Nurses relate the contributing factors involved in medication errors

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Aims and objectives. Understanding the processes by which nurses administer medication is critical to the minimization of medication errors. This study investigates nurses’ views on the factors contributing to medication errors in the hope of facilitating improvements to medication administration processes.

Design and methods. A focus group of nine Registered Nurses discussed medication errors with which they were familiar as a result of both their own experiences and of literature review. The group, along with other researchers, then developed a semi-structured questionnaire consisting of three parts: narrative description of the error, the nurse’s background and contributing factors. After the contributing factors had been elicited and verified with eight categories and 34 conditions, additional Registered Nurses were invited to participate by recalling one of the most significant medication errors that they had experienced and identifying contributing factors from those listed on the questionnaire. Identities of the hospital, patient and participants involved in the study remain confidential.

Results. Of the 72 female nurses who responded, 55 (76.4%) believed more than one factor contributed to medication errors. ‘Personal neglect’ (86.1%), ‘heavy workload’ (37.5%) and ‘new staff’ (37.5%) were the three main factors in the eight categories. ‘Need to solve other problems while administering drugs,’ ‘advanced drug preparation without rechecking,’ and ‘new graduate’ were the top three of the 34 conditions. Medical wards (36.1%) and intensive care units (33.3%) were the two most error-prone places. The errors common to the two were ‘wrong dose’...
(36.1%) and ‘wrong drug’ (26.4%). Antibiotics (38.9%) were the most commonly misadministered drugs.

Conclusions. Although the majority of respondents considered nurse’s personal neglect as the leading factor in medication errors, analysis indicated that additional factors involving the health care system, patients’ conditions and doctors’ prescriptions all contributed to administration errors.

Relevance to clinical practice. Identification of the main factors and conditions contributing to medication errors allows clinical nurses and administration systems to eliminate situations that promote errors and to incorporate changes that minimize them, creating a safer patient environment.

Key words: contributory factors, medication errors, nurse

Introduction

Despite the efforts by nursing scholars to develop nursing theory and the expansion of practicing arenas by clinical nurses, drug administration remains a traditional task of nurses, consuming up to 40% of work time and involving significant responsibility (Armitage & Knapman 2003). Administering the correct drugs to patients is a basic but extremely important requirement for a competent nurse, but this task is becoming more complex and difficult. For example, only 656 medications were available in 1961; now over 8000 are being prescribed (Leape 1995) with more than 17 000 trade and generic names in North America alone and the number continues to increase (ISMP 2000). In addition, medication delivery routes, which were once limited to oral (p.o.), hypodermal (Hypo), intramuscular (i.m.) and intravenous (i.v.), now also include patient-controlled analgesia, central venous pressure lines, subcutaneous implanted Port-A lines, arterial lines (A-line) and others, involving different types of pumps, tubes and valves. These increases in medication complexity and technological advancements could contribute to the risk of nursing errors in medication administration.

Before medication reaches a patient, four stages – prescription, transcription, dispensing and administration – need to be completed correctly. These stages involve physicians, pharmacists and nurses. According to several studies, medication errors usually occur during the prescription and administration stages and can account for between 65% and 87% of all medication errors (Bates et al. 1993, 1995, Wilson et al. 1998, Benjamin 2003). The computerized physician order entry (CPOE) system, however, may eliminate 80% of prescribing errors (Bates et al. 1998, 1999b, Kaushal et al. 2001). Recent reports indicate that prescribing errors account for 11% of medication mistakes, while administration errors are responsible for 40% of such mistakes (USP 2000).

Nursing professionals must accept responsibility for reducing errors that occur during the administration of medication. However, shame, guilt and fear of punishment may cause nurses to be reluctant to report mistakes (Cohen 1996, Osborne et al. 1999), which makes the analysis of incident reports related to medication errors and any estimation of frequency difficult (Novek et al. 2000, Low & Belcher 2002). The opportunity to learn from these mistakes may, in turn, be lost.

Although researchers and experts claim that medication errors should be viewed as a system failure rather than a personal inadequacy (Kohn et al. 1999), it is unclear to what extent nurses think about the factors contributing to medication errors. The main purpose of this study was to identify and understand the contribution of errors in medication administration from a nursing perspective, so that improvements can be implemented.

Literature review

Medication errors are underreported, due to emphasis on blame and reprisal consequences (Osborne et al. 1999, Horns & Loper 2002). Only the most serious cases emerge, while others are covered up or discussed in private (Leape 1995). In 1999, the Institute of Medicine published a book titled To Err Is Human: Building a Safer Health System, which alarmed health professionals by reporting that more than one million medical mishaps occur each year, resulting in 100 000 patient deaths, 77 000 of which are because of adverse drug events (ADEs). The number of deaths caused by medical errors is estimated to lie between 44 000 to 98 000 each year, which is greater than the number of deaths caused by vehicle accidents, breast cancer and AIDS in the USA (Kohn et al. 1999). Some experts consider that number an exaggeration (Brennan 2000, McDonald et al. 2000), but undoubtedly the number of errors and resulting costs are

Medication errors are 50 to 100 times more common than ADEs, with 1–2% of medication errors resulting in injury (Leape et al. 2000). From 1983 to 1993, deaths caused by medication errors increased by factor of 2.6 (Phillips et al. 1998) and 2% of in-patients experienced a preventable adverse event, resulting in increased costs of $4700 per admission or $2.8 million per annum for a 700-bed hospital. Each adverse event increased hospital stays from 1.9 to 4.6 days and increased costs from $2262 to $4685 (Bates et al. 1997, Classen et al. 1997).

Nurses have been held responsible for a great number of medication errors. Raju et al. (1989), in a four-year prospective quality assurance study, reported that nurses accounted for 60.3% and pharmacists 29.6% of 315 medication errors in neonatal and paediatric intensive care units (ICUs). In 1995, by prospective cohort study, Bates et al. indicated that, in a total of 70 preventable ADEs, nurses caused 34% of the administration errors, with the remaining 56% occurring during ordering and 10% during transcription and dispensing. Wilson et al. (1998), by using the same method in a two-year study of incident, reported from a paediatric hospital in the UK, a multidisciplinary committee analysed 441 medication errors and concluded that nurses accounted for 22% of errors and that 25% of errors were administration errors. Seventy-two per cent of errors were attributed to doctors, 68% were prescribing errors, 5% were attributed to pharmacy staff and 7% were recorded as supply errors and the outstanding 1% was attributed to doctor/nurse combinations. Recently, a secondary analysis of the database from the Medmarx program of US Pharmacopoeia (USP), Beyea et al. (2003) reported that of 731 errors specific to the operating theatre, administration errors accounted for 62.0%. These results suggest that most medication errors occur during the prescription and administration stages.

To reduce the number of prescribing errors, CPOE systems have been developed to eliminate illegible orders, unusual dosages and contraindications. This can reduce ordering errors by 93% (Kaushal et al. 2001). Use of a bar code system further reduces dispensing and administration errors (Larabee & Brown 2003). However, with a modern medication supply system, either because of a lack of baseline data for comparison, or because of distrust of the technology on the part of nurses, the functions for reducing medication errors, especially in the administration stage, remain ambiguous (Novek et al. 2000). In the study 83 intercepted potential ADEs, however, 62 were intercepted at the ordering stage, while 0% were intercepted at the administration stage (Bates et al. 1995). Those findings show that administration errors not only play the major part in medication errors but are also difficult to intercept. Reducing the incidence of administration errors by nurses requires additional strategies.

Errors attributable to human factors usually result in more serious outcomes (Meurier et al. 1998). In a retrospective analysis of 469 fatal medication errors that happened between 1993 and 1998, human factors played the most prominent role (65.2%), mainly because of deficiencies in performance and knowledge (44%) (Phillips et al. 2001). Another study indicated that performance errors were the leading cause of 42.5% of operating room (OR) medication errors (Beyea et al. 2003). Existing research, however, suggests that contributing factors attributed to performance errors vary. Doctor-initiated ordering errors are due mainly to lack of information concerning medication and patients (Lesar et al. 1997). More than 50% of incidents involving pharmacist errors are related to distractions (Knox 1999). Stress and understaffing are the two major factors in errors by chemotherapy nurses (Schulmeister 1999).

In the above studies, evaluation by experts, such as retrospective case note review and incident report analysis were commonly used, but nurses’ points of view are not clear. The principle of right patient, drug, dose, route and time when administering drugs is emphasized in nursing guidelines. An understanding of why nurses violate the ‘five rights’ and make mistakes is central to efforts to reduce medication errors.

Methods

Research design

Medication errors are universally underreported (Leape 1995, Wolf et al. 2000); most errors have not been filed and some information may not be documented in the incident reports. Fearing damage to their reputations, hospitals in Taiwan are hesitant about releasing incident reports and reluctant to encourage staff to participate in error surveys by researchers not associated with the hospital. It is, therefore, not appropriate simply to analyse incident reports from hospitals in order to understand nurses’ subjective points of view concerning contributory factors involved in medication errors. Other reports have been gained by mailing questionnaires to nurse subjects. These showed low response rates, from 6.8% (Schulmeister 1999) to 26% (Wolf et al. 2000), but, in another study, 51% of those nurses who did respond admitted to being involved in at least one medication error per year (Walters 1992). Owing to the above considerations, the main issue in the current research is to gain participants’ willingness and trust so that they will release the information concerning the medica-
tion errors in which they have been involved. The researchers therefore planned to take advantage of relationships of trust to gain participants among Registered Nurses (RNs) by means of a study which was designed to be highly anonymous and confidential. Given the sensitive topic of this study, therefore, certain distinctive considerations have been applied, as follows. Firstly, no names of hospitals or persons are identified in any manner whatsoever. Secondly, to provide a free and safe environment in which to answer the questionnaire, the participants could choose either to mail their response back to the researchers or undergo an interview. Mailing, for which a stamped addressed envelope was supplied, was intended to provide privacy in completion of the questionnaire. Participants who feared recognition by handwriting or had some other objections to responding in writing, had the option of an interview which was based solely on the questionnaire. In fact, however, all of the subjects who responded did so in writing; none opted for an interview.

Instrument development and validation

The focus group comprised nine RN students at the National Yang-Ming University (Taipei, Taiwan), who possessed at least three years of clinical experience and had worked in inpatient and out-patient settings. After four sessions to discuss situations leading to errors and to review the literature, a semi-structured questionnaire was developed, with the following three parts: (i) narrative description of the incident, (ii) nurse’s background and (iii) contributing factors. These included a total of 40 possible conditions under eight categories (personal neglect, new staff, heavy workload, unfamiliarity with patient’s condition, unfamiliarity with medication, complicated prescription, complicated doctor-initiated order and insufficient training).

Face validity

In addition to the nine members of the focus group, 10 additional RNs validated the questionnaire by recalling one medication error which they had experienced in person and identifying contributing factors by using the questionnaire. Preliminary results indicated that all potential causes were included in the questionnaire list; six conditions were eliminated from the questionnaire as rare occurrences. The nurses agreed that the questionnaire was clear, understandable and certain to be capable of maintaining confidentiality.

Content validity

Five experts, including three head nurses, one clinical pharmacist and one ICU physician, reviewed the questionnaire and helped in the validation of its content. They agreed on the categories and conditions, with only minor changes in wording.

Sampling procedure and ethical considerations

Because of the study’s design, the snowball-sampling method was applied (Rubin & Babbie 1993, Babbie 2004). The focus group members contacted RN coworkers and other RN acquaintances who, it was considered, might be willing to be recruited to participate. Each member said, after discussing the network of interpersonal relationships, that they planned to recruit between six to eight participants.

The participants were asked to recall a significant error in which they had been involved in person. Before they were asked to do so, they were given, for ethical purposes, the following:

1 A thorough explanation of the purpose of the research and the procedures involved therein, including the fact that all information provided would be used only for the purposes of this research and would not be released for any other purposes.
2 A request for their oral consent to participation in this research.
3 Notification of their rights to refuse to answer any of the questions and to stop the interview at any time.
4 Notification of their rights to refuse further clarification and withdraw information at any time.
5 A guarantee that, throughout the research process, only the focus group member who invited them to participate and expressly no other group member and no researcher, would know of their identity as a participant in this survey.

Analysis

SPSS statistical software was used for descriptive analysis of the nurses’ backgrounds and demographics (SPSS Inc., Chicago, IL, USA). Narrative statements were analysed by two researchers, who coded the errors and read the statements independently. Whenever the two researchers had unclear or inconsistent interpretations, these were resolved by asking the relevant member of the focus group to ask the respondent for clarification.

Results

Ninety female nurses, including the nine focus group members, were invited to participate, 72 of whom (80%) responded, providing details of 72 medication errors. All the respondents completed the questionnaire by themselves, none of them opting to be interviewed.
Nurses were given eight categories and 34 conditions from which to choose in order to identify factors contributing to errors. Seventeen nurses (23.6%; n = 17) responded that only one category contributed to their error. Eighteen (25.0%; n = 18) chose two categories, while 21 (29.2%; n = 21) chose three and 16 (22.7%; n = 16) chose more than four. Over 60% of nurses believed that three (31.9%; n = 23) or four (30.6%; n = 22) conditions were contributed to the error, while <40% selected either two (18.1%; n = 13) or more than four conditions (19.5%; n = 14). None selected only one condition.

**Background of errors**

Sixty-eight (94.4%) of the errors had occurred after the nurse in question graduated from nursing school. Twenty-three (31.9%) of the nurses had graduated within the previous year. Average length of working experience at the time the errors occurred was 2.2 ± 0.7 years. Slightly more than half (51.4%) of the errors occurred in large teaching hospitals (medical centres), while 36.1% occurred in regional hospitals and 12.5% in local hospitals, mainly on medical wards and ICUs (36.1%; n = 26 vs. 33.3%; n = 24) (Table 1).

**Contributing factors**

The three most common categories selected as contributing to errors were: personal neglect (n = 62), heavy workload (n = 27) and new staff (n = 27) (Table 2; Fig. 1). The three most common conditions were: need to solve other problems (36.1%) while administering drugs (n = 34), advanced drug preparation without rechecking (n = 31) and new graduate (n = 23) (Table 3). A total of 199 choices of category was made, only one of which was ‘other’ (i.e. outside the eight specified categories). A total of 267 choices of conditions was made, only 24 of which were for ‘other’ (i.e. outside the 34 specified conditions), mainly in the categories of personal neglect (n = 9) and unfamiliarity with medication (n = 8) (Tables 2 and 3).

**Table 1** Background of medication errors (N = 72)

<table>
<thead>
<tr>
<th>Category</th>
<th>Incidence (n)</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hospital*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Medical centre</td>
<td>37</td>
<td>51.4</td>
</tr>
<tr>
<td>Regional</td>
<td>26</td>
<td>36.1</td>
</tr>
<tr>
<td>Local</td>
<td>9</td>
<td>12.5</td>
</tr>
<tr>
<td>Wards</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Medical</td>
<td>26</td>
<td>36.1</td>
</tr>
<tr>
<td>ICU</td>
<td>24</td>
<td>33.3</td>
</tr>
<tr>
<td>Surgical</td>
<td>6</td>
<td>8.3</td>
</tr>
<tr>
<td>Paediatric</td>
<td>4</td>
<td>5.6</td>
</tr>
<tr>
<td>ER</td>
<td>3</td>
<td>4.2</td>
</tr>
<tr>
<td>Others</td>
<td>9</td>
<td>12.5</td>
</tr>
<tr>
<td>Nurse</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Student nurse</td>
<td>4</td>
<td>5.6</td>
</tr>
<tr>
<td>RN</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;1 year</td>
<td>23</td>
<td>31.9</td>
</tr>
<tr>
<td>1–2 year</td>
<td>35</td>
<td>48.6</td>
</tr>
<tr>
<td>&gt;2 year</td>
<td>10</td>
<td>13.9</td>
</tr>
</tbody>
</table>

ICU, intensive care unit; ER, Emergency Room; RN, Registered Nurse.

*Medical centre > 500 beds; Regional > 250 beds; Local ≤250 beds.

**Table 2** Nurses’ reports of the causes of medication errors (N = 72; multiple response)

<table>
<thead>
<tr>
<th>Category</th>
<th>Nurse (n)</th>
<th>Percentage</th>
<th>Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>Personal neglect</td>
<td>62</td>
<td>86.1</td>
<td>1</td>
</tr>
<tr>
<td>Heavy workload</td>
<td>27</td>
<td>37.5</td>
<td>2</td>
</tr>
<tr>
<td>New staff</td>
<td>27</td>
<td>37.5</td>
<td>2</td>
</tr>
<tr>
<td>Unfamiliarity with medication</td>
<td>23</td>
<td>31.9</td>
<td>3</td>
</tr>
<tr>
<td>Complicated doctor-initiated order</td>
<td>17</td>
<td>23.6</td>
<td>4</td>
</tr>
<tr>
<td>Unfamiliarity with patient’s condition</td>
<td>16</td>
<td>22.2</td>
<td>5</td>
</tr>
<tr>
<td>Complicated prescription</td>
<td>15</td>
<td>20.8</td>
<td>6</td>
</tr>
<tr>
<td>Insufficient training</td>
<td>11</td>
<td>15.3</td>
<td>7</td>
</tr>
<tr>
<td>Others</td>
<td>1</td>
<td>1.4</td>
<td>8</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>199</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Figure 1** The percentage of each category caused of medication errors (N = 72; multiple response).

**Types of errors**

Reports of violations of the five rights broke down, by category, as follows: wrong dose 36.1% [either over (n = 13) or under dosage (n = 13); total n = 26]; using the wrong drug 26.4% (n = 19); administering medication at the wrong time 18.1% (n = 13); medicating the wrong patient 11.1% (n = 8); and choosing the wrong route 8.3% (n = 6) (Fig. 2). Many types of medications were involved in errors, but
antibiotics were involved in more than one-third (38.9%; n = 28); the remaining errors involved electrolytes (n = 6), analgesics (n = 5), hypoglycaemic agents (n = 5) and others, such as cardiovascular or gastric drugs (n = 28) (Fig. 3). Examples are shown in Table 4.

**Discussion**

**Background of errors**

Our results showed that medical wards and ICUs are the most common locations for medication errors. Similar results were reported by Bates et al. (1999a). ICUs are error-prone places (Cullen et al. 1997) with error rates as high as 1.7 per patient per day (Donchin et al. 1995), especially in paediatric and neonatal ICU wards (Kaushal et al. 2001). Our research,

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**Table 3** Nurse identification of conditions that result in a medication error (N = 72; multiple responses)

<table>
<thead>
<tr>
<th>Category</th>
<th>Condition</th>
<th>Number (n)</th>
<th>Others (n)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Personal neglect</td>
<td>Must solve other problems while administrating drug</td>
<td>34</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>Advanced drug preparation without rechecking</td>
<td>31</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Poor mood that day</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Interruptions by others</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Physical discomfort</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Heavy workload</td>
<td>Poor patient condition</td>
<td>14</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Hospital policy reduced working staff</td>
<td>11</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Head nurse scheduled fewer staff</td>
<td>9</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Other nurses left the job</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Extra load as preceptor for new nurse</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Unfamiliarity with medication</td>
<td>New drug name</td>
<td>6</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>New drug mechanism</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Similar drug names</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Seldom used drug</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Unclear labelling</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td></td>
<td>New side-effects</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Newly ordered drug</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Similar drug packages</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>New staff</td>
<td>New graduate</td>
<td>23</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Change in ward</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Complicated order</td>
<td>Senile patient</td>
<td>7</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Chronic patient</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Critical patient</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Paediatric patient</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Postoperative patient</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Complicated doctor-initiated order</td>
<td>Unclear expression</td>
<td>10</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Illegible writing</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td></td>
<td>New physician</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Unfamiliarity with patient’s condition</td>
<td>New patient</td>
<td>9</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Recent patient change</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Return after long vacation</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>Insufficient training</td>
<td>Insufficient ward training</td>
<td>6</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>No advance warning</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Insufficient hospital training</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>243</td>
<td>24</td>
</tr>
</tbody>
</table>

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**Figure 2** The percentage of types of medication errors (N = 72).
like others, indicates that older patients over 60 years of age commonly experience errors in medication (Phillips et al. 2001), usually because of complicated prescriptions and the number of contraindicated drugs (Willcox et al. 1994). In the medical wards, a combination of older patients with complicated prescriptions may result in higher error rates.

### Contributing factors

Our results indicated that a majority of nurses believed that multiple factors were involved in each medication error. The three main factors that they believed to be involved were personal neglect, heavy workload and new staff. This result is consistent with those of Beyea et al. (2003) and USP (2000) data on the investigation of 158 medication errors and 6188 accident reports. Both studies indicated that nearly 50% of errors are due to a lack of concentration and the presence of distractions and that about 30% are due to increased workloads and inexperienced staff.

We found that the ‘need to solve other problems while administering drugs’ was the main condition cited under ‘personal neglect’. However, nurses are seldom undisturbed while administering medication. The normal procedure for checking the five rights is easily neglected when interruptions occur. Pharmacists’ reports have shown that their mistakes also are due mainly to telephone call interruptions (62%), an unusually busy day (59%), too many customers (53%), lack of concentration (41%) and staff shortage (32%) (Knox 1999).

Interestingly, ‘advanced drug preparation without rechecking’ was another major condition involved in medication errors, which has seldom been reported. Upon interviewing hospital nurses, we found that it is common, although against hospital policy, for a ‘task-oriented’ nurse to work on the busy wards. Some nurses on the day shift even confided that they prepare medications for evening shift nurses out of friendship during understaffing situations. Although nurses are encouraged to use standard protocols in administering drugs and to avoid interruptions (Ashton & Iyer 2003), the reality of time pressures and excessive workloads causes them to modify protocols, resulting in error-prone situations. Our results also indicated that an increased workload is the second major factor contributing to medication errors, mostly because of patients’ dependency and understaffing (Table 2).

### Hospitals change policies and procedures to manage economic situations; having fewer staff members may improve economics in the short term but result in poorer quality of patient care (Arndt 1994). As far as the system model is concerned, Reason (2000) indicated that understaffing created error traps in the workplace, as physicians and the public believe understaffing is the primary cause of errors (Blendon et al. 2002). By answering a postal questionnaire, 186 chemotherapy nurses assessed trends in the workplace. Forty-nine per cent of them observed a trend in reducing the number of RNs provided in direct patient care. Eighty-one per cent noted increases in the number of patients cared for by RNs. Ninety-four per cent observed increased patient acuity (Schulmeister 1999). Understaffing leads to hurried working environments, reducing attention to work details, diminishing quality of care and promoting error (Worthington 2001, Beyea et al. 2003). This study indicated that 23 (31.9%) of the nurses considered their error to be related to their being newly
graduated. New graduates have limited work experience and may not recognize high-risk situations or medications such as potassium chloride (KCl) and chemotherapy agents (Benner et al. 2002). The chemotherapy nurses also reported that a lack of experience was a main reason for their medication error (Schulmeister 1999).

Unfamiliarity with the medications was another major factor contributing to errors in the present and previous studies (Phillips et al. 2001). In a systematic analysis of a prospective cohort study of 264 preventable ADEs, failure to disseminate drug knowledge was the leading problem (Leape et al. 1991). Another study of 696 prescribing errors also showed that the most common errors (30%) were those related to drug knowledge (Lesar et al. 1997). The present study also found that drug name and mechanism unfamiliarity were involved in a number of errors. However, nursing school curricula and hospital continuing education still lack sufficient teaching of pharmacology (Kraus et al. 1991, Jordan et al. 1999, Naylor 2002, Grandell-Niemi et al. 2003).

Prescriptions complicated because of patient old age, chronic or critical conditions, or complex orders, may result in misinterpretation (Benner et al. 2002). Inadequate collaboration and communication between nurses and physicians is a possible reason for such mistakes (Thomas et al. 2003). Our study demonstrated that Chinese nurses find it especially difficult to understand complicated English prescriptions and are hesitant about requesting clarification from physicians because of respect for the traditional health system hierarchy. Instead of asking the prescribing doctor for clarification of a confusing prescription, nurses often guessed or asked other nurses for help, which created an error-prone situation.

Types of errors
This study found that choosing the wrong dose or wrong drug were the two leading error types, a finding that has been reported previously (Bates et al. 1995, Leape et al. 1995, Lesar et al. 1997, Phillips et al. 2001). Administration of the wrong dose accounted for 39% of the 140 errors reported by chemotherapy nurses (Schulmeister 1999). After 54 months of data collection on cardiology wards in a university hospital, the results showed that more than 70% of 4768 medication errors were due to the wrong drug (36.0%) and wrong dose (35.3%) (LaPointe & Jollis 2003). Paediatric wards, especially, were involved in 10-fold dosing errors (Folli et al. 1987, Koren & Haslam 1994, Kaushal et al. 2001) because of misplaced decimal points and poor calculation skills on the part of nurses (Bindler & Bayne 1991, Ashby 1997). We and others found that antibiotics are the leading type of drug involved in medication errors. Antbiotics are widely used in hospitals, with variations in their fixed intervals (q6h, q8h, q12h, etc.) of administration. It is easy for nurses to omit a scheduled dosing or to confuse one drug with another with a similar name. The Agency for Healthcare Research and Quality has identified antibiotics as the most high-risk category of drug and the most likely type to be involved in a medication error (Lesar et al. 1997, Benjamin 2003).

Our study, like others before it, suggests that errors do not result from one single human factor. Errors in the system have been identified as responsible for medication errors (Leape et al. 1998, Anderson & Webster 2001) and Phillips et al. (2001) reported seven system failures responsible for 78% of 264 preventable ADEs. However, our results indicate that most nurses (86.1%) consider ‘personal neglect’ to have contributed to their errors, while only 15.3% believe that ‘insufficient training’ was responsible. Traditionally, nurses blame themselves for making an error when hospital systems should take the responsibility for failing to establish a safe working environment (Beyea et al. 2003). For example, in this study, under the category of ‘personal neglect’, the leading two conditions of ‘solve other problems while administering’ and ‘advanced drug preparation’ should be viewed as system failures – failure to arrange enough nursing staff and failure to establish a clear protocol – but nurses tend not to hold the system responsible for medication errors. This result further demonstrates nurses’ subjective feelings of personal error rather than system failure in recognizing medication errors.

We developed eight categories and 34 conditions, on the basis of nurses’ experiences, which reflected the reality of nurses’ situations. Interviews with a subset of participants concerning the design and content of the questionnaire revealed that most found it easy to find appropriate ‘answers’ in the questionnaire. They also said that it was easy to recall past medication errors because the experiences left painful and persistent memories.

Conclusion
The rapid progress in medical science and technology is creating an ever more complicated environment for nursing practice, which views patient safety as the first and foremost principle. Accurate administration of medication is a critical task, but administration of the wrong medication or the wrong dose is a ubiquitous nursing problem. Our results demonstrate that medication administration errors result from interrelated factors concerning the system (heavy workload and insufficient training), patients (complicated conditions), doctors (complex orders) and nurses (personal neglect, new staff, unfamiliarity with medication,
unfamiliarity with patient). All of these issues need to be addressed if improvements are to be made (Wilson et al. 1998, Greengold et al. 2003, Preston 2004).

Implications for nursing practice

The contributing factors developed in this study can be used in the hospital in an easy way to document incidents of medication errors. The main factors identified in this study suggest that error-prone conditions can be minimized by extending the training period for new staff and increasing nursing manpower, two crucial ways to reduce errors in medication administration. In addition, making the culture of hospital systems less punitive in nature and helping nurses to blame themselves less for feelings of ‘personal neglect’ could create a more constructive attitude towards medication errors. Only in an atmosphere free of reprisal for nurses will medication errors be reported freely and the learning opportunities that they present be properly utilized.

Limitations

This is the first trial using the snowball sampling method to gain nurses’ willingness to disclose administration errors. Although most of the results are consistent with previous reports, more studies are still needed to validate the methods and the results. In the current study, the relatively small sample size and distinctive sampling procedure may have caused a sampling bias.

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Contributions

Study design: F-IT, S-JS, data analysis: C-HC, I-LW; manuscript preparation: F-IT, SY.

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