doi.org/10.36721/PJPS/2026.40.16111.1

Prophylactic use of granulocyte colony-stimulating factor in breast cancer chemotherapy in china: A retrospective observational study

Lilian Hu[1,2] Heqin Yin[1,2] and Xiaohua Wang[1,3]*

[1]Affiliated Hospital of Zunyi Medical University, Zunyi, Guizhou 563000, China
[2]Nursing School of Zunyi Medical University, Zunyi, Guizhou 563000, China
[3]Medical Information Engineering School of Zunyi Medical University, Zunyi, Guizhou 563000, China

Abstract: **Background**: Febrile neutropenia (FN) is a serious complication of myelosuppressive chemotherapy. Clinical practice guidelines recommend risk-stratified prophylactic G-CSF therapy, which is indicated primarily for patients with a high risk of febrile neutropenia (FN >20%).Although G-CSF is widely used in clinical practice in China, it remains unclear whether this use aligns with guideline-recommended risk stratification, as few real-world studies have evaluated adherence. **Objectives**: This study aimed to evaluate the appropriateness of prophylactic G-CSF use in hospitalized breast cancer patients and identify the gap between clinical practice and current guidelines. **Methods**: In this single-center, retrospective observational study, we evaluated the prophylactic use of G-CSF according to FN risk category among breast cancer patients scheduled to receive myelosuppressive chemotherapy in hospitalized patients in China between January 2019 and December 2021. **Results**: A total of 4,181 chemotherapy cycles from 630 breast cancer patients were documented. The overall rate of prophylactic G-CSF use was 53.1%. Among these, 1,963 cycles (46.9%) involved inappropriate prophylactic use, including 1,836 cycles (43.9%) with underuse, 101 cycles (2.4%) with overuse and 26 cycles (0.6%) with non-standard use. **Conclusion**: This study reveals substantial inappropriate use of prophylactic G-CSF in Chinese breast cancer patients, primarily characterized by underuse in guideline-indicated scenarios.

Keywords: Breast neoplasms; Drug therapy; Granulocyte colony-stimulating factor; Febrile neutropenia

Submitted 20-01-2026 – Revised 12-03-2026 – Accepted 01-04-2026

Article in Press

INTRODUCTION

According to data from the Global Cancer Observatory released by the International Agency for Research on Cancer (IARC), breast cancer has surpassed lung cancer as the most commonly diagnosed cancer worldwide (Bray *et al*., 2024). Chemotherapy remains a cornerstone of systemic treatment for breast cancer and significantly improves patient survival (Langeh et al., 2023). Febrile neutropenia (FN), a consequence of severe chemotherapy-induced neutropenia, is a major dose-limiting toxicity. FN often leads to chemotherapy dose reduction or delay and can cause life-threatening infections, rendering it a critical oncologic emergency.(Foley and Hoffman, 2023). Granulocyte colony-stimulating factor (G-CSF) is primarily used to manage chemotherapy-induced neutropenia and represents an important supportive care intervention for patients with cancer (Adamo *et al*., 2022; Chinese Society of Integrative Oncology Pharmacy and Chinese Society of Medical Oncology, 2026). Clinical practice guidelines recommend that prophylactic G-CSF should not be routinely administered to all patients receiving chemotherapy, but rather be selectively used in those at substantial risk of FN, for example, patients receiving high-risk chemotherapy regimens or those with additional risk factors (Becker *et al*., 2020). Studies have demonstrated that prophylactic G-CSF significantly reduces the incidence, shortens the duration and decreases the severity of chemotherapy-related neutropenia, thereby enabling patients to complete scheduled chemotherapy on time and at full dose and cycle intensity (Mezzanotte et al., 2025).G-CSF is widely used in clinical practice in China for prophylaxis of chemotherapy-induced neutropenia. However, real-world evidence on adherence to risk-stratified guideline recommendations remains limited. We therefore systematically analyzed patterns of prophylactic G-CSF use among patients with breast cancer receiving chemotherapy at our institution, aiming to evaluate its adherence to guideline-recommended risk stratification and to provide evidence supporting rational G-CSF use.

MATERIALS AND METHODS

Study design and data source

This was a retrospective observational study. Data were extracted from the electronic medical record system of our hospital on medication orders for hospitalized patients with breast cancer who received chemotherapy between January 2019 and December 2021. The following information was collected: (1) patient demographics (sex, age, tumor stage and chemotherapy modality); (2) chemotherapy-related characteristics (chemotherapy regimen, number of cycles, routine blood test results during chemotherapy, patient-related risk factors, past medical history and treatment history); and (3) clinical use of G-CSF (dosage and timing of administration). This study was approved by the

**Corresponding author*: e-mail: hongxingss99@163.com

Hospital Ethics Committee and complied with relevant medical ethics regulations (Ethics Approval No.: KLLY-2024-042).

Study population

Patients with breast cancer treated at our hospital between January 2019 and December 2021 were retrospectively enrolled. The inclusion criteria were as follows: (1) pathologically confirmed breast cancer; (2) age ≥ 18 years; (3) eligible for chemotherapy and scheduled to receive multi-cycle chemotherapy; and (4) availability of complete medical records. The exclusion criteria were as follows: (1) contraindications to chemotherapy based on abnormalities in routine blood tests, liver or kidney function tests, or electrocardiogram findings; (2) concurrent coagulation disorders; (3) history of alcohol or psychoactive substance dependence; (4) history of hematopoietic stem cell transplantation; (5) pregnancy or lactation; and (6) receipt of chemotherapy regimens not classified for FN risk according to NCCN guidelines.

Febrile neutropenia risk stratification

According to the National Comprehensive Cancer Network (NCCN) guidelines, patients receiving chemotherapy are stratified into three risk categories based on the risk of febrile neutropenia (FN): high-risk (FN incidence >20%), intermediate-risk (FN incidence 10%–20%) and low-risk (FN incidence <10%). Assessment of FN risk requires consideration of multiple factors, including tumor type, chemotherapy regimen, patient performance status and treatment intent. FN risk should be evaluated individually prior to each chemotherapy cycle based on the patient's specific circumstances.

Both the NCCN guidelines (Griffiths *et al*., 2022) and Chinese expert consensus (Chinese Society of Integrative Oncology Pharmacy and Chinese Society of Medical Oncology, 2026) recommend that prophylactic G-CSF not be routinely administered to all patients receiving chemotherapy, but rather be selectively used in those at substantial risk of FN. Specifically:

1. For patients receiving high-risk chemotherapy regimens, routine prophylactic G-CSF is recommended regardless of treatment intent (cure, prolongation of survival, or palliation of disease-related symptoms).
2. For patients receiving intermediate-risk chemotherapy regimens, prophylactic G-CSF may be considered in the presence of the following patient-related risk factors: history of neutropenia during prior chemotherapy, persistent neutropenia, bone marrow involvement by tumor, recent surgery or open wounds, hepatic or renal dysfunction, age ≥65 years receiving standard-dose chemotherapy, or human immunodeficiency virus (HIV) infection.
3. For patients receiving low-risk chemotherapy regimens, routine prophylactic G-CSF is not recommended.

Evaluation of clinical G-CSF utilization

The appropriateness of prophylactic G-CSF use was evaluated against the recommendations of the NCCN guidelines (Griffiths *et al*., 2022) and Chinese expert consensus (Chinese Society of Integrative Oncology Pharmacy and Chinese Society of Medical Oncology, 2026). Clinical practice that was consistent with guideline recommendations was defined as "appropriate use." Clinical practice that deviated from guideline recommendations was defined as "inappropriate use," which was further classified into the following categories:

Overuse: Prophylactic G-CSF was administered to patients with low FN risk (<10%) or to those receiving intermediate-risk chemotherapy (FN 10%–20%) without any additional patient-related risk factors, for which NCCN guidelines do not recommend routine primary prophylaxis. *Underuse*: Prophylactic G-CSF was not administered in situations where it was recommended by the guidelines. *Non-standard use*: Prophylactic G-CSF was administered within 24 hours before or after chemotherapy, or the dosage administered deviated from guideline recommendations.

Statistical analysis

Statistical analyses were performed using SPSS software (version 29.0). Descriptive statistics were used to summarize patient and treatment characteristics. Categorical data were presented as frequencies and percentages. Continuous data were expressed as mean ± standard deviation, median with interquartile range and minimum and maximum values. Comparisons between the high-risk and intermediate-risk groups were performed using the chi-square test for categorical variables. All tests were two-sided and a P value < 0.05 was considered statistically significant. The frequencies and patterns of missing data were examined; no imputation was performed in the outcome analyses.

RESULTS

Participants

A total of 630 patients met the eligibility criteria and were included in the study, including 625 female patients (99.2%) and 5 male patients (0.8%).The median age at enrollment was 49.0 years (range, 20–83 years) and 10% of patients were aged ≥65 years. Detailed baseline characteristics of the study population are summarized in table 1.

FN risk

Table 2 summarizes the chemotherapeutic regimens received by the study population. The most frequently used regimen was anthracycline plus cyclophosphamide, administered to 194 patients (30.8%), followed by docetaxel plus anthracycline plus cyclophosphamide, administered to 166 patients (26.4%). A total of 18 patients (all female) received other regimens, including eribulin, utidelone, trastuzumab and vinorelbine.

Article in Press

Table 1: Baseline patient and disease characteristics (N=630)

Characteristic	*N*=630
Sex, *n* (%)	
Male	5 (0.8)
Female	625 (99.2)
Age, years	
Mean	50.3
SD	9.9
Median	49.0
Q1, Q3	44.0, 56.0
Minimum, Maximum	20, 83
Age group, *n* (%)	
<65 years	567 (90.0)
≥65 years	63 (10.0)
TNM stage at diagnosis, *n* (%)	
Stage I	76 (12.1)
Stage II	346 (54.9)
Stage III	102 (16.2)
Stage IV	31 (4.9)
Unknown	75 (11.9)
Type of chemotherapy, *n* (%)	
Neoadjuvant chemotherapy	322 (51.1)
Adjuvant chemotherapy	308 (48.9)

All percentages are based on total number of patients (N=630). Abbreviations: Q, quartile; SD, standard deviation; TNM, tumor-node-metastasis.

As these regimens are not classified according to FN risk in the guidelines, the prophylactic use of G-CSF in these 18 patients (corresponding to 109 chemotherapy cycles) was not evaluated in this study. A total of 630 patients met the eligibility criteria and were included in the study. These patients received 4,181 chemotherapy cycles.

Use of G-CSF prophylaxis

Table 3 summarizes the patterns of G-CSF prophylaxis across 4,181 chemotherapy cycles administered to 630 patients. Inappropriate prophylactic use of G-CSF was observed in 1,963 cycles (46.9%), comprising 1,836 cycles (43.9%) with underuse, 101 cycles (2.4%) with overuse and 26 cycles (0.6%) with non-standard use. Among the 294 patients in the high-risk group, who underwent a total of 1,943 chemotherapy cycles, inappropriate G-CSF prophylaxis occurred in 786 cycles (40.4%). A total of 336 patients (2,238 cycles) received chemotherapy regimens associated with an intermediate risk of febrile neutropenia; among these, inappropriate G-CSF use was observed in 1,177 cycles (52.6%). The rate of inappropriate use was significantly higher in the intermediate-risk group than in the high-risk group (52.6% vs. 40.4%; $\chi^2 = 47.83$, $P < 0.001$). This difference was driven primarily by higher rates of underuse (48.6% vs. 38.6%; $P < 0.001$) and overuse (3.4% vs. 1.3%; $P < 0.001$) in the intermediate-risk group, while rates of non-standard use were similar between groups (0.6% vs. 0.6%; $P = 0.88$). The distribution of risk factors among patients receiving intermediate-risk chemotherapy regimens is presented in table 4.

G-CSF-related adverse events

Mild to moderate adverse events were bone pain (189/630, 30.0%), fatigue (96/630, 15.2%), and injection site erythema and pruritus (76/630, 12.1%). No serious adverse events were identified as G-CSF-related.

DISCUSSION

In this single-center retrospective study of 630 breast cancer patients receiving chemotherapy, we found that inappropriate prophylactic use of G-CSF occurred in nearly half (46.9%) of all chemotherapy cycles, with underuse being the predominant form (43.9%). These findings, derived from a single-center analysis, demonstrate a discrepancy between real-world clinical practice and current guideline recommendations at our institution. While these results may have implications for other similar healthcare settings, the single-center design limits generalizability and further multicenter studies are needed to confirm whether similar patterns exist elsewhere.

Article in Press

Table 2: Chemotherapy regimens and FN risk stratification (N=630).

Cancer treatments	*N*=630
High-risk (FN incidence >20%), *n (%)*	
TEC/TAC	166 (26.4)
TC	4 (0.6)
TCH/TPH	124 (19.7)
Intermediate-risk (FN incidence 10%–20%), *n (%)*	
EC-T/AC-T	91 (14.4)
EC/AC	194 (30.8)
T	12 (1.9)
EC-TH/AC-TH	16 (2.5)
TH	23 (3.7)
Number of chemotherapy cycles, *n* (%)	
12	1 (0.2)
11	2 (0.3)
10	8 (1.2)
9	18 (2.9)
8	248 (39.4)
7	69 (10.9)
6	155 (24.6)
5	34 (5.4)
4	63 (10.0)
3	22 (3.5)
2	10 (1.6)

All percentages are based on total number of patients (N=630). Abbreviations: TEC, docetaxel plus epirubicin plus cyclophosphamide; TC, docetaxel plus cyclophosphamide; TCH, docetaxel plus carboplatin plus trastuzumab; EC-T, epirubicin plus cyclophosphamide followed by paclitaxel; EC, epirubicin plus cyclophosphamide; T, docetaxel; TH, paclitaxel plus trastuzumab; EC-TH, epirubicin plus cyclophosphamide followed by paclitaxel plus trastuzumab.

Table 3: Patterns of prophylactic G-CSF use across 4,181 chemotherapy cycles

Category	Total cycles (N=4,181)	High-risk group (n=1,943)	Intermediate-risk group (n=2,238)	*P* value*
Appropriate use, *n* (%)	2,218 (53.1)	1,157 (59.6)	1,061 (47.4)	<0.001
Inappropriate use, *n* (%)	1,963 (46.9)	786 (40.4)	1,177 (52.6)	<0.001
Underuse	1,836 (43.9)	749 (38.6)	1,087 (48.6)	<0.001
Overuse	101 (2.4)	25 (1.3)	76 (3.4)	<0.001
Non-standard use	26 (0.6)	12 (0.6)	14 (0.6)	0.88
Administration within 24 hours before chemotherapy	4 (0.1)	1 (0.05)	3 (0.1)	-
Administration within 24 hours after chemotherapy	19 (0.5)	10 (0.5)	9 (0.4)	-
Non-standard dosage, *n* (%)	3 (0.1)	1 (0.05)	2 (0.1)	-

**P* values were calculated using the chi-square test comparing the high-risk and intermediate-risk groups. Percentages for the Total Cycles column are based on N=4,181, percentages for the High-Risk and Intermediate-Risk groups are based on the respective group totals (n=1,943 and n=2,238). Abbreviations: G-CSF, granulocyte colony-stimulating factor; FN, febrile neutropenia.

This rate of underuse was particularly pronounced in the intermediate-risk group, suggesting that a substantial proportion of patients at risk for FN are not receiving guideline-recommended prophylaxis. These findings highlight a significant gap between real-world clinical practice and evidence-based guidelines in our institution and underscore the urgent need for interventions to improve adherence. The results demonstrate that the rate of inappropriate prophylactic G-CSF use observed in the current analysis (46.9%) is higher than the 10% – 40% range reported in previous retrospective studies (Campbell *et al*., 2022; Shokane *et al*., 2023).

Article in Press

Table 4: Risk factors among patients receiving intermediate-risk chemotherapy regimens (N=2,238 Cycles)

Risk factor category	Intermediate-risk cycles (n=2,238)
Absence of risk factors, n (%)	96 (4.3)
Presence of at least one risk factor, *n* (%)	2,142 (95.7)
Presence of a single risk factor, *n* (%)	713 (31.9)
Presence of two or more risk factors, n (%)	1,429 (63.9)
Specific risk factors*	
Chronic disease	92 (4.1)
Recent surgery	327 (14.6)
Hepatic or renal dysfunction	114 (5.1)
Grade 3/4 myelosuppression	112 (5.0)
Prior chemotherapy or radiotherapy	68 (3.1)

Note: *Cycles may have more than one risk factor; therefore, the sum of specific risk factors exceeds the number of cycles with at least one risk factor. All percentages are based on the total number of intermediate-risk cycles (N=2,238). Abbreviations: G-CSF, granulocyte colony-stimulating factor; FN, febrile neutropenia.

This discrepancy may be attributed to differences in study populations, chemotherapy regimens, criteria for evaluating guideline adherence and definitions of "inappropriate use" across studies. For instance, a large retrospective study reported that the rate of G-CSF primary prophylaxis varied by cancer type (Gawade *et al*., 2020), with 66.3% in breast cancer, 57.6% in colorectal cancer, 38.1% in lung cancer and 44.3% in ovarian cancer among patients receiving myelosuppressive chemotherapy. The 53.1% rate of appropriate use in our cohort is lower than the 66.3% reported for breast cancer in that study, suggesting that G-CSF guideline adherence at our institution may be suboptimal compared to some international settings.

Consistent with our finding that underuse was the predominant form of inappropriate use (43.9% of total cycles), Ku *et al*. (2022) reported underuse of prophylactic G-CSF in breast cancer patients receiving adjuvant docetaxel/cyclophosphamide (TC) chemotherapy, a regimen classified as intermediate-risk for FN. Similarly, a population-based study (Jiménez Nieves *et al*., 2022) in Puerto Rico evaluated adherence to G-CSF guidelines among breast cancer patients at high risk for FN and identified multiple predictors of non-adherence, underscoring the complexity of factors influencing real-world prescribing practices. These findings, together with our results, highlight that deviations from guideline recommendations—particularly underuse—are a persistent challenge across diverse healthcare settings. This finding aligns with the Delphi consensus statement (Adamo *et al*., 2022), which emphasized the need for clearer guidance on G-CSF use in intermediate-risk scenarios.

Taken together, these comparisons indicate that while inappropriate G-CSF use is a global issue, the patterns and determinants of non-adherence may vary by region, healthcare system and clinical setting. Our study adds to the growing body of evidence documenting the gap between guideline recommendations and real-world practice (Campbell *et al*., 2022; Shokane *et al*., 2023; Gawade *et al*., 2020; Ku *et al*., 2022; Jiménez Nieves *et al*., 2022) and underscores the urgent need for targeted interventions to improve G-CSF prescribing patterns in China.

Several factors may contribute to the high rate of underuse observed in this study. First, physician-related factors may play a role. Some clinicians may lack adequate familiarity with current guidelines or rely on habitual treatment patterns rather than evidence-based recommendations (Aras et al., 2020). Additionally, when G-CSF prophylaxis is indicated, some physicians may consider patients' economic circumstances and prefer adjunctive measures of unproven efficacy (such as dietary modification or traditional Chinese medicine) over G-CSF, potentially leading to underuse.Second, patient-related economic factors, such as the cost of G-CSF, may contribute to nonadherence to guideline-recommended prophylaxis, particularly when patients face high out-of-pocket expenses or limited insurance coverage.However, we did not collect data on patients' insurance status or economic background and this potential explanation requires confirmation in future studies specifically designed to assess these factors. Concerns about cumulative economic burden may lead some patients to choose therapeutic G□CSF (administered after neutropenia or FN develops) rather than prophylactic use, despite evidence that, in high□risk patients, prophylactic G□CSF reduces infection risk and prevents treatment delays. Furthermore, fear of potential side effects such as bone pain or fatigue may lead some patients to refuse prophylaxis, particularly when physicians fail to provide adequate patient education on the benefits and risks of G-CSF.

Despite the high rate of inappropriate use, our study found that when G-CSF was administered, dosing was generally appropriate. The consistent use of 200 μg as a single dose, while not precisely weight-based, fell within the recommended range of 1.25–5 μg/kg and reflected practical considerations related to available dosage

Article in Press

specifications at our institution. Only two cases of excessive dosing and 23 cycles (0.55%) of administration within 24 hours of chemotherapy were documented, indicating good adherence to guideline recommendations regarding timing and dosage among clinicians who chose to prescribe G-CSF.

Regarding safety, we observed elevated white blood cell counts in 335 cycles (8.0%) and elevated platelet counts in 543 cycles (13.0%) following G-CSF administration. However, no severe adverse events were documented, consistent with the generally favorable safety profile of G-CSF reported in the literature (Qu *et al*., 2025; Li *et al*., 2024; Ichihara *et al*., 2024). While long-term risks such as acute myeloid leukemia or myelodysplastic syndrome have been reported with prolonged G-CSF use (Danese *et al*., 2022), our study was not designed to assess these outcomes.

CONCLUSION

This single-center retrospective study reveals a substantial rate of inappropriate prophylactic G-CSF use among hospitalized patients with breast cancer receiving chemotherapy in China. These findings highlight a significant gap between real-world clinical practice and evidence-based guidelines, underscoring the urgent need for targeted interventions—including physician education, clinical decision support systems and patient engagement strategies—to improve guideline adherence and optimize supportive care in this population.

Limitations and future directions

This study has several limitations. First, as a single-center retrospective study based on electronic medical records, it is subject to the inherent limitations of such designs, including potential incompleteness or inaccuracy of clinical documentation. Consequently, our evaluation of prophylactic G-CSF use may have been subject to information bias. Second, this study did not collect data on patients' insurance status or economic background. While we hypothesize that cost and reimbursement may contribute to underuse based on clinical experience and the literature, this remains speculative and should be confirmed in future research with appropriate data collection. Third, this study focused on evaluating the appropriateness of G-CSF prescribing patterns but did not assess important patient outcomes such as febrile neutropenia incidence, hospital-acquired infections, chemotherapy dose reductions or delays, adverse drug reactions, drug-drug interactions, or mortality. Fourth, the study population predominantly consisted of female patients (99.2%), reflecting the low incidence of male breast cancer. While this composition aligns with the epidemiological reality of breast cancer, the findings may not fully capture potential differences in G-CSF prescribing patterns or outcomes between male and female patients and caution is warranted when extrapolating the results to the male breast cancer population. Finally, as this study is a single-center retrospective analysis intended to characterize real-world prescribing patterns and generate hypotheses, the findings should be considered exploratory. Prospective validation in larger, multicenter cohorts is necessary before these results can be directly translated into clinical practice or used to inform treatment decisions. These limitations notwithstanding, several important questions remain for future investigation. Multicenter prospective studies with standardized data collection are warranted to validate our findings. In addition, research incorporating detailed assessments of socioeconomic and insurance-related factors would provide a more comprehensive understanding of the determinants of G-CSF prophylaxis patterns. Finally, intervention studies are needed to evaluate strategies—such as electronic reminders, educational programs, or clinical decision support systems—aimed at improving guideline adherence and reducing underuse of G-CSF in patients at risk for FN.

Acknowledgments

This work was supported by the National Natural Science Foundation of China (Grant No. 61861047) and the Natural Science Foundation of Guizhou Province (Qian Ke He Ji Chu-MS [2026]-929). The authors thank Dr. Zhihui Shang for improving the English expression of this manuscript. We also appreciate the helpful comments from the anonymous reviewers on an earlier version of this manuscript.

Author's contributions

Hu: Conceptualization and design, data acquisition and analysis, writing – original draft; Yin: Data acquisition and analysis, writing – review & editing; Wang: Conceptualization, writing – review & editing, supervision. All authors made substantial contributions to the research and writing of this article and reviewed and approved the final version for submission and publication.

Funding

This work was supported by National Natural Science Foundation of China Project (61861047) and the Natural Science Foundation of Guizhou Province (Qian Ke He Ji Chu-MS [2026]-929).

Data availability statement

All data generated or analyzed during this study are available within the published article.

Ethical approval

This retrospective study was conducted in accordance with the Declaration of Helsinki and was approved by the Institutional Review Board of the Affiliated Hospital of Zunyi Medical University (Approval No.: KLLY-2024-042). This study was performed in adherence with the STROBE guidelines. See supplementary file for the STROBE checklist.

Conflict of interests

The authors declare no competing interests.

Consent to participate

The requirement for informed consent was waived due to the retrospective nature of the study.

REFERENCES

Adamo V, Antonuzzo L, Danova M, De Laurentiis M, Marchetti P, Pinto C and Rosti G (2022). Supportive therapies in the prevention of chemotherapy-induced febrile neutropenia and appropriate use of granulocyte colony-stimulating factors: A Delphi consensus statement. *Support Care Cancer*, **30**(12): 9877-9888.

Aras E, Bayraktar-Ekincioglu A and Kilickap S (2020). Risk assessment of febrile neutropenia and evaluation of G-CSF use in patients with cancer: A real-life study. *Support Care Cancer*, **28**(2): 691-699.

Becker PS, Griffiths EA, Alwan LM, Bachiashvili K, Brown A, Cool R, Curtin P, Dinner S, Gojo I, Hicks A, Kallam A, Kidwai WZ, Kloth DD, Kraut EH, Landsburg D, Lyman GH, Miller R, Mukherjee S, Patel S, Perez LE, Poust A, Rampal R, Rosovsky R, Roy V, Rugo HS, Shayani S, Vasu S, Wadleigh M, Westbrook K, Westervelt P, Burns J, Keller J and Pluchino LA (2020). NCCN Guidelines Insights: Hematopoietic Growth Factors, Version 1.2020. *J. Natl. Compr. Canc. Netw.*, **18**(1): 12-22.

Bray F, Laversanne M, Sung H, Ferlay J, Siegel RL, Soerjomataram I and Jemal A (2024). Global cancer statistics 2022: GLOBOCAN estimates of incidence and mortality worldwide for 36 cancers in 185 countries.*CA Cancer J. Clin.*, **74**(3): 229-263.

Campbell K, Chadha N, Dimri S, Wang W and Li E (2022). G-CSF primary prophylaxis use and outcomes in patients receiving chemotherapy at intermediate risk for febrile neutropenia: A scoping review. *Expert Rev. Hematol.*, **15**(7): 619-633.

Chinese Society of Integrative Oncology Pharmacy and Chinese Society of Medical Oncology (2026). Chinese expert consensus on clinical application management of recombinant human granulocyte colony-stimulating factor (2026 edition). *Cancer Res. Prev. Treat*, **53**(1): 1-16.

Danese MD, Schenfeld J, Shaw J, Gawade P, Balasubramanian A, Kelsh M, Hernandez RK and Lyman G (2022). Association between granulocyte colony-stimulating factor (G-CSF) use and myelodysplastic syndrome (MDS) or acute myeloid leukemia (AML) among elderly patients with breast, lung, or prostate cancer. *Adv. Ther.*, **39**(6): 2778-2795.

Foley AM and Hoffman M (2023). CE: Febrile neutropenia in the chemotherapy patient. *Am. J. Nurs*., **123**(5): 36-42.

Gawade PL, Li S, Henry D, Smith N, Belani R, Kelsh MA and Bradbury BD (2020). Patterns of granulocyte colony-stimulating factor prophylaxis in patients with cancer receiving myelosuppressive chemotherapy. *Support Care Cancer*, **28**(9): 4413-4424.

Griffiths EA, Roy V, Alwan L, Bachiashvili K, Baird J, Cool R, Dinner S, Geyer M, Glaspy J, Gojo I, Hicks A, Kallam A, Kidwai WZ, Kloth DD, Kraut EH, Landsburg D, Lyman GH, Mahajan A, Miller R, Nachar V, Patel S, Patel S, Perez LE, Poust A, Riaz F, Rosovsky R, Rugo HS, Simon S, Vasu S, Wadleigh M, Westbrook K, Westervelt P, Berardi RA and Pluchino L (2022). NCCN Guidelines® Insights: Hematopoietic Growth Factors, Version 1.2022. *J. Natl. Compr. Canc. Netw*, **20**(5): 436-442.

Ichihara E, Ochi N, Makimoto G, Kudo K, Harada D, Ozaki Y, Nishio H, Tsuchihashi K, Miura Y, Endo M, Yano S, Maruyama D, Yoshinami T, Susumu N, Takekuma M, Motohashi T, Ito M, Baba E, Uchino K, Kimura T, Kamiyama Y, Nakao S, Tamura S, Nishimoto H, Kato Y, Sato A, Takano T and Kubo T (2024). Effectiveness and safety of primary prophylaxis with G-CSF for lung cancer: A systematic review and meta-analysis to develop clinical practice guidelines for the use of G-CSF 2022. *Int. J. Clin. Oncol.*, **29**(4): 355-362.

Jimenez Nieves Y, Ortiz-Ortiz KJ, Rios Motta RE, Castaneda-Avila MA and Tortolero-Luna G (2022). Granulocyte colony stimulating factor use and adherence to clinical practice guidelines among women with breast cancer living in Puerto Rico: A population-based study. *BMC Health Serv. Res*, **22**(1): 935.

Ku M and Je NK (2022). Underutilisation of prophylactic G-CSF in breast cancer patients receiving adjuvant docetaxel/cyclophosphamide chemotherapy. *J. Chemother*, **34**(8): 534-542.

Langeh U, Kumar V, Ahuja P, Singh C and Singh A (2023). An update on breast cancer chemotherapy-associated toxicity and their management approaches. *Health Sci. Rev*, **9**: 100119.

Li Y, Qiu X, Lei Y and Zhou R (2024). G-CSF + plerixafor versus G-CSF alone mobilized hematopoietic stem cells in patients with multiple myeloma and lymphoma: A systematic review and meta-analysis. *Ann. Med.*, **56**(1): 2329140.

Mezzanotte V, Paterno G, Cerroni I, De Marchi L, Taka K, Buzzatti E, Mallegni F, Meddi E, Moretti F, Buccisano F, Maurillo L, Palmieri R, Gurnari C, Venditti A and Del Principe MI (2025). Use of primary prophylaxis with G-CSF in acute myeloid leukemia patients undergoing intensive chemotherapy does not affect quality of response. *J. Clin. Med.*, **14**(4): 1254.

Qu Y, Zuo L, Zhang S, Zhou W and Chen R (2025). Comparative analysis of adverse events linked to PEG-rhG-CSF and rhG-CSF in real-world settings: Disproportionate examination of the US food and drug administration (FDA) adverse event reporting system (FAERS) database. *Clin. Ther.*, **47**(8): 624-630.

Shokane LL, Bezuidenhout S and Lundie M (2023). Use of granulocyte colony-stimulating factor in patients with chemotherapy-induced neutropaenia. *Health SA*, **28**: 2221.

Article in Press