Using a Computer-Based Risk Assessment Tool to Identify Risk for Chemotherapy-Induced Febrile Neutropenia

Kevin Miller, RN, BSN, OCN®, CCRC

This article evaluates the feasibility of developing and implementing a computer-based risk assessment tool (CBRAT) for febrile neutropenia and determines whether it could improve documentation of risk assessment in patients starting myelosuppressive chemotherapy regimens. The CBRAT was designed using a template creator in a commercial electronic medical records system. The effectiveness of the CBRAT was evaluated by comparing medical records data of patients with one or more risk factor for febrile neutropenia who were given prophylactic granulocyte–colony-stimulating factor before and after implementation. CBRAT usage significantly increased the likelihood of documented febrile neutropenia risk assessment from 13% before implementation to 100% after implementation (p < 0.001). No significant changes occurred in febrile neutropenia incidence rates, dose reductions, or dose delays. In addition, healthcare providers quickly learned how to operate the CBRAT and used it routinely, significantly improving the number of patients with documented febrile neutropenia risk assessment. Implementation of a computer-based tool can help nurses follow evidence-based guidelines that recommend routine febrile neutropenia risk assessment for patients initiating myelosuppressive chemotherapy.

Febrile neutropenia is recognized as a serious adverse event of myelosuppressive chemotherapy. Defined as the occurrence of fever (higher than 38.2°C for longer than an hour) associated with an absolute neutrophil count lower than 500/mm³ (Freyer, Ligneau, & Trillet-Lenoir, 1998), febrile neutropenia typically requires hospitalization, blood cultures, and broad-spectrum antibiotics (National Comprehensive Cancer Network [NCCN], 2008b). Even with treatment, febrile neutropenia can be associated with substantial mortality. Research on febrile neutropenia–related hospitalizations in the United States has determined that the risk for inpatient mortality is 6.8%–9.5% overall (Caggiano, Weiss, Rickert, & Linde-Zwirble, 2005; Kuderer, Dale, Crawford, Cosler, & Lyman, 2006) and 21% in patients with more than one major comorbidity (Kuderer et al., 2006).

Complications of febrile neutropenia often result in chemotherapy dose reductions and delays (Crawford et al., 2008; Lyman, Dale, & Crawford, 2003; Lyman, Dale, Friedberg, Crawford, & Fisher, 2004), which can compromise treatment outcomes. Clinical trials have documented that dose reductions are associated with poorer overall survival in the curative setting in chemosensitive cancers, such as non-Hodgkin lymphoma (Bosly et al., 2007; Pettengell, Schwenkglenks, & Bosly, 2008) and early-stage breast cancer (Bonadonna et al., 2005; Early Breast Cancer Trialists’ Collaborative Group, 2005). Dose reductions and delays also have been shown to preclude optimal outcomes in the noncurative setting in patients with metastatic breast cancer (Hryniuk, Frei, & Wright, 1998), metastatic colorectal cancer (Scheithauer et al., 2003), and small cell lung cancer (Ardizzoni et al., 2005).

At a Glance

- Chemotherapy-induced febrile neutropenia is associated with significant morbidity and mortality and may require dose modifications that compromise survival in some patients.
- International evidence-based guidelines recommend routine assessment for febrile neutropenia risk before patients start myelosuppressive chemotherapy.
- Use of a standardized computer-based template can help oncology nurses target the use of granulocyte–colony-stimulating factor to patients who are most likely to receive benefit.

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More than 50% of cases of febrile neutropenia occur in the first cycle of chemotherapy (Crawford et al., 2008), and the risk for infection increases with the depth and duration of neutropenia (Bodey, Buckley, Sathe, & Freireich, 1966). The consensus of international guidelines is that risk for febrile neutropenia should be assessed prior to the first cycle of chemotherapy (Aapro et al., 2006; NCCN, 2008a; Smith et al., 2006). Prophylactic granulocyte-colony-stimulating factor (G-CSF) should be given if the chemotherapy regimen is associated with a febrile neutropenia risk of 20% or higher or if the risk for febrile neutropenia is from 10%–20% and certain patient-related risk factors (e.g., advanced age, comorbid conditions) are present. The guidelines also agree that G-CSF should be used for support of dose-dense and dose-intense chemotherapy and maintenance of dose intensity and dose density when the treatment intent is curative or prolongation of survival. In addition, the guidelines support the use of G-CSF as secondary prophylaxis in subsequent cycles after a neutropenic event has occurred. Guidelines from the American Society of Clinical Oncology (ASCO) and NCCN recommend that patients should be reassessed for febrile neutropenia risk prior to every cycle of chemotherapy (NCCN, 2008a; Smith et al., 2006).

Oncology nurses should participate in risk assessment for chemotherapy-induced febrile neutropenia. The author’s past practice at Mid Ohio Oncology/Hematology in Westerville, OH, consistently has made febrile neutropenia risk assessment a priority; however, staff recognized that procedures could be improved. Although febrile neutropenia risk assessments were conducted during most examinations, they were not always documented. Therefore, staff developed an observational before-and-after study aimed at evaluating whether developing and implementing a computer-based risk assessment tool (CBRAT) for febrile neutropenia could improve documentation in patients initiating myelosuppressive chemotherapy regimens.

The current study aimed to compare the number of febrile neutropenia risk assessments that were documented in patient charts before and after implementation of the CBRAT. This comparison allowed the staff to evaluate the feasibility of using a CBRAT in clinical practice. Staff also evaluated the number of participants who received first- or second-cycle growth factor.

Methods

Development of the Tool

The investigator created a CBRAT by using a template-creator function in a commercial electronic medical records system (VARIS MedOnCology™ software) to extract the data needed. The resulting report presents information on a patient’s febrile neutropenia–related risk factors that can be printed or reviewed on screen.

Febrile neutropenia–related risk factors included in the CBRAT were chemotherapy regimen and treatment duration, comorbidities, pretreatment laboratory values, absolute neutrophil count of 1,000/mm³ or lower, hemoglobin level lower than 12 g/dl, serum albumin level lower than 3.5 g/dl, and lactate dehydrogenase level higher than 618 units/L. The risk factors are applicable to all nonleukemia cancer types, typically are included in patient charts, and are verified easily by healthcare providers. A principal goal in designing the CBRAT was to keep it simple enough that practice personnel would be willing to incorporate it into their daily routine.

Implementation

On January 1, 2006, healthcare providers at the four offices of a community oncology practice began to implement the CBRAT. The investigator trained clinicians via conference calls over a three-week period on how to use the CBRAT. Periodic updates were given to RNs. The investigator also educated precertification specialists in the billing department so that they could help identify potential participants for the after phase of the study.

In both the before and after phases, patients who were noted to have one or more risk factors for febrile neutropenia received prophylactic filgrastim or pegfilgrastim (i.e., starting in the first cycle of chemotherapy). The choice of whether to use filgrastim or pegfilgrastim was made at the treating physician’s discretion. Absolute neutrophil count was measured at routine office visits at intervals determined by the treating physician.

Study Design and Objectives

The study was designed as an observational chart review conducted before and after implementation of the CBRAT. The planned sample was 100 consecutive charts for patients treated prior to the implementation of the CBRAT and 100 consecutive charts for patients treated after implementation. Records were reviewed for patients treated from January 1, 2004–December 31, 2004, for the before group and from January 1, 2005–October 29, 2007, for the after group. Both electronic and paper charts were examined, and data were recorded for the first and second cycles of chemotherapy. The study protocol was approved by the Western Institutional Review Board. Statistical significance was tested using Fisher’s exact test. All tests of significance were two-tailed.

Study Population

The study was restricted to adult patients (aged 18 years or older) initiating myelosuppressive chemotherapy for breast cancer or non–small cell lung cancer (neoadjuvant treatment, adjuvant treatment, or first-line treatment of metastatic or recurrent disease for breast and lung cancer). Patients who received a dose-dense chemotherapy regimen were excluded because they always receive prophylactic G-CSF. In the before phase, patients were excluded if they were participating in a current chemotherapy treatment trial. To boost accrual in the after phase, concurrent enrollment in chemotherapy trials and the CBRAT study was allowed if the use of CSFs was optional.

Results

Patient Characteristics

One-hundred and one charts of patients treated before implementation of the CBRAT and 98 charts of patients treated after implementation were reviewed. Table 1 summarizes patient demographics and characteristics. The chemotherapy regimens
### Table 1. Patient Demographics and Characteristics

<table>
<thead>
<tr>
<th>CHARACTERISTIC</th>
<th>BEFORE IMPLEMENTATION (N = 101)</th>
<th>AFTER IMPLEMENTATION (N = 98)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>58</td>
<td>62.5</td>
</tr>
<tr>
<td>Gender</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>5</td>
<td>29</td>
</tr>
<tr>
<td>Female</td>
<td>96</td>
<td>69</td>
</tr>
<tr>
<td>Cancer type</td>
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<td></td>
</tr>
<tr>
<td>Breast cancer</td>
<td>91</td>
<td>45</td>
</tr>
<tr>
<td>Neoadjuvant</td>
<td>8</td>
<td>3</td>
</tr>
<tr>
<td>Adjuvant</td>
<td>75</td>
<td>42</td>
</tr>
<tr>
<td>Metastatic</td>
<td>8</td>
<td>–</td>
</tr>
<tr>
<td>NSCLC</td>
<td>10</td>
<td>53</td>
</tr>
<tr>
<td>Neoadjuvant</td>
<td>–</td>
<td>2</td>
</tr>
<tr>
<td>Adjuvant</td>
<td>5</td>
<td>15</td>
</tr>
<tr>
<td>Metastatic</td>
<td>5</td>
<td>36</td>
</tr>
<tr>
<td>Pretreatment laboratory values</td>
<td></td>
<td></td>
</tr>
<tr>
<td>All values normal</td>
<td>80</td>
<td>61</td>
</tr>
<tr>
<td>Low hemoglobin level</td>
<td>18</td>
<td>24</td>
</tr>
<tr>
<td>Low serum albumin level</td>
<td>5</td>
<td>14</td>
</tr>
<tr>
<td>Elevated LDH level</td>
<td>1</td>
<td>8</td>
</tr>
<tr>
<td>ANC of 1,000/mm³</td>
<td>–</td>
<td>3</td>
</tr>
<tr>
<td>or lower</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Comorbidities</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Arthritis or DJD</td>
<td>30</td>
<td>26</td>
</tr>
<tr>
<td>CVD</td>
<td>20</td>
<td>32</td>
</tr>
<tr>
<td>Hypertension without other CVD</td>
<td>33</td>
<td>18</td>
</tr>
<tr>
<td>Respiratory disease</td>
<td>16</td>
<td>30</td>
</tr>
<tr>
<td>Thyroid disorder</td>
<td>15</td>
<td>9</td>
</tr>
<tr>
<td>Diabetes</td>
<td>15</td>
<td>10</td>
</tr>
<tr>
<td>Bleeds or bruises easily</td>
<td>8</td>
<td>7</td>
</tr>
<tr>
<td>Urinary tract infection</td>
<td>8</td>
<td>10</td>
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<tr>
<td>Other</td>
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<td>29</td>
</tr>
<tr>
<td>None</td>
<td>14</td>
<td>8</td>
</tr>
<tr>
<td>None noted</td>
<td>3</td>
<td>14</td>
</tr>
</tbody>
</table>

ANC—absolute neutrophil count; CVD—cardiovascular disease; DJD—degenerative joint disease; LDH—lactate dehydrogenase; NSCLC—non-small cell lung cancer

Discussion

The results of this study show that developing a CBRAT for assessing febrile neutropenia risk was feasible. The tool was developed readily from existing medical records software, and healthcare providers quickly adopted it for routine use because it was simple to use. Implementation of the CBRAT significantly increased the likelihood of documented febrile neutropenia risk assessment. The importance of evaluating all patients for risk for febrile neutropenia has been recognized in guidelines from ASCO (Smith et al., 2006), NCCN (2008a), and the European Organization for Research and Treatment of Cancer (Aapro et al., 2006). The guidelines recommend that patients be assessed routinely for risk for febrile neutropenia and receive appropriate supportive care if indicated.

As part of the wider movement toward evidence-based nursing practice, oncology nurses are being urged to help implement the guidelines into community practice (Moore & Crom, 2006; Wilson & Gardner, 2007). In the author’s practice, the process of establishing the CBRAT promoted collaboration among physicians, nurses, and other healthcare providers who formed a multidisciplinary team to improve the practice. Physicians at the practice were asked to provide input on the risk factors to incorporate into the CBRAT. Involving all stakeholders in the project from its inception helped to gather data smoothly.

Implementation of the CBRAT significantly improved the practice’s rate of documented risk assessment and, therefore, adherence to the guidelines. In addition, risk factors that warranted intervention to reduce the incidence of severe chemotherapy-induced neutropenia and its complications were detected in more than 50% of the patients assessed. Routine use of the CBRAT in the current study was associated with a 16% increase in the use of prophylactic G-CSF overall and a 9% decrease in the reactive use of G-CSF. By using the CBRAT, the practice targeted the more appropriate use of G-CSF toward patients who had the highest risk for febrile neutropenia and could benefit from primary prophylaxis (i.e., starting G-CSF in the first cycle of chemotherapy). In addition, staff were able to identify patients who were not initially at substantial risk for febrile neutropenia and, therefore, did not require prophylactic G-CSF.

Other nurse-initiated studies have shown that the systematic identification of patients at high risk for febrile neutropenia, followed by G-CSF prophylaxis as necessary, can improve patient outcomes (Donohue, 2006; Doyle, 2006; White, Maxwell, Michelson, & Bedell, 2005). Examples of improvements have included significant reduction in the need for chemotherapy dose delays (Donohue, 2006) and in the rate of febrile neutropenia-related hospitalization and the duration of hospital stays (Doyle, 2006). Similar to the current study’s, the protocols have recognized nurses’ role in risk assessment and the importance of communication among members of the multidisciplinary team. The Oncology Nursing Society Outcomes Project Team designated neutropenia as a patient outcome that is amenable to nursing intervention (Given & Sherwood, 2005). Involving nurses in risk assessment will encourage them to become stakeholders in this important aspect of patient care.

Standardizing febrile neutropenia risk assessment also may have advantages with regard to practice efficiency. Assessment templates help streamline care by ensuring that clinicians collect

Outcomes

Before the implementation of the CBRAT, 13 of 101 patients (13%) had documented risk assessments for febrile neutropenia. Of the 98 patients reviewed after implementation, 100% of risk assessments for febrile neutropenia were documented (p < 0.001).

The use of first-cycle G-CSF in patients was higher after the implementation of the CBRAT than in the before phase (52% versus 35% of patients). The reactive use of G-CSF (the need for G-CSF use after the occurrence of a neutropenic event when no prophylaxis was given in the first cycle) decreased (23% versus 14%). Hospitalizations for febrile neutropenia were not tracked.
all necessary data, and empowering nurses to use the templates frees physician time. Careful record-keeping also improves reimbursement because billing departments can submit charges for appropriately documented procedures. In addition, standardized documentation facilitates data collection when nurses conduct research or quality improvement initiatives to improve patient care. A CBRAT similar to the current study’s could be integrated readily into an electronic medical records system, assisting both the clinicians and the business staff in a practice. Oncology nurses also can improve the management of chemotherapy-induced neutropenia and febrile neutropenia by incorporating standing orders into evidence-based practice guidelines. Standing orders instruct nurses to follow a specified evidence-based treatment protocol for all patients who meet certain predetermined criteria (Maxwell & Stein, 2006). A direction for future research in any practice would be to investigate the feasibility and clinical effect of establishing standing orders so that nurses can administer G-CSF appropriately to patients who are most likely to benefit from it on the basis of risk factors identified with a CBRAT.

Limitations

Limitations of the current study are that although only 13% of patients had risk assessment documented before implementation of the CBRAT, the number of patients who were assessed likely was higher. Shifts in treatment patterns also may have affected the results, although the before and after phases were close in time. In addition to the small number of participants in the study, the patient populations before and after implementation were not adequately matched with regard to gender, tumor type, and treatment setting. However, the study population did reflect typical patients encountered in community practices where most patients with cancer are treated. In addition, other febrile neutropenia outcomes such as the number of febrile neutropenia-related hospitalizations or antibiotic use were not tracked.

Conclusion

In the author’s past practice, use of a CBRAT increased the likelihood that patients had febrile neutropenia risk assessment documented. Additional studies with a larger number of patients will help evaluate the effect of the CBRAT in improving patient outcomes. This process also could be applied to other clinical issues.

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