Implementation of safety standards of compounded sterile preparations in hospital pharmacies: a multinational cross-sectional study

Nouf Al-Fadel,[1] Mansour A Mahmoud,[2] Rabih Dabliz,[3] Osama Tabbara,[4] Hisham Aljadhey[2]

▶ Additional material is published online only. To view please visit the journal online (http://dx.doi.org/10.1136/ejhpharm-2015-000872).

[1]Vigilance and Benefit-Risk Assessment Executive Directorate, Saudi Food and Drug Authority, Riyadh, Saudi Arabia
[2]Medication Safety Research Chair, College of Pharmacy, King Saud University, Riyadh, Saudi Arabia
[3]Quality & Medication Safety Services, Cleveland Clinic Abu Dhabi (CCAD), Abu Dhabi, United Arab Emirates
[4]Department of Pharmacy Services, CCAD, Abu Dhabi, United Arab Emirates

Correspondence to
Nouf S Al-Fadel, Vigilance and Benefit-Risk Assessment Executive Directorate, Saudi Food and Drug Authority, PO Box 6288, Riyadh 13312, Saudi Arabia; noufalfadel@yahoo.com

Received 8 January 2016
Revised 7 February 2016
Accepted 25 February 2016
Published Online First 21 March 2016

ABSTRACT

Objectives To evaluate implementation of safety standards of compounded sterile preparations in different hospitals.

Methods This cross-sectional study included 124 hospitals from 19 countries. A survey was developed based on the guidelines and safety practices of the Institute for Safe Medication Practices (ISMP) for sterile preparations compounding, and was sent to the members of the Intravenous and Parenteral Nutrition experts' network (IV PN experts' network) in the Gulf region and beyond using SurveyMonkey software.

Results 124 pharmacists were invited to participate in this study. Only 39 (31.5%) pharmacists from seven countries responded: 16 (41%) of the participants were pharmacy supervisors, and 23 (59%) had >10 years of work experience. However, a majority, 27 (69%), of the respondents were from Saudi Arabia. Written policies and procedures for sterile preparations compounding were available in 37 (95%) hospitals. The concentrated electrolytes were removed from all patient care areas in 28 (72%) hospitals, and 30 (77%) hospitals clearly labelled those as high-alert medications. The use of advanced technologies, such as bar code verification or IV robotics, for compounding sterile preparations were not implemented in 27 (69%) hospitals.

Conclusions Minimum standards and best practice recommendations to ensure safety of sterile preparation compounding were implemented in many hospitals of different countries. However, advanced technologies were not implemented by the majority of the hospitals.

INTRODUCTION

The process of compounding sterile preparations in hospital pharmacies encompasses the preparation of medications that are not commercially available based on the medical need of individual patients. Compounded sterile preparations are commonly used for adults and children admitted to hospitals and home healthcare services for a range of indications. Therefore, it is essential that they must be prepared, labelled and administered with appropriate care, so that the highest standard of safety and efficacy can be ensured and serious adverse reactions can be avoided.

Compounding errors in sterile preparations can cause fatal injuries to the patients and may even lead to tragic deaths.[1–7] A number of studies have demonstrated that the incidents of serious compounding errors that frequently occur in hospital pharmacies were largely due to the improper medication dose/concentration,[1–3] infectious contamination,[4–6] or incorrect product labelling.[7] Moreover, an observational study, where five hospital pharmacies in the USA were observed for 5 days, found that error rates were highest for parenteral nutrition (PN) solutions and the mean error rate in intravenous (IV) products compounding combined was 9%.[8] Another study conducted in a teaching hospital reported that about 34% of medication errors in the critical care unit were linked to IV admixtures compounding.[9] In Saudi Arabia, a national survey found that 47 out of 78 hospitals had concentrated electrolyte solutions in their floor stocks, and only 34% of the hospitals labelled the diluted electrolyte solutions as 'high risk'.[10] In addition, independent verification or double-checking of the final concentrations of prepared electrolyte solutions was not done in >40% of the surveyed hospitals.[10]

The Institute for Safe Medication Practice (ISMP) has developed guidelines and safety practices for sterile preparations compounding in order to maximise patient safety and minimise the risk of errors.[11] The guidelines include mandatory requirements that should be established by law or regulations, minimum standards to ensure safe sterile preparation compounding, and best practice recommendations that should be highly encouraged.[11] The implementation of these guidelines and safety practices is a prerequisite in compounding sterile preparations to ensure utmost patient safety. Therefore, in this study, we have aimed to assess the hospitals' practices in different countries toward implementing the safety standards of compounded sterile preparations.

METHOD

Study design

This was a multinational cross-sectional study. A survey instrument was developed based on the ISMP guidelines and safety practices for the safe preparation of sterile compounds.[11] To ensure the questions were unambiguous, the survey was subjected to a pilot test with five pharmacists who did not participate in the final survey. The final version of the survey was sent to the members of the IV and PN experts network in the Gulf region and beyond using SurveyMonkey software in December 2013. This network was established in February 2013. It included 282 IV and PN therapy experts from 19 countries and 124 health institutions.

To cite: Al-Fadel N, Mahmoud MA, Dabliz R, *et al*. *Eur J Hosp Pharm* 2016;**23**:339–342.

The survey investigated the following areas:

1. Country and level of hospital care in the different countries.
2. Qualification of the health professionals in sterile compounding: current position, types of training, and professional experience of the contacted pharmacists.
3. Design and structure of the rooms, complying with the US Pharmacopeia (USP) 797 requirements for a clean room.
4. Implementation of minimum standards and best practice recommendations for safe sterile preparation compounding.

Setting

The study included 124 hospitals from 19 countries (Saudi Arabia, United Arab of Emirates, Bahrain, Oman, Kuwait, Qatar, Lebanon, Jordan, Morocco, Egypt, Ghana, Turkey, Pakistan, USA, France, Canada, UK, Australia, and Malta).

Participants

One hundred and twenty-four clinical/operational IV and PN therapy experts from different countries were invited to participate. A purposive sampling technique was applied. An email message was sent to one pharmacist from each hospital, mostly pharmacy supervisors or clinical pharmacists, inviting them to participate in the survey. They were chosen because they had a wealth of knowledge and experience in clinical and practical issues of IV fluid and PN management, design and structure of clean rooms, and handling of IV drug shortage. The confidentiality of the information gathered was emphasised.

Data analysis

The Statistical Package for Social Science (SPSS) V.18 was used to analyse the study data. Results are displayed as counts and percentages. Descriptive statistics were used to illustrate respondents' demographic characteristics and the frequency of safety standards. Categorical variables were presented as count and percentages.

RESULTS

One hundred and twenty-four pharmacists were invited to participate in this study, of whom only 39 (31.5%) pharmacists from seven countries responded. Sixteen (41%) of them were pharmacy supervisors, and 23 (59%) participants had >10 years of work experience. However, a majority of these respondents (27, 69%) were from Saudi Arabia. In addition, among the studied hospitals, 20 (51%) were government tertiary hospitals (table 1).

Table 1 Demographic information

Demographic data	N (%)
Countries	
Saudi Arabia	27 (69.2)
United Arab Emirates	6 (15.4)
Bahrain	1 (2.6)
Kuwait	1 (2.6)
Egypt	1 (2.6)
Malta	1 (2.6)
USA	2 (5)
Level of care	
Governmental hospital (primary/secondary care)	10 (25.6)
Governmental hospital (tertiary care)	20 (51.3)
Private hospital (primary/secondary care)	3 (7.7)
Private hospital (tertiary care)	6 (15.4)
Position of contact pharmacist	
Clinical	14 (35.9)
Manager/supervisor	16 (41)
Staff member	9 (23.1)
Professional experience of contacted pharmacist	
<5 years	4 (10.3)
5–10 years	12 (30.8)
>10 years	23 (58.9)

Eleven of the pharmacists reported that they have taken courses or training in sterile compounding as part of their undergraduate degrees. The other sources of basic training include online courses (n=10), continuing education (n=20), audiovisual materials (n=18), and comprehensive orientation and training programmes in the workplace (n=25).

The study found that 30 (77%) hospitals complied with the USP (797) clean room requirements. Written policies and procedures on how to compound sterile preparations and guidelines for drug stability and compatibility were available in 37 (95%) hospitals. A second pharmacist verified orders of chemotherapeutic drugs, PN and other high-alert medications in 30 (77%) hospitals. The concentrated electrolytes were removed from all patient care areas in 28 (72%) hospitals, and 30 (77%) hospitals clearly labelled those as high-alert medications (see online supplementary table S1).

Eleven (28%) hospitals did not involve pharmacy services for the compounding of all sterile preparations. Standard concentrations for complex sterile preparations, such as PN, cardioplegia solutions or dialysis solutions, were not used in seven (18%) hospitals, and 23 (59%) hospitals permitted one pharmacist to work in the compounding room for the compounding of chemotherapy and complex sterile preparations. In addition, 27 (69%) hospitals used commercially premixed parenteral products (see online supplementary table S1).

Errors related to the pharmacy compounding of sterile preparations, including near misses, were reported in 31 (79.5%) hospitals. The implementation of automation and technology was not in the strategic plans of 14 (36%) hospitals. The use of advanced technologies, such as bar code verification or IV robotics, for compounding sterile preparations was not implemented in 27 (69%) hospitals. Furthermore, 25 (64%) hospitals did not utilise IV workflow software (see online supplementary table S1).

All mandatory requirements of the ISMP for sterile preparations compounding were implemented by all US hospitals and >80% of Saudi hospitals. Removal of concentrated electrolytes from all patient care areas and use of commercially premixed parenteral products were implemented in all hospitals in the USA and the Emirates. The use of automation and technology was in the strategic plans of all the US hospitals (see online supplementary table S2).

In Saudi Arabia, high-alert medications were verified by a second pharmacist in 22 (81.5%) hospitals, concentrated electrolytes were removed from all patient care areas in 19 (70%) hospitals, and they were clearly labelled as 'high-alert medications' in 21 (78%) hospitals (see online supplementary table S2).

DISCUSSION

The study found that 77% of the hospitals adhered to the USP (797) clean room requirements. This finding can be inferred as a very positive sign of improvement; however, it also suggests that full adherence to the USP requirements has still been a daunting challenge for many hospitals.

Policies and procedures for the compounding of sterile preparations and written guidelines for drug stability and

compatibility were available in 96% of the Saudi hospitals. A previous study conducted in Saudi Arabia reported that 69.2% of the hospitals had a written policy for parenteral preparations compounding,[12] a finding that clearly suggests a significant improvement in overall pharmacy compounding. However, this also indicates that there is still a need to enforce these requirements further. High-alert medication orders were verified by a second pharmacist in 81.5% of Saudi hospitals, which is considerably better compared to the findings of the previous report.[12] This statistic implies a good consideration of patient safety before administering these medications. Clearly, countrywide regulatory efforts are required to make the double-checking of medication orders by a second pharmacist mandatory for the dispensing of high-risk medications.

In Saudi Arabia, concentrated electrolytes were removed from all patient care areas in 70% of the hospitals. In addition, 78% of the hospitals used labelled red boxes to stock all concentrated electrolytes in their pharmacies, and they were clearly identified as high-alert medications. This can be interpreted as a noteworthy improvement compared to the previous findings.[10] However, further improvement is required to ensure the safe use of concentrated electrolytes.

Pharmacy services were not involved in the compounding of all sterile preparations in 28% of the hospitals, although the Joint Commission (TJC) recommends that such practice should only be available in emergencies or when the medication's stability period is short.[13] Furthermore, standard concentrations for complex sterile preparations were not used in 18% of the hospitals, and only 59% of the hospitals allowed one pharmacist to work in the compounding room for the compounding of chemotherapy and complex sterile preparations. These practices can be considered a risky behaviour, since these hospitals did not follow the minimum safety practices to ensure patient safety.

In this study, we also found that the majority of the hospitals used commercially premixed parenteral products over manual preparations. The increased use of these products could reduce the incidence of compounding and prescribing errors and infectious contamination.[8 14] However, the premixed products are not the final solution to the problem because they can raise some safety issues as well, such as dispensing errors.[15]

The errors that occurred during the pharmacy compounding of sterile preparations, including near misses, were reported in 79.5% of the hospitals. An observational study involving two hospitals in the UK found that 49% of IV preparations had a minimum of one error.[16] Another UK based study found that reported errors related to IV compounding in hospital pharmacies were mostly near misses.[17] Therefore, reporting of pharmacy compounding errors can provide lessons to avoid similar incidents,[1–7] and promote safety culture practices.[17]

The implementation of automation and technology was not in the strategic plans of 36% of the organisations. This indicates poor strategic planning, because automation and robotic technology utilisation have been reported to improve medication safety, accuracy, and the quality of service.[18 19] However, the use of automation and technology in sterile preparation compounding is not common in many hospital pharmacies of different countries, because adoption of this system involves not only a large budget for equipment, licensing, training, and maintenance,[20] but also a hospital commitment to redesign the way of practice. Furthermore, this will also require devoting significant time in staff training to operate the system.[20] Nevertheless, even if the financial and resource difficulties are attained, the adoption of automation and technology may raise structural challenges to make the system and data interoperable and technical barriers to harmonise it with the coexisting systems.[21]

The current study noted a lack of studies that aim to assess the implementation of ISMP safety standards for sterile preparation compounding in other countries such as the Emirates, Kuwait, Bahrain, Egypt, and Malta. This study might be the first to assess ISMP standards in those countries.

One of the study's limitations is the small sample size. While 124 pharmacists from 19 countries were invited to take part in this survey, only 39 pharmacists from seven countries responded. Moreover, the participants were predominantly from Saudi Arabia, and in some countries only one pharmacist responded. Therefore, the data might not be representative of the hospitals in the respective countries. Another limitation is that some of our findings came from primary/secondary hospitals; thus, the results cannot be generalised to include tertiary hospitals that provide specialised inpatient care.

In conclusion, minimum standards and best practice recommendations to ensure safety of sterile preparation compounding were implemented in many hospitals of different countries. However, there is still a lack of standardisation in compounding, labelling, and order verification of sterile preparations. In addition, advanced technologies for compounding sterile preparations were not implemented in the majority of the hospitals. Therefore, collaborative efforts and more research for optimising sterile preparation compounding are needed to improve overall patient safety and service efficiency.

Key messages

What is already known on this subject

- The Institute for Safe Medication Practice (ISMP) has developed guidelines and safety practices for sterile preparation compounding.
- Many studies have reported the incidence of medication errors related to parenteral preparations.

What this study adds

- Minimum standards to ensure safety of sterile preparation compounding are widely implemented, whereas advanced technologies such as bar code verification or intravenous robotics are not implemented by the majority of the hospitals.

Acknowledgements We extend our appreciation to the IV and PN therapy experts who participated in the survey.

Contributors RDz, OT and HA designed the study. MAM analysed the data and reviewed the manuscript. Nouf Al-Fadel conducted the study and wrote the manuscript. All authors approved the final manuscript.

Competing interests None declared.

Provenance and peer review Not commissioned; externally peer reviewed.

REFERENCES

1 Institute for Safe Medication Practices (ISMP). Fatal 1,000-fold overdoses can occur, particularly to neonates, by transposing mcg and mg [internet]. 2007 [cited 11 December 2015]. https://www.ismp.org/newsletters/acutecare/articles/20070906.asp
2 Institute for Safe Medication Practices (ISMP). Criminal prosecution of human error will likely have dangerous long-term consequences [internet]. 2007 [cited 11 December 2015]. https://www.ismp.org/newsletters/acutecare/articles/20070308.asp
3 Centers for Disease Control and Prevention (CDC). Deaths from intravenous colchicine resulting from a compounding pharmacy error--Oregon and Washington, 2007. *MMWR Morb Mortal Wkly Rep* 2007;56:1050.

4 Selenic D, Dodson DR, Jensen B, *et al*. Enterobacter cloacae bloodstream infections in pediatric patients traced to a hospital pharmacy. *Am J Health Syst Pharm* 2003;60:1440–6.
5 Hughes CF, Grant AF, Leckie BD, *et al*. Cardioplegic solution: a contamination crisis. *J Thorac Cardiovasc Surg* 1986;91:296–302.
6 Institute for Safe Medication Practices (ISMP). Sterile compounding tragedy is a symptom of a broken system on many levels [internet]. 2012 [cited 11 December 2015]. http://www.ismp.org/newsletters/acutecare/showarticle.aspx?id=34
7 Institute for Safe Medication Practices (ISMP). A mislabeling event with batched drugs: the unintended consequences of practice changes [internet]. 2014 [cited 11 December 2015]. https://www.ismp.org/newsletters/acutecare/showarticle.aspx?id=68
8 Flynn EA, Pearson RE, Barker KN. Observational study of accuracy in compounding iv admixtures at five hospitals. *Am J Health Syst Pharm* 1997;54:904–12.
9 Fahimi F, Ariapanah P, Faizi M, *et al*. Errors in preparation and administration of intravenous medications in the intensive care unit of a teaching hospital: an observational study. *Aust Crit Care* 2008;21:110–16.
10 Aljadhey H, Alhusan A, Alburikan K, *et al*. Medication safety practices in hospitals: a national survey in Saudi Arabia. *Saudi Pharm J* 2013;21:159–64.
11 Institute for Safe Medication Practices (ISMP). Proceedings from the ISMP sterile preparation compounding safety summit: guidelines for SAFE preparation of compounded sterile preparations [internet]. 2013 [cited 11 December 2015]. https://www.ismp.org/tools/guidelines/IVSummit/IVCGuidelines.pdf
12 Alsultan MS, Khurshid F, Mayet AY, *et al*. Hospital pharmacy practice in Saudi Arabia: dispensing and administration in the Riyadh region. *Saudi Pharm J* 2012;20:307–15.
13 Rich DS. New JCAHO medication management standards for 2004. *Am J Health Syst Pharm* 2004;61:1349–58.
14 Pounds T, Lovett A, Eng S, *et al*. Evaluation of efficacy and safety of premixed parenteral nutrition versus customized parenteral nutrition in a large teaching hospital. *Adv Pharmacol Pharm* 2013;1:68–73.
15 Institute for Safe Medication Practices (ISMP). Hespan and heparin mix-ups—reduce the risk by using generic name and product [internet]. 1999 [cited 11 December 2015]. https://www.ismp.org/newsletters/acutecare/articles/19990908.asp
16 Taxis K, Barber N. Ethnographic study of incidence and severity of intravenous medicine errors. *BMJ* 2003;326:684.
17 Bateman R, Donyai P. Errors associated with the preparation of aseptic products in UK hospital pharmacies: lessons from the national aseptic error-reporting scheme. *Qual Saf Health Care* 2010;19:e29.
18 Poon EG, Cina JL, Churchill W, *et al*. Medication dispensing errors and potential adverse drug events before and after implementing bar code technology in the pharmacy. *Ann Intern Med* 2006;145:426–34.
19 Chaudhry B, Wang J, Wu S, *et al*. Systematic review: impact of health information technology on quality, efficiency, and costs of medical care. *Ann Intern Med* 2006;144:742–52.
20 Congressional Budget Office (CBO). Evidence on the costs and benefits of health information technology [internet]. 2008 [cited 11 December 2015]. https://www.cbo.gov/sites/default/files/110th-congress-2007-2008/reports/05-20-healthit.pdf
21 Siska MH, Tribble DA. Opportunities and challenges related to technology in supporting optimal pharmacy practice models in hospitals and health systems. *Am J Health Syst Pharm* 2011;68:1116–26.