RESEARCH ARTICLE

Improving Safety-Related Knowledge, Attitude and Practices of Nurses Handling Cytotoxic Anticancer Drug: Pharmacists' Experience in a General Hospital, Malaysia

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Abstract

Background: An increasing trend of cytotoxic drug use, mainly in cancer treatment, has increased the occupational exposure among the nurses. This study aimed to assess the change of nurses' safety-related knowledge as well as attitude levels and subsequently to assess the change of cytotoxic drug handling practices in wards after a series of pharmacist-based interventions. Materials and Methods: This prospective interventional study with a before and after design requested a single group of 96 nurses in 15 wards actively providing chemotherapy to answer a self-administered questionnaire. A performance checklist was then used to determine the compliance of all these wards with the recommended safety measures. The first and second assessments took 2 months respectively with a 9-month intervention period. Pharmacist-based interventions included a series of technical, educational and administrative support measures consisting of the initiation of closed-system cytotoxic drug reconstitution (CDR) services, courses, training workshops and guideline updates. Results: The mean age of nurses was 32.2±6.19 years. Most of them were female (93.8%) and married (72.9%). The mean knowledge score of nurses was significantly increased from 45.5±10.52 to 73.4±8.88 out of 100 (p<0.001) at the end of the second assessment. Overall, the mean practice score among the wards was improved from 7.6±5.51 to 15.3±2.55 out of 20 (p<0.001). Conclusions: The pharmacist-based interventions improved the knowledge, attitude and safe practices of nurses in cytotoxic drug handling. Further assessment may help to confirm the sustainability of the improved practices.

Keywords: Cytotoxic drugs - oncology nurses - occupational exposure - pharmacist-based interventions - Malaysia

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Introduction

There is an increasing trend of occupational exposure to cytotoxic hazards among the healthcare workers as cancer patients are usually diagnosed at earlier stages and receiving multiple chemotherapy regimens for a longer period of time nowadays (Ben-Ami et al., 2001; Turk et al., 2004; Connor and McDiarmid, 2006; Verity et al., 2008; Kyprianou et al 2010; Elshamy et al., 2010; Khan et al., 2012). Cytotoxic drugs are therapeutic agents mainly used in chemotherapy for their actions on killing cancerous cells. However, their non-selective mechanism of action affects both cancerous and non-cancerous cells, resulting in well documented side effects (Ahmad, 2001; Connor and McDiarmid, 2006, Yuan et al., 2012).

Long-term occupational exposure to cytotoxic drugs is associated with various carcinogenic, teratogenic and mutagenic effects (Ahmad, 2001; Ben-Ami et al., 2001; Schreiber et al., 2002; Vollono et al., 2002; Zingler et al., 2002; Turk et al., 2004; Connor and McDiarmid, 2006; Elshamy et al., 2010; Kyprianou et al., 2010; Baraoui et al., 2011; Yuan et al., 2012). Among the possible reproductive side effects experienced by exposed nurses were infertility, abortion and abnormalities in fetus (Zingler et al., 2002; Dranitsaris et al., 2005; Connor and McDiarmid, 2006; Polovich and Clark, 2010; Lawson et al., 2012). Studies have also been reporting on the cancer risk among the nurses actively handling cytotoxic drugs. Some indicated the genotoxic damage in their peripheral lymphocytes. On top of that, cases of contact dermatitis, skin local reactions, abdominal pain, headaches, hair loss and liver damage related to cytotoxic drug exposure were reported (Ahmad, 2001; Kristev et al., 2003; Connor and McDiarmid, 2006; Ratner et al., 2010; Baraoui et al., 2011).

The main routes of cytotoxic drug exposure include the inhalation of aerosolized droplets, skin absorption, ingestion and needle stick injury during the process of handling (Zingler et al., 2002; Polovich, 2004; Turk et al., 2004; Connor and McDiarmid, 2006; Kyprianou et al., 2010). Among the possible risky activities in cytotoxic drug handling are drug transportation, preparation, administration, storage, cytotoxic spillage management,

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waste disposal and patient's excreta handling (Ahmad, 2001; Connor and McDiarmid, 2006). Of all, cytotoxic drug preparation and administration were consistently identified with the greatest risk (Ahmad, 2001; Kristev et al., 2003; Turk et al., 2004; Connor and McDiarmid, 2006). In the very first evidence which documented occupational exposure in healthcare workers, nurses involving in these activities had higher indicators of mutagenic substances in their urine compared with other workers (Connor and McDiarmid, 2006).

International safety guidelines for cytotoxic drug handling have been available for more than two decades (Polovich, 2004; Dranitsaris et al., 2005; Kyprianou et al., 2010). For examples, guidelines from US developed by the National Institute for Occupational Safety and Health (NIOSH), the Occupational Safety and Health Administration (OSHA), the Oncology Nursing Society (ONS) and the American Society of Hospital Pharmacists (ASHP) are well-accepted worldwide. In Malaysia, most of the health settings have been adapting these guidelines to develop their own Standard Operating Procedures (SOP). Despite the availability of guidelines, compliance with the safe handling practices has been reported to be sporadic. Generally, studies over the past twenty years showed a lower compliance level among the developing countries compared with the developed countries (Vollono et al., 2002; Turk et al., 2004; Elshamy et al., 2010; Kyprianou et al., 2010; Polovich and Clark, 2010; Yuen et al., 2012). The poor compliance of nurses with the safety measures were consistently associated with several barriers including the incomplete facility, multitasking and work pressure, insufficient knowledge and techniques, lack of awareness and wrong beliefs as well as insufficient in-service training (Ahmad, 2001; Ben-Ami et al., 2001; Aldape et al., 2004; Kyprianou et al., 2010; Polovich and Clark, 2010, Khan et al., 2012).

In our hospital, cytotoxic drugs had been mainly handled by nurses for about thirty years. Despite the recommendation of good practice for pharmacy unit undertaking the drug preparation, cytotoxic drug reconstitution (CDR) activities were conducted in wards. On a daily basis, ward nurses actively involved in transportation of undiluted cytotoxic drugs from pharmacy, drug preparation, administration, drug storage, cytotoxic spillage management, waste disposal and patient's excreta handling. Through our observation, the improper handling practices in wards were of concern. With the knowledge on cytotoxic drug properties and their hazardous effects, pharmacists were required by the hospital authorities to implement a remedial strategy. The aims of this study were: 1) to detect the change of individual nurse's safety-related knowledge and attitude; 2) to detect the change of ward practices in cytotoxic drug handling after a series of pharmacist-based interventions.

Materials and Methods

Setting and study design

The Sultanah Bahiyah Hospital is the biggest general hospital in Kedah State, Malaysia. The number of cancer patients receiving chemotherapy in this hospital is over 1,500 annually. This prospective interventional study, with a before and after design, took place in 15 selected wards of the Department of Surgery (4), General Medicine (3), Obstetrics and Gynaecology (2) , Haematology (1), Nephrology (1), Ophthalmology (1), Paediatrics (1), Pulmonary Diseases (1) and Ear, Nose and Throat (1).

This study comprised two observation periods and an intervention period. The first assessment was conducted to collect the baseline data during June and July 2010. This was followed by a 9-month intervention period from August 2010 to April 2011. The second assessment was then performed during May and June 2011 using the same data collection tools.

Data collection

A single group of 96 nurses from these 15 wards were enrolled in a survey for their knowledge and attitude assessment. They were the permanent nurses in these wards who actively provided chemotherapy for a variety of malignant diseases. The response rates were increased with the assistance of ward pharmacists and senior nurses. All nurses completed and returned the self-administered questionnaires anonymously during the first assessment (response rate 100%) but 2 of them dropped out during the second assessment (response rate 97.9%).

The survey questionnaire was constructed by the oncology pharmacists after referring to several guidelines and previous cross-sectional studies (Ahmad, 2001; Aldape et al., 2004; Turk et al., 2004; Connor et al., 2006; Ismail et al., 2007; Kyprianou et al., 2010; Polovich and Clark, 2010). It was designed using simple English, containing 3 parts with a clear subtitle for each. The first part included sociodemographic information such as department, gender, age, marital status, year of work experience as a registered nurse and as an oncology nurse, the activities they involved in and the frequency of their involvement. The second part contained 40 closed-ended questions to evaluate their knowledge on the hazardous effects (10), ways of exposure to cytotoxic drugs (6), personnel protective equipment (PPE) use (6) and safe handling measures (18). Each question was given options of "yes", "no" and "do not know". Each correct answer received a score of 2.5, yielding a possible full score of 100. The third part contained another 5 closed-ended questions, mainly to determine their attitude towards few safety-related issues and improper practices in the wards. Each question in this part was given options of "yes" and "no". This questionnaire was reviewed by a panel of 5 members (2 oncologists, 2 academicians and 1 pharmacist). It was then pilot tested with a non-random sample of 25 oncology nurses in another general hospital with the similar practices in Kedah State. The internal consistency reliability was acceptable (α=0.71 for second part; 0.78 for third part).

The evaluation of the ward practices was conducted using a self-constructed performance checklist. It contained 20 items which were subdivided into 7 categories: drug preparation (3), transportation (3), storage (3), administration (4), spillage management (3) and waste disposal and decontamination (4). The adherence to each item received a score of 1, yielding a possible full score

of 20. The practices of nurses in all these 15 wards were observed on selected days by pharmacists when patients were admitted for chemotherapy. Any mistake found during the observation periods was considered as non-compliance with the particular item.

Data analysis

Continuous data were expressed as the mean±standard deviation (SD) while categorical data were expressed as frequencies and percentages. Paired-t tests and Wilcoxon signed rank tests were used to compare the mean knowledge scores, mean practice scores as well as all the breakdowns of both scores before and after the interventions. McNemar tests were used to detect the change of nurses' attitude in certain safety-related issues. The threshold of significance was fixed at the 5% level.

Pharmacist-based interventions

During the intervention period, pharmacy CDR service using closed-system was initiated. Cytotoxic drugs, instead of being sent undilutedly to the wards, were prepared in readily-used forms with drug-specific labels which contained clear handling instructions. In a general hospital without a hazard-controlled preparation room, closed-system served as a temporary alternative for cytotoxic drug reconstitution which is proven to minimize the occupational exposure to cytotoxic hazards (Nishigaki et al., 2010). On top of that, two sessions of continuous nursing education (CNE) and cytotoxic drug handling workshop were conducted, respectively. All 15 wards were visited by pharmacists to ensure that the nurses were updated with the newly created SOP. A new cytotoxic drug policy which stressed on the application of safety measures in cytotoxic drug handling was established by pharmacists and approved by the hospital authorities.

Results

Of 96 nurses participating in the survey, majority of them were female (93.8%). The mean age of the participants was 32.2±6.19 years. About two-third (72.9%) of them were married. Their nursing experience and cytotoxic drug handling experience were reported as 7.8±6.09 years and 2.3±1.66 years, respectively. Majority of them (85.4%) reported that they involved in at least one of the steps of cytotoxic drug handling on a daily basis. Most of them worked in the surgical wards (36.4%), followed by medical wards (13.5%), respiratory wards (9.4%), gynaecology wards (8.3%) and others (32.4%).

The summary of the findings of nurses' knowledge levels is given in Table 1, whereas the results reflecting their attitude change are summarized in Table 2. The improvement of ward practices after the pharmacist-based interventions is demonstrated in Table 3.

Discussion

This study appears to be the first local investigation of the nurses' safety-related knowledge, attitude and practices in cytotoxic drug handling in a general hospital. To our knowledge, it is also the only study which demonstrates the roles of pharmacists in improving the nurses' capability to handle cytotoxic drugs safely. Many previously published, non-Malaysian studies were mainly cross-sectional surveys to assess nurses' knowledge and practice using self-reported questionnaires (Turk et al., 2004; Elshamy et al., 2010; Kyprianou et al., 2010; Polovich and Clark, 2010; Yuan et al., 2012). This is the first study using a prospective interventional design to detect the change of both individual knowledge and attitude as well as ward practices after multidimensional strategies implemented. It may serve as an example for those general hospitals without a proper hazard-controlled preparation room for cytotoxic drugs to improve their safe handling using a combination of few methods.

The results of our study suggests that there was a significant improvement of knowledge levels among the nurses on cytotoxic drug handling, with a mean

Table 1. Mean Scores of Nurses' Knowledge on General and Four Important Areas before and after the Pharmacist-based Interventions

Area of Concern	Pre-Intervention (n=96)		Post-Intervention (n=94)		Total score	P*
	Mean Score	SD	Mean Score	SD		
Overall	45.5	10.52	73.4	8.88	100	<0.001
Hazardous effects	9.2	3.15	15.4	4.65	25	<0.001
Ways of exposure to cytotoxic drugs	5.7	2.36	8.6	1.78	15	<0.001
Use of PPE	5.8	2.34	10.6	2.15	15	<0.001
Safe handling measures	24.8	6.4	38.8	4.6	45	<0.001

*Paired-t tests

Table 3. Mean Scores of Ward Practices in General and Certain Important Areas before and after the Pharmacist-based Interventions (n=15)

Area of Concern	Pre-Intervention Mean Score	SD	Post-Intervention Mean Score	SD	Total score	p*
Overall	7.6	5.51	15.3	2.55	20	0.001**
Drug Preparation	0.8	0.86	3	-	3	<0.001
Drug transportation	1.5	0.92	2.5	0.64	3	<0.001
Drug Storage	1.4	0.74	2.4	0.63	3	<0.001
Drug administration	1.1	1.25	3	0.65	4	0.001**
Spillage management	1.4	1.12	2.7	0.59	3	0.001**
Waste disposal and decontamination	1.3	1.1	1.7	1.29	4	0.014

*Wilcoxon signed rank tests; **Paired-t tests

Table 2. Attitude of Nurses towards Five Safety-related Issues before and after the Pharmacist-based Interventions

Area of concern	Pre-Intervention (n=96)	Post-Intervention (n=94)	p*
Feeling confident to handle cytotoxic drugs safely.	53 (55.2%)	75 (79.8%)	<0.001
Believing that complete PPE use was unnecessary.	51 (53.1%)	25 (26.6%)	<0.001
Worried about the long-term side effects of occupational exposure.	43 (44.8%)	90 (95.7%)	<0.001
Able to tolerate a certain level of improper practice when they were busy.	72 (75.0%)	32 (34.0%)	<0.001
Able to tolerate a certain level of improper practice among their peers.	58 (60.4%)	26 (27.7%)	<0.001

*McNemar tests

knowledge score of 45.5 in the first assessment and 73.4 in the second assessment, respectively. The results of the second assessment were noticeably comparable to the achievement of Cypriot (79.4 out of 100) and Turkish (61.3 out of 100) nurses shown in two similar studies which comprehensively tested the nurses' knowledge on cytotoxic drug handling (Turk et al., 2004; Kyprianou et al., 2010). The mean score for chemotherapy exposure knowledge was increased from 5.7 to 8.6 out of 15 which was still proportionally lower than that of US nurses (10.9 out of 12) shown in a recent study (Polovich and Clark, 2010). The knowledge levels on the cytotoxic hazardous effects, usage of PPE and safe handling measures were generally improved, too. Overall, the findings of nurses' knowledge assessment reflect the effectiveness of education and training which has been claimed as a useful tool to improve the nurses' knowledge on cytotoxic drug handling (Ahmad, 2001; Turk et al., 2004; Kosgeroglou et al., 2006; Khan et al., 2012; Yuan et al., 2012). This achievement is exceptionally encouraging as our hospital had fewer nurses (9.4%) receiving formal post-registration training on chemotherapy than did UK (96%), Cyprus (18.2%) and Pakistani (37.0%) hospitals (Verity et al., 2008; Kyprianou et al., 2010; Khan et al., 2012). In addition, none of them received pre-registration training. High knowledge levels among the nurses are important to improve their adherence to the safety measures and to elevate their sense of well-being though knowledge alone may be insufficient to ensure the complete precaution use (Ben-Ami et al., 2001; Turk et al., 2004; Kyprianou et al., 2010; Polovich and Clark, 2010, Khan et al., 2012).

On top of that, the interventions had led to the change of nurses' attitude towards certain safety-related issues. The confidence level among the nurses to handle cytotoxic drugs safely after the interventions (79.2%) was comparable to the findings in a recent Pakistani study (77%) (Khan et al., 2012). Besides that, their awareness on long-term hazardous effects due to the occupational exposure was significantly improved. This is important as previous studies had consistently shown a positive relationship between the nurses' perceived risk of harms from hazardous drug exposure and the application of safety measures (Turk et al., 2004; Polovich et al., 2010). The percentage of nurses who believed that using PPE was not necessary during cytotoxic drug handling was also tremendously decreased. This finding is again comparable to the achievement of Pakistani nurses (Khan et al., 2012). Meanwhile, their levels of tolerance towards their own and co-workers' improper practices were alleviated. All these changes indicate an improved safety climate in this hospital which was proven to be associated with the nurses' self-efficacy of precaution use (Polovich and Clark, 2010).

Besides improving individual knowledge and attitude levels, the adoption of safety measures and the change of organizational safety climate still heavily depend on the multidimensional management actions including the safety policies, procedures, reinforcement and support for the safety programs (Polovich and Clark, 2010). The impact of pharmacist-based interventions was also shown on the change of the ward practices in this study. The mean score for overall ward practices was increased two-fold, from 7.6-15.3 out of 20.0. All tested aspects including the drug preparation, transportation, storage, administration, spillage management and waste disposal and decontamination were significantly improved after the interventions.

Before the initiation of CDR services in pharmacy, wards only obtained a mean score of 0.8 out of 3.0 for the tested aspects of drug preparation, indicating a relatively poor performance in this area compared with previous studies (Turk et al., 2004; Kyprianou et al., 2010; Polovich and Clark, 2010). In this part, assessment focused on the use of closed system, availability of ventilation system and adherence to the adoption of complete PPE. All these criteria were finally fulfilled via the centralization of drug preparation using closed-system in pharmacy. Besides, practices in drug transportation, storage, administration and spillage management were all significantly improved with the increment of mean scores by at least 60% after the interventions. Waste disposal and decontamination practices, though, achieved the least improvement with an initial mean score of 1.3 slightly increasing to 1.7 out of 4.0. Similar poor performances were reported in a Turkish study which assessed the same aspects (Turk et al., 2004). This part mainly investigated the availability of cytotoxic waste bins, labeling of cytotoxic wastes and the use of cytotoxic decontaminant solution. Most of these practices were still inappropriate even after the distribution of SOP to the wards and numerous sessions of CNE. Efforts should be made to strengthen the safety regulations regarding cytotoxic waste disposal and decontamination in the future.

It is noted that this is a limited study and we may need to be cautious about the representative nature of the study setting. It was conducted in a single general hospital in Malaysia involving a group of nurses without pre-registration training on cytotoxic drug handling. Our findings may not be representative of other hospitals with a bigger number of nurses having pre-registration or post registration training. Furthermore, the assessment of nurses' attitude change was based entirely on self-reporting, which may have led to an over-reporting of awareness level. The assessment of ward practices after the interventions was based on a single visit of pharmacists to each ward, which may not have reflected the continuity of the improved practices. Future studies should employ multiple ward-checks to allow a more precise and reliable assessment of nurses' compliance with the recommended good practices.

In conclusion, overall, the results of this study indicate a significant improvement of knowledge, attitude and practices among the nurses handling cytotoxic anticancer drugs after a series of interventions. Pharmacists, with the knowledge on the nature and potential hazards of cytotoxic drugs, play an important role to improve the nurses' capability to handle these drugs safely. The centralization of CDR activities is a crucial strategy to minimize the improper drug handling in wards. On top of that, sufficient education and training as well as hospital policy are effective tools to improve the safety climate in a hospital catering chemotherapy actively.

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