC)	Chemotherapy with/without radiotherapy or supportive care	· Initiated 1 L: 903 (46.5%) · Initiated 2 L: 169 (8.7%) · Initiated 3 L: 28 (1.4%)

Table 3 (continued)

Author/year	Cancer type	Treatment	Attrition rates - summary
Minson 2024 [32]	Mantle cell lymphoma	Chemotherapy	· Received 2 L: *n* = 150 · Received 3 L: *n* = 55 · Received 4 L+: *n* = 26
Carruthers 2019 [13]	Mixed	Referral for radiation therapy	· Did not complete RT for non-medical reasons, *n* = 19 · Non-medical break, *n* = 65 · Fully compliant, *n* = 499
Chan 2015 [44]		Definitive oncology treatment (i.e. chemotherapy or radiotherapy)	· Rate of treatment and/or visit default: 159 (34.0%)
Jensen 2019 [47]		NR	· Non-attenders: 11,567 (9.3%)
Rim 2018 [36]		Radiotherapy	· Early-phase incompletion: 15 (4.2%) · Mid-phase incompletion: 33 (9.3%) · Total interruption: 68 (19.3%) · Mid-phase incompletion without early-phase incompletion: *N* = 18
Benda 2023 [11]	Multiple myeloma	Proteasome inhibitors, immunomodulators, antibodies, and chemotherapy.	· Met attrition criteria at 1 L: 63 (21.9%) · Met attrition criteria at 2 L: 31 (19.5%) · Met attrition criteria at 3 L: 20 (23.5%) · Met attrition criteria at 4 L: 10 (27%) · Met attrition criteria at 5 L: 3 (16.7%) · AR across 1 L to 4 L: 22%
Fonseca 2020 [16]		Chemotherapy	Attrition rates across all LOTs · Non-transplanted patients : range, 43–57% · Transplanted patients : range, 21–37%
Jimenez 2022 [21]		Chemotherapy	Non-ASCT patients · Received 2 L: 52.7% · Received 3 L: 22.7% · Received 4 L+: 14.7% ASCT cohort · Received 2 L: 57.6% · Received 3 L: 31.4% · Received 4 L+: 29.6%
McCurdy 2023 [30]		Anti-MM agent	ASCT cohort · IL attrition rate: 7% · 2 L attrition rate: 12% · 3 L attrition rate: 23% Non-ASCT cohort · 1 L attrition rate: 19% · 2 L attrition rate: 26% · 3 L attrition rate: 40%
More 2023 [33]		Chemotherapy	· Received 2 L: 200 (73%) · Received 3 L: 92 (61%) · Attrition rate 2 L: 27% · Attrition rate 3 L: 39% · Attrition rate 4 L: 39% · Attrition rate 5 L+: 50%
Tang 2023 [38]		Chemotherapy	· Attrition rate, 1–2 L: 45.7%, · Attrition rate, 2–3 L: 48.7%, · Attrition rate, 3–4 L: 58.9% · Attrition rate, 4–5 L: 62.5%
Fu 2021 [17]	Oral cancer	Neoadjuvant chemotherapy, surgery	· No surgery: *n* = 23/171
Wang 2023 [43]		Surgery	· Did not attend any follow-up visits: 54 (12.6%) · Attended ≤ 5 follow-up visits: 255 (59.3%) · Adhered to the monthly follow-up: 7 (1.6%)
Dobbs 2018 [14]	Prostate cancer	Referred to urologic oncology clinic	· Missed 1 appointment: 28.1%, *n* = 162 · Missed 2 appointments: 2.1%, *n* = 12 · Missed more than 2 appointments: 0
Swami 2023 [37]		Chemotherapy, ADT	· Received 2 L: 57.4% · Received 3 L: 49.3%

Table 3 (continued)

Author/year	Cancer type	Treatment	Attrition rates - summary
Germani 2004 [19]	Urothelial Carcinoma	Chemotherapy	· Received 2 L: 2714 (37.4%) · Received 3 L: 857 (11.8%)
Morgans 2022 [46]		PD- 1/L1 inhibitor therapy following chemotherapy	Following PD-1/L1 inhibitor as 1 L · Received 2 L: 34.3% ($n=68$) Following PD-1/L1 inhibitor as 2 L · Received 3 L: 29.4% ($n=30$) Following PD-1/L1 inhibitor as 2–3 L · Received second PD-1/L1 inhibitor: 20% (approx.)
Tapia 2024 [39]	Urothelial Carcinoma	Systemic therapy	· Received 2 L: 98 (48%) · Received 3 L: 54 (26%)
Kumar 2020 [25]	Vulvar cancer	Surgery, chemoradiotherapy, radiotherapy	· Defaulted in postoperative period: $n=3$ · Not interested in further treatment other than surgery: $n=3$

Abbreviations: 1L: first line, 2L: second line, 3L: third line, 4L: fourth line, 5L: fifth line, ADTs: androgen deprivation therapy, ASCT: autologous stem cell transplant, CAF: cytoxan, adriamycin and 5-flurouricil, EGFR: Epidermal growth factor receptor, EGFR-TKI : EGFR tyrosine kinase inhibitor, LCNEC: large-cell neuroendocrine carcinoma, MM: multiple myeloma, NSCLC: non-small cell lung cancer, PD- 1/L1 : Programmed death-ligand 1, RT: radiotherapy, SCLC: small cell lung cancer

Psychological factors, such as distress and the burden of treatment, also contributed to patients' decisions to discontinue therapy. Additionally, logistical barriers like travel difficulties and financial constraints were noted as significant contributors to attrition, particularly among socioeconomically disadvantaged populations. There was not a standardised mechanism for collecting data on the reasons for treatment attrition, or the timing for when to gather that information and how.

Inequalities in treatment attrition

The review identified potential inequalities in treatment attrition, with some studies showing people with lower income and those who did not have health insurance (which can act as another marker for low income) were more likely to experience early discontinuation of treatment. While other factors were commented on, there was no comprehensive assessment of the inequalities associated with cancer treatment attrition. Wider disparities such as differences in access to healthcare services or cultural differences in attitudes towards healthcare were not reported on. These findings suggest that whilst systemic factors may play a critical role in treatment adherence, at present data collection on the wider characteristics of patients who drop out of treatment is inconsistent and does not appear to be collected as part of ongoing local or national datasets.

Implications for policy and practice

The findings of this review have important implications for clinical practice and health policy. Clinicians should be aware of the factors contributing to treatment attrition and proactively address them through patient education, close monitoring of treatment-related side effects, and early intervention and signposting for appropriate support for wider social and cultural factors. Health systems and policymakers must focus on reducing barriers to care, particularly for vulnerable populations, to ensure equitable access to treatment and adherence throughout treatment regimes.

At present, treatment attrition is a poorly measured construct. Without more widespread data collection and consistent measurement and analysis of attrition, it is not possible to conclude why people stop treatment and whether there is scope for improvement. More comprehensive data collection would inform whether interventions are needed and where to target them. This requires development of a consistent treatment attrition measurement which, in the UK context, could be embedded into national cancer surveillance data as well as available to service teams and provider organisations. There also needs to be development of a mechanism for collecting data on the reasons for treatment attrition. The timing and format of that data collection needs to be sensitive to the patient's context and realistic to implement, but again would benefit from consistency and comprehensively covering the range of risk factors highlighted above. Gathering data on the scale of treatment attrition, when it happens, to whom, and why, will provide critical insights with regards to where interventions are needed.

Limitations

The review followed a rapid methodology. Searches were restricted to two databases, and studies were screened and extracted by single reviewer therefore it is possible that relevant evidence was missed. The rapid review methodology may also limit the depth of analysis and exclude relevant studies published outside the search period or in languages other than English. The terminology used to describe treatment attrition may vary and despite a comprehensive search strategy which included a range of index terms and text words it is possible that the search may have missed relevant publications that used different descriptors. The variability in

the definitions and measures of treatment attrition used across the included studies, may also affect the comparability of findings and lead to inconsistencies in reported attrition rates. The review does not account for all possible confounding factors, such as differences in healthcare systems, availability of treatments, and cultural attitudes towards healthcare, which may influence attrition rates. Decisions to discontinue treatment may be in line with patients' values and preferences rather than an indication of systemic issues in care delivery. However, without data on reasons for treatment attrition, it is not possible to conclude whether interventions are required or not.

Conclusions

This rapid review identified significant variability in how treatment attrition is measured and defined, as well as notable inequalities in who discontinues treatment. To improve cancer care outcomes and equity, it is essential to develop standardized measures of attrition, understand the underlying reasons for discontinuation, and implement targeted interventions to support at-risk populations. Measurement of cancer attrition and the reasons for it has been more widely incorporated into clinical trials, but as yet is not part of standard data collection within service delivery. Future research and policy efforts should focus on developing standardized attrition metrics, and measurement of reasons for cancer attrition (including the breadth of social, cultural and personal considerations as well as clinical) and exploring interventions that specifically target the identified disparities to support cancer patients to stay in treatment. Understanding and addressing the root causes of treatment discontinuation may support more equitable and effective cancer care.

Abbreviations

1L	First line, the first cancer treatment the patient receives
2L	Second line, the second cancer treatment the patient receives
3L	Third line, the third cancer treatment the patient receives
4L	Fourth line, the fourth cancer treatment the patient receives
5L	Fifth line, the fifth cancer treatment the patient receives
ADTs	Androgen deprivation therapy
ASCT	Autologous stem cell transplant
CAF	Cytoxan, adriamycin and 5-flurouricil
EGFR	Epidermal growth factor receptor
EGFR-TKI	EGFR tyrosine kinase inhibitor
HRQOL	Health-related quality of life
LCNEC	Large-cell neuroendocrine carcinoma
LOT	Line of treatment
MM	Multiple myeloma
NSCLC	Non-small cell lung cancer
PD- 1/L1	Programmed death-ligand 1
RT	Radiotherapy
SCLC	Small cell lung cancer

Supplementary Information

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Supplementary material 1

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Author contributions

JS designed the review, supported analysis and interpretation of data, and drafted the manuscript. ES executed the review, designed search terms, led data extraction and analysis, and write up of methods and results sections. KC and LG contributed to review design. All authors read and approved the final manuscript.

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Data availability

No datasets were generated or analysed during the current study.

Declarations

Ethics approval and consent to participate

Not applicable.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

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References

1. Health-Europe TLR. Reduce cancer inequity and inequality to reduce cancer mortality. Lancet Reg Health-Europe. 2023;25.
2. Singh GK, Jemal A. Socioeconomic and Racial/Ethnic disparities in Cancer Mortality, incidence, and Survival in the United States, 1950–2014: over six decades of changing patterns and widening inequalities. J Environ Public Health. 2017;2017(1):2819372.
3. Hui D, Glitza I, Chisholm G, Yennu S, Bruera E. Attrition rates, reasons, and predictive factors in supportive care and palliative oncology clinical trials. Cancer. 2013;119(5):1098–105.
4. Garritty C, Hamel C, Trivella M, Gartlehner G, Nussbaumer-Streit B, Devane D, et al. Updated recommendations for the Cochrane rapid review methods guidance for rapid reviews of effectiveness. BMJ. 2024;384:e076335.
5. Ouzzani M, Hammady H, Fedorowicz Z, Elmagarmid A. Rayyan-a web and mobile app for systematic reviews. Syst Rev. 2016;5(1):210.
6. Page MJ, McKenzie JE, Bossuyt PM, Boutron I, Hoffmann TC, Mulrow CD, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. BMJ. 2021;372:n71.
7. Wells GA, Shea B, O'Connell D, Peterson J, Welch V, Losos M et al. The Newcastle-Ottawa Scale (NOS) for assessing the quality of nonrandomized studies in meta-analyses. https://www.ohrica/programs/clinical_epidemiology/oxfordasp (accessed 02/07/2024).
8. Abdel-Rahman O, Koski S, Mulder K. Real-world patterns of chemotherapy administration and attrition among patients with metastatic colorectal cancer. Int J Colorectal Dis. 2021;36(3):493–9.
9. Addeo A, Hochmair M, Janzic U, Dudnik E, Charpidou A, Pluzanski A, et al. Treatment patterns, testing practices, and outcomes in the pre-FLAURA era for patients with EGFR mutation-positive advanced NSCLC: a retrospective chart review (REFLECT). Ther Adv Med Oncol. 2021;13:17588359211059874.

10. Basile D, Gerratana L, Corvaja C, Pelizzari G, Franceschin G, Bertoli E, et al. First- and second-line treatment strategies for hormone-receptor (HR)-positive HER2-negative metastatic breast cancer: a real-world study. Breast. 2021;57:104–12.
11. Benda MA, Ulmer H, Weger R, Reimann P, Lang T, Pichler P, et al. Attrition rates in multiple myeloma treatment under Real World Conditions-An analysis from the Austrian Myeloma Registry (AMR). Cancers (Basel). 2023;15(3):962.
12. Boyne DJ, Ngan E, Carbonell C, Wani RJ, Cirone Morris C, Martinez DJ, et al. Real-world study to Assess Patterns of Treatment Practices and clinical outcomes in metastatic colorectal Cancer patients with RAS Wild-Type Left-Sided tumours in Canada. Curr Oncol. 2023;30(9):8220–32.
13. Carruthers S, Pennefather M, Ward L, Giam K, Penniment M. Measuring (and narrowing) the gap: the experience with attendance of indigenous cancer patients for Radiation Therapy in the Northern Territory. J Med Imaging Radiat Oncol. 2019;63(4):510–6.
14. Dobbs RW, Malhotra NR, Caldwell BM, Rojas R, Moreira DM, Abern MR. Determinants of Clinic Absenteeism: a Novel Method of Examining Distance from Clinic and Transportation. J Community Health. 2018;43(1):19–26.
15. Fisch D, Bozorgmehr F, Kazdal D, Kuon J, Klotz LV, Shah R, et al. Comprehensive dissection of treatment patterns and outcome for patients with metastatic large-cell neuroendocrine lung carcinoma. Front Oncol. 2021;11:673901.
16. Fonseca R, Usmani SZ, Mehra M, Slavcev M, He J, Cote S, et al. Frontline treatment patterns and attrition rates by subsequent lines of therapy in patients with newly diagnosed multiple myeloma. BMC Cancer. 2020;20(1):1087.
17. Fu JY, Zhang CP, Zhang ZY. Tracking the dropout patients of neoadjuvant chemotherapy with locally advanced oral cavity cancer. BMC Cancer. 2021;21(1):663.
18. Garattini SK, Basile D, Bonotto M, Ongaro E, Porcu L, Corvaja C, et al. Drug holidays and overall survival of patients with metastatic colorectal Cancer. Cancers (Basel). 2021;13(14):3504.
19. Germani MM, Vetere G, Santamaria F, Intini R, Ghelardi F, Bensi M, et al. Treatment of patients with BRAF(V600E)-mutated metastatic colorectal cancer after progression to encorafenib and cetuximab: data from a real-world nationwide dataset. ESMO Open. 2024;9(4):102996.
20. Janzic U, Turnsek N, Dediu M, Donev IS, Lupu R, Teodorescu G, et al. Real-World Testing practices, treatment patterns and clinical outcomes in patients from Central Eastern Europe with EGFR-Mutated Advanced Non-small Cell Lung Cancer: a Retrospective Chart Review study (REFLECT). Curr Oncol. 2022;29(8):5833–45.
21. Jimenez-Zepeda VH, Chen G, Shaw E, Farris MS, Cowling T, Tay J. Real-world treatment patterns for patients with newly diagnosed multiple myeloma in Alberta, Canada. Leuk Lymphoma. 2022;63(11):2557–64.
22. Kakish HH, Ahmed FA, Pei E, Dong W, Elshami M, Ocuin LM, et al. Understanding factors leading to Surgical Attrition for Resectable Gastric Cancer. Ann Surg Oncol. 2023;30(7):4207–16.
23. Kennecke H, Berry S, Maroun J, Kavan P, Aucoin N, Couture F, et al. A retrospective observational study to estimate the attrition of patients across lines of systemic treatment for metastatic colorectal cancer in Canada. Curr Oncol. 2019;26(6):e748–54.
24. Kronenfeld JP, Collier AL, Turgeon MK, Ju M, Alterio R, Wang A, et al. Attrition during neoadjuvant chemotherapy for gastric adenocarcinoma is associated with decreased survival: a United States Safety-Net collaborative analysis. J Surg Oncol. 2021;124(8):1317–28.
25. Kumar N, Ray MD, Sharma DN, Pandey R, Lata K, Mishra A, et al. Vulvar cancer: surgical management and survival trends in a low resource setting. J Egypt Natl Canc Inst. 2020;32(1):4.
26. Lampaki S, Mountzios G, Georgoulias V, Rapti A, Xanthakis I, Baka S, et al. Real-world management patterns in EGFR-mutant advanced non-small-cell lung cancer before first-line adoption of osimertinib: the REFLECT study in Greece. Future Oncol. 2022;18(28):3151–64.
27. G MPPS. Patient and disease related factors associated with lost-to follow-up/drop-outs of cervical cancer patients: a study at a major cancer hospital in South India. Asian Pac J Cancer Prev. 2010;11(6):1529–34.
28. Martinelli E, Cremolini C, Mazard T, Vidal J, Virchow I, Tougeron D, et al. Real-world first-line treatment of patients with BRAF(V600E)-mutant metastatic colorectal cancer: the CAPSTAN CRC study. ESMO Open. 2022;7(6):100603.
29. Mathew Thomas V, Jo Y, Tripathi N, Roy S, Chigarira B, Narang A, et al. Treatment Patterns and Attrition with Lines of Therapy for Advanced Urothelial Carcinoma in the US. JAMA Netw Open. 2024;7(5):e249417.
30. McCurdy A, Mian H, LeBlanc R, Jimenez-Zepeda VH, Su J, Masih-Khan E, et al. Redefining attrition in multiple myeloma (MM): a Canadian Myeloma Research Group (CMRG) analysis. Blood Cancer J. 2023;13(1):111.
31. McLean J, Rho YS, Kuruba G, Mamo A, Gilabert M, Kavan T, et al. Clinical practice patterns in Chemotherapeutic Treatment regimens for metastatic colorectal Cancer. Clin Colorectal Cancer. 2016;15(2):135–40.
32. Minson A, Hamad N, Di Ciaccio P, Talaulikar D, Ku M, Ratnasingam S, et al. Death from mantle cell lymphoma limits sequential therapy, particularly after first relapse: patterns of care and outcomes in a series from Australia and the United Kingdom. Br J Haematol. 2024;204(2):548–54.
33. More S, Corvatta L, Manieri MV, Olivieri A, Offidani M. Real-world assessment of treatment patterns and outcomes in patients with relapsed-refractory multiple myeloma in an Italian haematological tertiary care centre. Br J Haematol. 2023;201(3):432–42.
34. Nieva J, Reckamp KL, Potter D, Taylor A, Sun P. Retrospective analysis of real-World Management of EGFR-Mutated Advanced NSCLC, after first-line EGFR-TKI treatment: US treatment patterns, attrition, and Survival Data. Drugs Real World Outcomes. 2022;9(3):333–45.
35. O'Sullivan DE, Cheung WY, Syed IA, Moldaver D, Shanahan MK, Bebb DG, et al. Real-world treatment patterns, clinical outcomes, and Health Care Resource utilization in extensive-stage small cell Lung Cancer in Canada. Curr Oncol. 2021;28(4):3091–103.
36. Rim CH, Yoon WS, Lee JA, Yang DS, Lee NK, Park YJ, et al. Factors predicting intolerance to definitive conventional radiotherapy in geriatric patients. Strahlenther Onkol. 2018;194(10):894–903.
37. Swami U, Aggarwal H, Zhou M, Jiang S, Kim J, Li W, et al. Treatment patterns, clinical outcomes, Health Care Resource utilization and costs in older patients with metastatic castration-resistant prostate Cancer in the United States: an analysis of SEER-Medicare Data. Clin Genitourin Cancer. 2023;21(5):517–29.
38. Tang W, Yang J, Li Y, Zhang L, Li H, Wang J, et al. Treatment attrition rates and relevant risk factors in multiple myeloma: a real-world study in China. Front Pharmacol. 2023;14:979111.
39. Tapia JC, Bosma F, Gavira J, Sanchez S, Molina MA, Sanz-Beltran J, et al. Treatment patterns and survival outcomes before and after Access to Immune Checkpoint inhibitors for patients with metastatic urothelial carcinoma: a single-Center Retrospective Study from 2004 to 2021. Clin Genitourin Cancer. 2024;22(3):102047.
40. Tsang ES, Davies JM, Loree JM, Lim HJ, Renouf DJ, Gill S. Eligibility for second-line therapy in patients with Advanced Hepatocellular Carcinoma: a Population-based study. Am J Clin Oncol. 2020a;43(11):788–91.
41. Tsang ES, Lim HJ, Renouf DJ, Davies JM, Loree JM, Gill S. Real-world treatment attrition rates in advanced esophagogastric cancer. World J Gastroenterol. 2020b;26(39):6027–36.
42. Turnsek N, Devjak R, Edelbaher N, Osrajnik I, Unk M, Vidovic D, et al. Real-world outcomes, treatment patterns and T790M testing rates in non-small cell lung cancer patients treated with first-line first- or second-generation epidermal growth factor receptor tyrosine kinase inhibitors from the Slovenian cohort of the REFLECT study. Radiol Oncol. 2022;56(3):371–9.
43. Wang SJ, Lin B, Shen SY, Lin JL, Zhang TW, Yang HY. Factors associated with follow-up attendance of patients with oral squamous cell carcinoma: a retrospective cohort study. Head Neck. 2023;45(4):963–71.
44. Chan CM, Wan Ahmad WA, Md Yusof M, Ho GF, Krupat E. Prevalence and characteristics associated with default of treatment and follow-up in patients with cancer. Eur J Cancer Care (Engl). 2015;24(6):938–44.
45. Groene O, Crosby T, Hardwick RH, Riley S, Greenaway K, Cromwell D. A population-based observational study on the factors associated with the completion of palliative chemotherapy among patients with oesophagogastric cancer. BMJ Open. 2015;5(3):e006724.
46. Morgans AK, Grewal S, Hepp Z, Fuldeore R, Odak S, Macahilig C, et al. Clinical and patient-reported outcomes of Advanced Urothelial Carcinoma following discontinuation of PD-1/L1 inhibitor therapy. Clin Genitourin Cancer. 2022;20(6):543–52.
47. Jensen H, Moller H, Vedsted P. Characteristics of customary non-attenders in general practice who are diagnosed with cancer: a cross-sectional study in Denmark. Eur J Cancer Care (Engl). 2019;28(6):e13143.

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