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Review

Factors contributing to medication errors: a literature review

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Summary

• Drug administration is an integral part of the nurse's role. Responsibility for correct administration of medication rests with the nurse, yet medication errors are a persistent problem associated with nursing practice.

• This review examines what constitutes a medication error and documents contributory factors in medication errors. These factors have been derived from reported medication errors and opinions of nurses as to factors which predispose to errors.

• A number of definitions exist as to what constitutes a medication error. The definition used should facilitate interpretation and comparison of a wide range of research reports.

• Medication errors are a multidisciplinary problem and a multidisciplinary approach is required in order to reduce the incidence of errors.

Keywords: contributory factors, definition, medication errors.

Introduction

Drug administration forms a major part of the clinical nurse's role. Medication administration by the nurse is only one part of a process that also involves doctors and pharmacists (Betz & Levy, 1985). Medicines are prescribed by the doctor and dispensed by the pharmacist, but responsibility for correct administration rests with the nurse. Each Registered Nurse is accountable for his or her practice. This practice includes preparing, checking and administering medications, updating knowledge of medications, monitoring the effectiveness of treatment, reporting adverse reactions and teaching patients about their drugs. The patient expects to receive the correct medication at each drug round, but several studies suggest that this does not always occur (Fuqua & Stevens, 1988; Raju *et al*., 1989; Keill & Johnson, 1993; Ferner, 1995). Medication errors do occur and are a persistent problem associated with nursing practice.

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REVIEW PROCESS

Using the keywords 'medication', 'errors' and 'nursing', computerized and hand-searches of MEDLINE and CINAHL were conducted. These produced 189 references dating back to 1982. Of these, 71 titles were dropped because they consisted of letters, opinions and anecdotal case studies. A further 21 articles were dropped on grounds of dealing with errors related to specific drugs. Bibliographies of all retrieved articles were examined for additional studies. In total approximately 97 articles were read. The review was conducted over a 7-month period.

Interestingly, the search of MEDLINE yielded more references relating to medication errors than CINAHL (70% vs. 30%). This may reflect the multidisciplinary nature of medication errors. The majority of articles reviewed are American or Canadian in origin. Literature from the UK and Australia was also reviewed. Only four research studies specifically dealing with medication errors were located from the UK. However, contributory factors identified in these studies were similar to those of American origin.

The material reviewed fell into two categories: definition and contributing factors. The review is arranged under these headings.

Definition

The definition and categories of medication errors vary throughout the literature. The American Society of Hospital Pharmacists (ASHP, 1982; p. 321) have defined a medication error as 'a dose of medication that deviates from the physician's order as written in the patient's chart or from standard hospital policy and procedures'. They qualify this by pointing out that, except for errors of omission, the medication dose must actually reach the patient. If the incorrect dose is discovered and corrected before administration to the patient, no error occurs. Their definition also excludes errors of prescribing. From the definition, the ASHP have identified nine categories of medication error, namely:

1 Omission error;
2 Unauthorized drug error;
3 Wrong dose error;
4 Wrong route error;
5 Wrong rate error;
6 Wrong dosage form error;
7 Wrong time error;
8 Wrong preparation of a dose;
9 Incorrect administration technique.

The ASHP definition has been modified by researchers (Girotti *et al*., 1987; Scholz, 1990). Girotti *et al.* (1987) conducted a study of medication errors in an adult intensive care unit in order to identify the types and frequency of medication errors which occurred within the unit. They used the definition and categories proposed by the ASHP; however, they identified wrong time errors as the administration of medicines 30 min before or after the prescribed time and included another category, error in infusion rates. Scholz (1990) conducted an examination of medication error rates in a hospital in Iowa, USA, in order to establish a baseline error rate against which all future error rates could be measured. As part of the study she adapted the ASHP definition to include a tenth category, failure to follow specific unit protocols.

Wolf (1989; p. 8) offers another commonly-used definition and categorization by defining medication errors as 'mistakes associated with drugs and IV solutions that are made during the prescription, transcription, dispensing, and administration phases of drug preparation and distribution'. Wolf further classifies medication errors as being of two types: errors of commission and errors of omission, each of which can be subdivided into intentional and unintentional errors. Each category of error involves failing to give the medication as prescribed by the doctor. Wolf's categorization incorporates the nine categories outlined by the ASHP.

A variety of definitions as to what constitutes a medication error have been identified from the literature. The definition selected for use should facilitate interpretation and comparison of a wide range of research reports.

Contributing factors

MATHEMATICAL SKILLS OF NURSES

Mathematical proficiency is a prerequisite to the performance of many nursing functions such as medication calculation, intravenous regulation, and intake and output calculation (Bindler & Bayne, 1984). A number of nursing studies have identified that medication errors resulting from the poor mathematical skills of nurses remain an ongoing problem (Bayne & Bindler, 1988; Chenger *et al*., 1988; Worrell & Hodson, 1989).

A descriptive study by Bindler & Bayne (1984) indicated that a substantial number of student nurses did not possess the basic mathematical skills necessary to function as Registered Nurses. In that study, the mathematical skills of 741 student nurses were examined. Bindler & Bayne found that each year between 9% and 38% of students in the sample were unable to pass the six parts of a mathematical proficiency examination at 70% or more. In 1991, Bindler & Bayne conducted another descriptive study of 110 Registered Nurses and found that 81% of those surveyed were unable to calculate medication doses at a 90% pass level on a 20-item medication calculation test. The authors concluded that calculation difficulties continue to exist and have not improved. These studies state or imply that students do not make correct dosage calculations because of lack of mathematical skill. However, two other sources of error have been identified. Blais & Bath (1992) tested the drug calculation skills of 66 nursing students using a 20-item test. They identified three areas of medication calculation deficiencies among

nurses, including mathematical, conceptual and measurement inabilities. Blais & Bath (1992) proposed that the most frequent type of mistake was conceptual errors (difficulty in setting up the problem), followed by mathematical errors and measurement errors. Segatore *et al.* (1993) conducted a study to examine the incidence and nature of medication errors, including conceptual errors and arithmetic errors (incorrect addition, subtraction, multiplication, division and use of decimals and fractions). The results of the study identified that 91% of the errors consisted of conceptual errors.

It is apparent from these studies that drug calculation is a risk factor and a potential source of error. Although much has been written on the severity of this problem, there is little research in the nursing literature specifically examining methods of dealing with poor medication calculation skills of nurses. Blais & Bath (1992) and Segatore *et al.* (1993) have suggested that more attention be focused on the problem-solving approach, incorporating attention to conceptual problems.

Preventative measures to decrease the incidence of errors have been implemented in many healthcare settings. One such measure has been to test nurses' knowledge of medications during orientation periods and at in-service updates. A number of researchers have addressed the relationship between performance on a mathematics test and medication errors (e.g. Conti & Beare, 1988; Calliari, 1995). Calliari (1995) conducted a descriptive study to investigate the relationship between pass/fail scores on a medication test given to Registered Nurses and medication errors made on nursing units. Medication errors made during a 3-year period were reviewed to determine the number of errors made and which nurses made the errors. Scores from the medication test given in orientation were checked to see whether nurses who made errors had passed or failed the test initially. Administration of medications was not permitted until a score of 83% was achieved on the test. The results showed that nurses who failed the medication test initially were more likely to make errors than nurses who had passed the test. Two-thirds of individuals who failed the test made at least one error, while only half of those who passed had made an error. In contrast, Conti & Beare (1988) assessed the relationship between performance on a drug calculation test by nurses and subsequent reported errors. They concluded that tests cannot be used as a reliable tool to screen for those individuals most likely to make a medication error. This is supported by Ludwig-Beymer *et al.* (1990) who found, in an exploratory study, that the absence of a medication test did not significantly change the overall reported medication error rate.

While mathematics tests will undoubtedly continue to be used, their effectiveness can be questioned. Such a test, depending on the skill of its developer, may measure knowledge at a lower level than that needed for actual practice (Demetrulias & McCubbin, 1982). In addition, the test can establish only the theoretical knowledge of the nurse, and not his or her actual performance in practice (Ludwig-Beymer *et al.*, 1990).

NURSES' KNOWLEDGE OF MEDICATIONS

Nurses are accountable for the drugs they administer and therefore require a knowledge of the action, side-effects and correct dosage of any drug they administer. With an increasing number of drugs available for administration in hospitals and in the community, nurses' responsibility for updating their knowledge of drugs has increased greatly (Westien, 1994; Lilley & Guanci, 1995).

Much of the research in relation to knowledge of medications has tended to focus on specific aspects of drug knowledge (Weiner & Schumacher, 1976; Perlstein *et al.*, 1979; Boggs *et al.*, 1988). Weiner & Schumacher (1976) looked at the knowledge of eight groups of healthcare workers in relation to psychotropic drug therapy. The results indicated that pharmacists were competent in this area, but many doctors and nurses had an inadequate knowledge of this drug group. This study was restricted to knowledge of one particular drug group. Markowitz *et al.* (1981) conducted a quantitative study to assess the knowledge of nurses, doctors and pharmacists in relation to drug actions, dosage, interactions, contra-indications and administration. This study encompassed a broader knowledge base than previous studies. Random samples of 100 nurses, 102 doctors and 14 pharmacists at one hospital took part in the study. The instrument included personal questions about the practitioners' positions and backgrounds and a 25-item examination of the hazards of medications. The response rate was 98%. Pharmacists scored the highest, followed by doctors, with nurses attaining the lowest scores. Analysis of the nurses' scores on the basis of educational background, years of experience and shift worked, was carried out. This indicated that nurses working on the day shift had a greater knowledge of medication than nurses who worked on evening or night shifts. Length of nursing experience was not a factor in drug knowledge. There was also no significant difference in nurses' scores on the basis of educational background. This supports the work of Bayne & Bindler (1988) in relation to medication calculation skills of Registered Nurses, when they found no significant difference between the incidence of medication errors

and years of experience or educational background of the participants.

In contrast, Boggs *et al.* (1988) tested nurses' knowledge of three commonly-administered drugs and sought to determine if a relationship existed between level of knowledge and educational background or experience. Following a 36-item test the investigators concluded that respondents overall had an inadequate level of knowledge. They also found an identifiable difference between staff members with different educational qualifications. Nurse managers and educators had a better knowledge of medications than those nurses who were responsible for administering them. This study raises questions regarding the educational attainment of nurses who administer medications and whether their level of knowledge allows them to be accountable for their practice. The investigators recommend examination of drug knowledge on starting employment and at regular in-service updates, for nurses who administer medications.

Lack of knowledge appears to be a persistent problem. Leape *et al.* (1995) carried out a qualitative study to identify the systems failures that underlie medication errors. Nurses, doctors and pharmacists involved in medication errors were interviewed. Results indicated that the most common systems failure was lack of drug knowledge, accounting for 29% of the 334 errors that occurred in a 6-month period. Specifically, in the administration of medications by nurses, lack of knowledge accounted for 15% of the problems.

Studies have focused on strategies to prevent medication errors, including increasing knowledge of medications. Both Fink (1983) and Rainbow (1984) agree that nurses who continually update their knowledge of drugs make fewer medication errors than those who do not. Using reference materials and communicating with colleagues were identified as useful means of updating knowledge. Nurses taking part in a study conducted by Conklin *et al.* (1990) endorsed the need for regular medication updates and easier access to drug information. Ludwig-Beymer *et al.* (1990) point out that it is unreasonable to expect nurses to know every drug used in practice, but rather emphasis should be placed on in-service education and lifelong learning.

LENGTH OF NURSING EXPERIENCE

Several of the studies previously mentioned have questioned the effect of length of nursing experience on medication errors. Ridge & While (1995) conducted a work sampling study to determine the medication-related workload of neonatal staff. In the course of 48 observation periods of 2 h each, 1920 observations were made; these indicated that approximately one-tenth of neonatal staff time was spent on medication-related activities. More importantly the study indicated that nurse seniority was associated with more medication-related activities, such as the preparation, checking and administration of medicines. This raises a question as to whether the errors are being made by experienced staff as opposed to more recent qualifiers.

Studies have shown that years of nursing experience have no bearing on nurses' calculation performance (Perlstein *et al.*, 1979; Bayne & Bindler, 1988; Bindler & Bayne, 1991). Perlstein *et al.* (1979) examined the ability of nurses, doctors and pharmacists to compute drug doses correctly for newborn babies. Doctors and pharmacists demonstrated greater accuracy in this task. One of every 12 doses calculated by Registered Nurses contained an error that would result in the administration of an amount that was 10 times greater or lower than that prescribed. Experience did not mitigate the rate of error. Also experienced nurses tended to be more certain, although wrong, in their judgement. A 1992 study by Walters described the influence of nurses' age, years of experience and years of employment at a hospital on the occurrence and reporting of medication errors. A questionnaire on medication errors was administered to 334 nurses attending an in-service education programme on medication administration and 284 nurses responded. Registered Nurses over the age of 35 years reported making fewer errors than those under 35 years: however, the difference was not statistically significant. Fewer medication errors were reported by respondents who had been in nursing over 1 year or by nurses employed in the hospital for more than 1 year. The author concluded that nurses new to the hospital were more likely to make errors, possibly due to the new environment, but also they were more likely to report errors than nurses employed for longer periods. Importantly length of time employed at a hospital is not related to one's years of experience. The research in relation to experience and medication errors appears therefore to be inconclusive.

LENGTH OF NURSING SHIFTS

A number of studies point to a variety of working conditions, including the type of shift worked, which contribute to medication errors (Markowitz *et al.*, 1981; Girotti *et al.*, 1987; Pearlson, 1988; Raju *et al.*, 1989; Gold *et al.*, 1992). Markowitz *et al.* (1981) found that nurses on the day shift had a better knowledge of drugs than those on evening and night-time shifts. Despite this, Raju *et al.*

(1989) in a UK study found that more medication errors occurred during the day shift than during the other two shifts. The researchers suggest that this may be due to the large number of prescriptions which are written, altered and administered during the day shift. Examination of error type shows that 38.6% of daytime errors were due to wrong drug, dose, or preparation technique, whereas these accounted for only 17% of evening and night-time errors. Errors on evening and night-time shifts consisted of wrong time, rate and administration technique. It may be that the types of error which occurred on evening and night-time shifts were not considered serious enough to report (Allen & Barker, 1990). Alternatively, detection of errors may have gone unnoticed on the less intensely staffed evening and night-time shifts. Girotti *et al.* (1987) carried out a prospective covert observation study to monitor the types and frequency of drug errors in an adult intensive care unit. Among the aims of the study was the desire to elicit staffing situations that contributed to medication errors. Medications given to all patients over a 1-year period were analyzed from the doctor's prescription, medication administration records and the patient's chart. Observation of drug rounds also took place to identify types of errors. All nurses in the hospital worked 12- or 8-h shifts. The results indicated that the number of opportunities for error (drugs administered: prescribed and unauthorized) were similar on day and night duty. Yet significantly more errors occurred on the day shift (64 out of a possible 2257 opportunities for error) than on the night shift (38 out of a possible 2324 opportunities for error). The researchers also found that there was an association between the number of admissions, deaths and discharges during the shift and the number of errors which occurred. While the study did confirm the existence of a difference in the incidence of medication errors on day and night shift, caution must be taken when interpreting the results due to the small number of errors detected. Further research is required to elicit variations in day and night-time workloads in order to identify factors which predispose to error. Also use of observation by the researchers could have led to observer bias in sampling, recording and interpreting phenomena (Polit & Hungler, 1987), and ethical issues such as intervening in errors which are about to occur (Allen & Barker, 1990).

In contrast Jones & Brown (1986) found no significant relationship between the 12-h shift as compared to shorter shifts and nurses' medication errors. A cross-sectional study by Gold *et al.* (1992) found that accidents including medication errors were related to rotating shift work, with the underlying problem thought to be disruption of sleep patterns. Nurses who worked a variety of shifts were twice as likely to make errors. These studies give rise to questions about the workload of nurses on various shifts and its relationship to medication errors. However, these studies must be viewed in conjunction with staffing levels and workloads on the various shifts.

WORKLOAD AND STAFFING LEVELS

Workload factors have been shown to affect the rate of medication errors (Conklin *et al.*, 1990; Taunton *et al.*, 1994; Leape *et al.*, 1995; Roseman & Booker, 1995). Conklin *et al.* (1990) conducted an exploratory study to ascertain the opinions and recommendations of nurses in relation to factors in the work situation which contributed to medication errors. A questionnaire containing open and closed questions was distributed to 175 nurses working in acute care settings. The findings were grouped into categories of contributory factors. Of the respondents, 32 cited contextual factors, including staffing problems, large patient workload, distractions whilst preparing medications and relief staff as being responsible for medication errors. The authors recommend that adequate staffing levels are necessary, along with a reduced workload, in decreasing medication errors. Leape *et al.* (1995) carried out an investigation of systems failures which contribute to adverse drug events. Errors were classified according to the cause and its underlying relationship to a systems failure. The writers identified deficiencies in the area of staffing and workload, including inadequate skill mix, as problems contributing to adverse drug events. It is important to note, however, that the authors of this study investigated adverse drug events, including side-effects and not just medication errors, which can influence how the results should be viewed. Roseman & Booker (1995) examined the effect of nine workload factors and seasonal changes on medication errors. Staffing levels, patient volumes and medication error data were collected at a 140-bed acute hospital over a 5-year period. Three workload factors were found to be significant in relation to medication errors. Errors increased with the number of patient days per month and the number of shifts worked by temporary staff. Errors decreased with the amount of overtime worked by permanent nursing staff. The authors suggest that the positive effect of overtime on medication errors may be due to the degree with which experienced staff worked overtime rather than employing agency staff. This is an important factor to be borne in mind by nurse managers. These studies indicate that workload and staffing levels do influence medication errors.

In contrast, Taunton *et al.* (1994) explored the possible relationships between patient outcomes (including

medication errors) and staff absenteeism, being sent on relief and workload. Data relating to these variables were collected from four hospitals over a 6-month period. The study found no relationship between medication errors and absenteeism, relief duty or workload.

Some research appears to indicate that workload and staffing levels can contribute to medication errors. All hospitals and nursing departments have staff shortages at some point in time. Shortages of nursing personnel increase the number of medication administrations per nurse and thus may increase the possibility of error (Fuqua & Stevens, 1988). The number of drug rounds a nurse has to perform relates to the system of nursing and the medication distribution system in place in a hospital.

NURSING CARE AND MEDICATION DELIVERY SYSTEMS

Nursing care delivery and medication distribution systems vary from hospital to hospital. No one system is problem free. Kahn (1995) is of the opinion that identifying systems failures or inadequacies is likely to encourage professionals to generate remedies rather than blame persons.

Poster & Pelletier (1988) conducted a study to evaluate and describe the effects of two medication administration systems on the frequency, type and reason for medication errors. A retrospective review of medication errors over a 12-month period was conducted. Two systems were compared: a functional medication administration system (i.e. a medication nurse is designated on each shift to administer all medications) and a primary medication administration system (i.e. each nurse administers medications for his or her assigned patients on a given shift). A total of 260 errors were reported over the 12-month period, out of a total of 258 549 doses of medication administered, resulting in an error rate of 0.1%. A comparison of the rates between the units using both systems, showed a significant difference between the two systems. The error rate was higher in the units utilizing the functional system. This could have implications for the single-nurse drug administration system.

SINGLE-NURSE DRUG ADMINISTRATION

Several writers advocate that single-nurse drug administration does not increase the number of errors (Winson, 1991; Jeanes & Taylor, 1992). Jeanes & Taylor (1992) describe a UK study of single-nurse drug administration over a 6-month period. A total of 18 nurses volunteered to take part in the scheme. These nurses underwent a series of lectures in pharmacology and a test of knowledge. Following this, seven nurses were deemed to have reached the required standard (test score above 90%) and were invited to begin administering drugs alone. Over the 6-month period no errors were reported and staff were of the opinion that single-nurse administration of drugs resulted in fewer errors. Kruse *et al*. (1992), in an Australian study, compared the implications and costs involved in two-nurse administration of drugs to that of single-nurse administration. They found that two-nurse administration had fewer mistakes, but the cost involved due to additional manpower did not justify the small difference found. Further research needs to be carried out in this area.

Consideration needs to be given by nursing staff and managers to the selection of appropriate nursing care and medication delivery systems. In addition, collaboration with other members of the healthcare team may elicit more appropriate medication delivery systems. Whatever system is in place should be stated clearly in hospital policy (Fuqua & Stevens, 1988).

POLICY AND PROCEDURES

Although medication administration policies exist, it would appear from the literature that adherence to these policies is poor (Long & Johnson, 1981; Conklin *et al*., 1990). This failure to follow policies is a potential source of medication error.

Long & Johnson (1981), in a study of medication error incidence, found that 72% of the errors were attributable to staff failure to follow policies. Conklin *et al*. (1990), in their study identifying factors which contribute to medication errors, found that the largest group of factors included failure to follow policy and procedure for safe drug administration. This failure of hospital staff to adhere to hospital policy is disturbing. It indicates that staff are endangering patients' welfare and raises doubts as to accountability to the patient and employer. Fuqua & Stevens (1988) contend that written medication policies and procedures are essential for the safe administration of medications. Pyne (1981) argues that policies and procedures should only serve as guides for the qualified nurse. He points out that many of the medication errors which are brought before the United Kingdom Central Council for Nursing, Midwifery & Health Visiting (UKCC) result from the lack of a clear medication administration policy. Pyne (1981) further contends that, as accountable practitioners, nurses should be free to deviate from a written policy if they can give a reasonable professional judgement for such an action.

Most nurses are familiar with the 'golden rules' for medication administration (Carr, 1989; McGovern, 1992;

Cohen & Cohen, 1996). Baker & Napthine (1994), in an Australian article, suggest that rules can lead to ritualistic behaviour which can result in an error. Poster & Pellitier (1988) carried out a retrospective review of medication errors over a 12-month period at a hospital dealing with neuropsychiatric disorders in children and adolescents. The authors analyzed the types and reasons for the occurrence of errors. They found that failure to follow hospital procedures contributed to a high proportion of the errors, although they failed to give an exact figure. They suggest that becoming lax in the proper procedures may result from having to administer medications less frequently in child/adolescent units or distractions at the time of medication administration. It is not possible to generalize these findings to other situations due to the specialized nature of the hospital.

Wolf (1989) argues that while the rules, routines and policies connected with medication administration provide the nurse with a sense of responsibility for the safe administration of drugs, they also provide the nurse with a sense of security. Nurses rely on rituals, policies and procedures to prevent them making errors (Keill & Johnson, 1993). A UK study by Cooper (1995) suggests the lack of adherence to policies may be due to the lack of a practical policy and recommends the development of a policy suitable to all staff involved in medication-related activities.

DISTRACTIONS AND INTERRUPTIONS

Several authors have cited distractions as a factor in the occurrence of medication errors (Scholz, 1990; Walters, 1992; Williams, 1996). Nurses administer medications in a sometimes chaotic environment, with many demands on their time. Davis (1994) suggests that being able to concentrate while preparing and administering medications will greatly assist in preventing errors.

Scholz (1990) conducted a quality assurance study in an attempt to identify the rate of medication errors in a unit. Errors were classified according to type and cause. Scholz attempted to elicit whether interruptions had any significance in the incidence of errors. She found that in general there was no link between task interruption and medication errors. This finding conflicts with the work of Conklin *et al.* (1990).

Conklin *et al.* (1990) conducted an exploratory study of factors perceived by nurses to contribute to errors. A questionnaire containing both open and closed questions was distributed randomly to 175 nurses. Of the respondents, 10% were randomly selected for analysis. Factors that nurse respondents felt contributed to errors were identified, and 32% of nurses considered that frequent interruptions or distractions contributed to medication errors. This concurs with the work of Walters (1992) and Williams (1996).

Although little research was located on the extent of the relationship between interruptions and medication errors, several authors have recommended that distractions be kept to a minimum or that nurses who administer medications have a quiet area in which to prepare drugs (Davis, 1994; Segatore *et al.*, 1994; Williams, 1996).

QUALITY OF PRESCRIPTIONS

Another factor identified in the literature as contributing to medication errors is the quality of written prescriptions by doctors. Prescriptions are the legal responsibility of the doctor. Nurses frequently come across poorly written and even illegible prescriptions, which conflict with policies for the safe administration of medications. Howell (1996) argues that the doctor's failure to follow policies puts the nurse responsible for administering medications at risk. If a nurse administers a medication from a poorly written prescription or one which does not comply with the legal requirements, the nurse must be prepared to be accountable for administering that medication.

Howell (1996) conducted an audit of prescription sheets in the medical unit of an acute hospital. Only half of the prescriptions recorded all the required details for correct identification of the patient, such as name, date of birth and hospital number. Of the 370 prescription sheets reviewed, 12% had no record of patient allergies, which nurses must ascertain prior to the administration of medicines. In 15% of cases the drug dosage was not clear. Although it was only a small survey, Howell concluded that nurses were frequently administering medications in an unsafe manner due to the poor standard of written prescriptions. While Howell's work points out problems with written prescriptions, no actual research linking the quality of prescriptions to medication errors was located. Despite this, a UK study by Gladstone (1995) cites nurses as identifying handwriting as a contributory factor to medication errors. This is supported by other authors (Fuqua & Stevens, 1988; Conklin *et al.*, 1990). Given the multidisciplinary nature of medication errors, attempts to reduce the problem should be approached on a multidisciplinary basis (Williams, 1996). Also if nurses are not satisfied with the written prescription they have a duty to consult the doctor in order to ensure patient safety and be accountable practitioners.

Conclusion

The literature reviewed acknowledged that medication errors are a persistent problem associated with nursing

practice. Accepted definitions of medication errors are reported. The factors identified are due to personnel, systems and managerial problems. Mathematical ability of nurses was highlighted and reference made to the suitability of calculation tests. Assessment of workload, nursing care delivery systems and staffing levels on different shifts are factors to be borne in mind by nurse managers. The need for nurse educators to provide in-service education relating to medications is highlighted. The multidisciplinary nature of medication errors is acknowledged and recognition given to the need for a multidisciplinary approach, which may counteract problems of non-adherence to policies and poorly written prescriptions. Interventions to reduce some of these have been applied in practice. However, the problems appear to continue, suggesting that the interventions have not had a lasting effect. There is a need for action in this area.

References

Allen E.L. & Barker K.N. (1990) Fundamentals of medication error research. *American Journal of Hospital Pharmacy* **47**(3), 555–571.

American Society of Hospital Pharmacists (ASHP): Council on Clinical Affairs (1982) ASHP standard definition of a medication error. *American Journal of Hospital Pharmacy* **3**(2), 321.

Baker H. & Napthine R. (1994) Nurses and medication part 6: ritual and workloads = medication errors. *Australian Journal of Nursing* **2**(5), 34–36.

Bayne T. & Bindler R. (1988) Medication calculation skills of registered nurses. *Journal of Continuing Education in Nursing* **19**(6), 258–262.

Betz R. & Levy B. (1985) An interdisciplinary method of classifying and monitoring medication errors. *American Journal of Hospital Pharmacy* **42**(8), 1724–1732.

Bindler R. & Bayne T. (1984) Do baccalaureate students possess basic mathematics proficiency? *Journal of Nursing Education* **23**(5), 192–197.

Bindler R. & Bayne T. (1991) Medication calculation ability of registered nurses. *Image: Journal of Nursing Scholarship* **23**(4), 221–224.

Blais K. & Bath J.B. (1992) Drug calculation errors of baccalaureate nursing students. *Nurse Educator* **17**(1), 12–15.

Boggs P., Brown-Molnar C.S. & DeLapp T.D. (1988) Nurses' drug knowledge. *Western Journal of Nursing Research* **10**(1), 84–93.

Calliari D. (1995) The relationship between a calculation test given in nursing orientation and medication errors. *Journal of Continuing Education in Nursing* **26**(1), 11–14.

Carr D.S. (1989) New strategies for avoiding medication errors. *Nursing 89* **29**(8), 39–46.

Chenger P., Conklin D., Hirst S., Reimer H. & Watson L. (1988) Nursing students in Alberta: their mathematical abilities. *AARN* **44**(1), 17–22.

Cohen M.R. & Cohen H.G. (1996) Medication errors: following a game plan. *Nursing 96,* **26**(11), 34–37.

Conklin D., MacFarland V., Kinnie-Steeves A. & Chenger P. (1990) Medication errors by nurses: contributing factors. *AARN Newsletter* **46**(1), 8–9.

Conti A. & Beare P.B. (1988) Performance on a mathematics/drug calculation test: relationship to subsequent reported medication errors. *Journal of Nursing Staff Development* **4**(2), 54–58.

Cooper M.C. (1995) Can a zero defects philosophy be applied to drug errors? *Journal of Advanced Nursing* **21**(3), 487–491.

Davis N.M. (1994) Concentrating on interruptions. *American Journal of Nursing* **94**(3), 14.

Demetrulias D. & McCubbin L.E. (1982) Constructing test questions for higher level thinking. *Nurse Educator* **7**(5), 13–17.

Ferner R.E. (1995) Is there a cure for drug errors? *British Medical Journal* **311**(7003), 463–464.

Fink J.L. (1983) Preventing lawsuits: medication errors to avoid. *Nursing Life* **3**(2), 26–29.

Fuqua R.A. & Stevens K.R. (1988) What we know about medication errors: a literature review. *Journal of Nursing Quality Assurance* **3**(1), 1–17.

Girotti M.J., Garrick C., Tierney M.G., Chesnick K. & Brown S.J.L. (1987) Medication administration errors in an adult intensive care unit. *Heart and Lung* **16**(4), 449–453.

Gladstone J. (1995) Drug administration errors: a study into the factors underlying the occurrence and reporting of drug errors in a district general hospital. *Journal of Advanced Nursing* **22**(4), 628–637.

Gold D.R., Rogacz S., Bock N. *et al.* (1992) Rotating shift work, sleep, and accidents related to sleepiness in hospital nurses. *American Journal of Public Health* **82**(7), 1011–1014.

Howell M. (1996) Prescription for disaster. *Nursing Times* **92**(34), 30–31.

Jeanes A. & Taylor D. (1992) Stopping the drugs trolley. *Nursing Times* **88**(2), 27–29.

Jones J.J. & Brown R.M. (1986) A survey of the 12-hour nursing shift in 25 North Carolina hospitals. *Nursing Management* **17**(5), 27–28.

Kahn K.L. (1995) Above all 'do no harm': how shall we avoid errors in medicine? *Journal of the American Medical Association* **274**(1), 75–76.

Keill P. & Johnson T. (1993) Shifting gears: improving delivery of medications. *Journal of Nursing Quality Assurance* **7**(2), 24–33.

Kruse H., Johnson A., O'Connell D. & Clarke T. (1992) Administering restricted medications in hospital: the implications and costs of using two nurses. *Australian Clinical Review* **12**(2), 77–83.

Leape L.L., Bates D.W., Cullen D.J. *et al.* (1995) Systems analysis of adverse drug events. *Journal of the American Medical Association* **274**(1), 35–43.

Lilley L.L. & Guanci R. (1995) Unfamiliar drug uses. *American Journal of Nursing* **95**(1), 15.

Long G. & Johnson C. (1981) A pilot study for reducing medication errors. *Quality Review Bulletin* **7**(4), 6–9.

Ludwig-Beymer P., Czurylo K.T., Gattuso M.C., Hennessey K.A. & Ryan C.J. (1990) The effect of testing on the reported incidence of medication errors in a medical center. *Journal of Continuing Education in Nursing* **21**(1), 11–17.

McGovern K. (1992) 10 golden rules for administering drugs safely. *Nursing 92,* **22**(3), 42–56.

Markowitz J.S., Pearson G., Kay B.G. & Loewenstein R. (1981) Nurses, physicians, and pharmacists: their knowledge of hazards of medications. *Nursing Research* **30**(6), 366–370.

Pearlson J.E. (1988) Development and implementation of systematic monitoring of medication errors. *Journal of Nursing Quality Assurance* **2**(2), 77–81.

Perlstein P., Callison C., White M., Barnes B. & Edwards N. (1979) Errors in drug computations during new-born intensive care. *American Journal of Diseases of Children* **133**(4), 376–379.

Polit D.F. & Hungler B.P. (1987) *Nursing Research: Principles and Methods*. J.B. Lippincott Company, Philadelphia.

Poster E.C. & Pelletier L. (1988) Primary versus functional medication administration: monitoring and evaluating medication error rates. *Journal of Nursing Quality Assurance* **2**(2), 68–76.

Pyne R. (1981) *Professional Discipline in Nursing*. Blackwell Scientific, London.

Rainbow J. (1984) Six legal safeguards vs drug errors. *Nursing Life* **4**(1), 56–58.

Raju T.N., Kecskes S., Thornton J.P., Perry M. & Feldman S. (1989) Medication errors in neonatal and paediatric intensive-care units. *Lancet* **2**(8659), 374–376.

Ridge H.E. & While A.E. (1995) Neonatal nursing staff time involved with medication-related activities. *Journal of Advanced Nursing* **22**(4), 623–627.

Roseman C. & Booker J.M. (1995) Workload and environmental factors in hospital medication errors. *Nursing Research* **44**(4), 226–230.

Scholz D.A. (1990) Establishing and monitoring an endemic medication error rate. *Journal of Nursing Quality Assurance* **4**(2), 71–85.

Segatore M., Edge D. & Miller M. (1993) Posology errors by sophomore nursing students. *Nursing Outlook* **41**(4), 160–165.

Segatore M., Miller M. & Webber K. (1994) Medication out of control. *The Canadian Nurse* **90**(8), 35–39.

Taunton R.L., Kleinbeck S.V.M., Stafford R., Woods C.Q. & Bott M.J. (1994) Patient outcomes are they linked to registered nurse absenteeism, separation, or work load? *Journal of Nursing Administration* **24**(4), 48–55.

Walters J.A. (1992) Nurses' perceptions of reportable medication errors and factors that contribute to their occurrence. *Applied Nursing Research* **5**(2), 86–88.

Weiner J. & Schumacher G.E. (1976) Psychotropic drug therapy knowledge of healthcare practitioners. *American Journal of Hospital Pharmacy* **33**(3), 237–241.

Westien M.J. (1994) Increased mentoring necessary to ensure safe medication delivery. *Nurse Educator* **19**(6), 10.

Williams A. (1996) How to avoid mistakes in medicine administration. *Nursing Times* **92**(13), 40–41.

Winson G. (1991) A Study of nurses' attitudes towards single administration of medicines. *Nursing Practice* **4**(3), 20–23.

Wolf Z.R. (1989) Medication errors and nursing responsibility. *Holistic Nursing Practice* **4**(1), 8–17.

Worrell P.J. & Hodson K.E. (1989) Posology: the battle against dosage calculation errors. *Nurse Educator* **14**(2), 27–31.