Risk Analysis of Falls in Patients Undergoing Allogeneic Hematopoietic Stem Cell Transplantation

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To identify fall risks in patients undergoing hematopoietic stem cell transplantation (HSCT), the authors reviewed retrospective data on inpatients from April 2010 to March 2011. Among 77 HSCT patient records reviewed, the authors found that 35 patients had experienced at least one fall, including near-miss episodes (fallers). The main location of the falls was a corridor, and the main activity at the time of the fall was going to the toilet. To investigate fall risks along the HSCT time trajectory, the authors divided the time into pre- and postengraftment periods and investigated the unique characteristics of each.

Injury rates from inpatient falls range from 2–20 falls per 1,000 patient days (Fischer et al., 2005; Healey, Monro, Cockram, Adams, & Heseltine, 2004), and can lead to increased morbidity and mortality (Fischer et al., 2005). Injury rates from inpatient falls range from 25%–45% (Fischer et al., 2005; Hitcho et al., 2004), and the risk of serious injury is as high as 10% (Grenier-Sennelier, Lombard, Jeny-Loeper, Maillet-Gouret, & Minvielle, 2002). Patient falls, particularly in the setting of hematopoietic stem cell transplantation (HSCT) units, may result in severe or fatal outcomes related to low platelet count or other health conditions. Despite various efforts to prevent falls (Bardino, Cohen, & Didwania, 2012), they remain a major problem in safety management in acute care settings, such as HSCT units. Although analyses of fall risks have been conducted in other fields (Abujudeh, Kaewlai, Shah, & Thrall, 2011; Titler, Shever, Kanak, Picone, & Qin, 2011; Weinberg et al., 2011), studies of falls in HSCT units are scarce. In the current study, the authors aim to describe the characteristics of falls along the HSCT timeline. To know causative mechanisms of falls along a clinical course and to identify patients at high risk for falls enables the prediction of fall episodes and may have beneficial implications for oncology nursing practice.

Methods
Medical Chart-Based Review

The retrospective study involved 77 patients who underwent an allogeneic HSCT on the HSCT unit at Hyogo College of Medicine in Japan from April 2010 to March 2011. Information on the following variables was extracted from each patient’s medical chart: (a) age and gender, (b) fall incident, (c) location and circumstances surrounding each incident, (d) date of the fall and medications used at that time, (e) time of the fall, (f) cause of the fall, (g) score on the Functional Independence Measure (FIM) (Forrest et al., 2012; Kwan, Kaplan, Hudson-McKinney, Redman-Bentley, & Rosario, 2012), (h) patient’s response to the fall, and (i) result of the Picture-Frustration (P-F) Study (Rosenzweig, 1945). The study was approved by the institutional review board of the Hyogo College of Medicine.

Functional Independence Measure Score

The FIM measures cognitive function, ability to communicate, mobility, and self-care skills (Forrest et al., 2012; Kwan et al., 2012). Some studies have identified a positive association between the FIM score and risk of falls (Saverino, Benevolo, Ottone, Zsirai, & Sessarego, 2006; Teasell, McRae, Foley, & Bhardwaj 2002; Zdobysz, Boradia, Ennis, & Miller, 2005). In the authors’ institution, FIM scores are assessed weekly by physiotherapists during the period of admission. The FIM score of fallers was defined as the score of the day or nearest to the day of the fall. The FIM scores of nonfallers in the pre- and postengraftment periods were represented by the minimum score in each period. Two or more incidents of falls in the same patients were counted as separate episodes.

Picture-Frustration Study

The P-F Study was originally designed to measure reactive aggressive behavior...
In this study, the authors focused on falls in pre- and postengraftment periods. Engraftment was defined as the first of three consecutive days in which the granulocyte count was more than 5 x 10^9/L. Pre-engraftment falls comprised 29%, and postengraftment falls made up 71%. Because an association between medications and falls has been previously reported (Kool, Ameratunga, & Robinson, 2012), the authors compared medications of fallers and nonfallers in each period (see Table 1). Hypnotics and anxiolytics were used more frequently in fallers than in nonfallers both in the pre- and postengraftment periods. This may explain the phenomenon whereby dizziness is the main symptom in pre-engraftment falls. On the other hand, opioids and nonopioid analgesics were

### Table 1. Medications for Patients in Fallers and in Nonfallers Groups (N = 77)

<table>
<thead>
<tr>
<th>Medication</th>
<th>Pre-Engraftment (29%)</th>
<th>Postengraftment (71%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Fallers n %</td>
<td>Nonfallers n %</td>
</tr>
<tr>
<td>Hypnotics</td>
<td>26 76 16 41 0.001</td>
<td>29 85 16 41 &lt; 0.001</td>
</tr>
<tr>
<td>Anxiolytics</td>
<td>11 32 4 10 0.021</td>
<td>21 62 7 18 &lt; 0.001</td>
</tr>
<tr>
<td>Opioids</td>
<td>10 29 6 15 NS</td>
<td>17 51 8 21 0.008</td>
</tr>
<tr>
<td>Nonopioid analgesics</td>
<td>16 47 10 26 NS</td>
<td>23 68 16 41 0.021</td>
</tr>
<tr>
<td>Hypotensive drugs</td>
<td>24 71 22 56 NS</td>
<td>23 68 23 59 NS</td>
</tr>
<tr>
<td>Diuretics</td>
<td>28 82 29 74 NS</td>
<td>24 71 23 59 NS</td>
</tr>
</tbody>
</table>

Note. Medication rates of fallers and nonfallers were divided into a pre-engraftment and a postengraftment period. Hypnotics and anxiolytics were used more frequently in fallers than nonfallers both in the pre- and postengraftment periods. Opioids and non-opioid analgesics were prescribed more frequently in fallers than in nonfallers only in the post-engraftment period. P values are described using Fisher’s exact test.

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**Results and Discussion**

Seventy-seven patients (45 male and 32 female with an age range of 19-70 years) who underwent allogeneic HSCT at Hyogo College of Medicine were included in this analysis. Among the 77 patients, 35 (20 male and 15 female, with an average age of 43 years) had experienced at least one fall or near miss fall (fallers). The remaining 42 patients (25 male and 17 female, with an average age of 45 years) who had never fallen were allocated as a control group (nonfallers). The main pattern of the falls was in a corridor while going to the toilet (see Figures 1 and 2).

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**Statistical Analyses**

Fisher’s exact test was used in the comparison of medications in fallers and nonfallers. Student’s t test was used in the comparison of FIM scores in fallers and nonfallers. P values equal to or below 0.05 were significant.

**Note.** Falls in each location of the ward are shown. The ward, a toilet and shower are present in each clean room, but patients have to go to shared toilets when they are in general rooms.
prescribed more frequently in fallers than in nonfallers only in the postengraftment period. This can be explained by the fact that some patients suffer from severe pain and need opioids and nonopioid analgesics in that period.

To identify other factors affecting postengraftment falls, the authors reviewed the time when falls occurred. Whereas pre-engraftment falls tended to occur from midnight to early in the morning, postengraftment falls tended to occur mainly in the day time (see Figure 3). Regarding symptoms, whereas the symptoms at time of pre-engraftment fall were dizziness (65%), loss of consciousness (25%), and sudden listlessness of the knee (10%), the symptoms at the time of postengraftment fall were sudden listlessness of the knee (73%), stumbling (19%), loss of consciousness (6%), and dizziness (2%). The postengraftment fallers said, “I stumbled because my legs would not rise,” or “sudden listlessness of the knees occurred.” Taken together, muscle weakness is suggested to be a key factor in postengraftment falls.

To quantitatively assess muscle weakness, the authors compared the data on FIM scores in fallers and nonfallers. In nonfallers, no significant change was noted in FIM scores between the pre- and postengraftment periods. In contrast, between fallers and nonfallers, the FIM score was not different in the pre-engraftment period (p = 0.263), but was significantly lower in fallers than in nonfallers in the postengraftment period (p = 0.004) (see Figure 4). Therefore, muscle weakness seems to be a factor associated with postengraftment falls.

Fallers also said, “I never dreamed that I would fall,” or “I didn’t call a nurse because I felt guilty calling them to help me so many times.” These comments led the authors to investigate the characteristics of fallers and nonfallers and to identify those who might be prone to falls. For this purpose, the results of the P-F studies were reviewed and the (M.A) + I score index, which is thought to show a characteristic of someone who would not accuse anyone and would consider the feelings of others, was used. A significant difference in the (M.A) + I score (40.2 for fallers versus 34.1 for nonfallers, p = 0.039) was noted, which can be interpreted that fallers tend to be more modest and patient than nonfallers.

Conclusions

The authors aimed to describe the fall risks in patients undergoing HSCT along the time course. Hypnotics and/or anxiolytics are usually started in the pre-engraftment period. Those drugs result in falls from symptoms such as dizziness. Some patients suffer from intense pain related to hemorrhagic cystitis or gut graft-versus-host disease and have to rush to the toilet many times. They feel sudden listlessness of the knees from muscle weakness and fall. The reserved character of fallers also may an additional risk.

The differences in falls by time of day and FIM score in the current study are the first to be reported in the hematology/HSCT setting. By checking the medications, assessing FIM scores, and knowing patient’s characteristics, oncology nurses are able to identify patients at high risk for falls, and to provide appropriate guidance to patients, such as, “Don’t hesitate to call nurses if you need,” or “It is a period you tend to fall because of medication and muscle weakness. It is appropriate to call for assistance before getting up.” Because the study is an exploratory and retrospective one, the suggested risks should be confirmed in future prospective studies. Finally, the factors affecting falls are complicated in the HSCT setting; therefore, a team effort involving doctors, nurses, pharmacists, physiotherapists, a pain control team, and clinical psychologists is needed to reduce falls in this population.

The authors gratefully acknowledge the medical, nursing, and laboratory staff of the participating departments for their contributions.

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