A drug-related problem (DRP) is commonly defined as an event or circumstance involving drug treatment that actually or potentially interferes with the optimal outcome of a patient’s medical care. It broadly includes events related to errors, adverse effects or adherence issues.1 DRPs are associated with increased healthcare costs and hospital admissions, prolonged hospital stays, reduced quality of life and increased mortality.2,3 Patients with multiple comorbidities and polypharmacy are at risk of DRPs, present during or immediately after discharge.4 Polypharmacy and DRPs are also associated with readmissions in Singapore.5

Healthcare professionals and primarily pharmacists help to identify and resolve DRPs daily in their course of work in different settings such as hospitals, nursing homes, polyclinics, community pharmacies and other community-based care facilities.6-10 In many pharmacy departments, data on DRPs and their resolution have also been collected as part of medication safety surveillance as well as to facilitate quality and safety improvements and education initiatives. In addition, such data may also be used to estimate pharmacy workload as DRPs can lead to reworking of prescriptions. A recently conducted cross-sectional study of DRPs detected 38.3% of 379 hospitalisations with one or more DRPs. Over 90% of these DRPs were preventable, with an estimated median admission cost of SGD1,424 and interquartile range of SGD1,068–2,678.11 The detection and resolution of DRPs optimises medication use, maximises the utility of medication costs and potentially reduces healthcare costs in Singapore’s healthcare system.12

Currently, there is no harmonised classification system across Singapore institutions. Different methods of classifications result in difficulties interpreting reports of DRP prevalence rates and causes.13 To tackle these DRPs as a healthcare system, it is important that institutions share similar classifications. This will enable development and research on pharmaceutical care practices. It is also important as a way to communicate to other healthcare professionals effectively.14

Development of the harmonised DRP classification system. In February 2019, a workgroup consisting of the following 7 Singapore healthcare institutions was convened: Tan Tock Seng Hospital, Khoo Teck Puat Hospital, Institute of Mental Health, National Skin Centre, NHG Pharmacy, National University Hospital and Ng Teng Fong General Hospital. DRP definitions that each institution adopted were obtained for reference to develop a harmonised classification system. The system aims to capture data on identification, causes and resolution of DRP across settings, including inpatient and outpatient acute care hospitals, community hospitals, polyclinics, nursing homes and home-based care. We took a broader definition of DRPs involving medication errors from prescribing and drug administration, as well as operational issues, such as missing instructions or signature in prescriptions, and expired medications.

Published DRP classification systems were reviewed. A widely used classification system recommends that DRPs be broadly categorised as “indication”, “adherence”, “safety” and “effectiveness” (Table 1).15 These systems are multi-focused, and usually have a “problem” and “intervention” sections.16 Many of these...
Table 1. Tasks taken in identifying and resolving broad categories of a drug-related problem (DRP)

| Broad categories of DRP | Tasks |
|-------------------------|-------|
| Indication (appropriateness) | Eliminate unnecessary medications. Initiate medicines for untreated indication. |
| Adherence | Increase patient’s willingness to adhere to medication regimen through different methods, which include motivational interviewing and shared decision making. |
| Safety | Eliminate toxicities. Identify and/or pre-empt adverse reactions. |
| Effectiveness | Identify most effective medication in a specific patient. Increase dosages to effective levels. |
Table 2 describes each DRP and the corresponding actions taken to resolve it based on broad DRP categories. DRPs categorised as “operational” describes the role of pharmacists as well as pharmacy technicians in addressing routine operational aspects of medication use, and hence do not require the reporter to document actions taken under IASE.

**Actions taken to address DRPs and process-related causes of DRPs.** Prior to developing the harmonised categorisation system, DPR definitions in some institutions were based on process-related causes of the DRP. For example, a wrong medical history taken by the prescriber resulting in a higher dose prescribed was classified as “wrong medical history” rather than “dose and regimen”. These processes-related causes of DRPs are routinely reported and tracked by quality and improvement committees of these institutions. In contrast, a DRP can also be caused by “risk of treatment continuation outweighs benefits”. There can be a multitude of descriptions for these “clinical causes”. DRP can also be caused by patient-related causes (e.g. lack of insight into disease, forgetfulness, etc). In the new categorisation, only process-related causes are defined. Hence, the “cause of DRP (process-related)” category was added following actions taken to address IASE in this hierarchical system.

However, operational DRPs will not be linked to “actions taken” and “process-related causes” as they refer to problems that are related to routine operational aspects of medication use, and are mainly used for estimation of workload or to drive process improvements. As we had to ensure continuity in the quality and safety surveillance system of each institution, these specific categories were placed under operational DRPs (Table 2).

**Defining DRPs that are regarded as medication errors, and documenting assessment and recommendations.** A DRP is commonly defined as an event or circumstance involving drug treatment that actually or potentially interferes with the optimal outcome of a patient’s medical care. It broadly includes events related to errors, adverse effects or adherence issues. DRPs can be preventable or unpreventable; and can potentially or actually be caused by an error, intentional or unintentional deviation from accepted drug use, or an unpredictable reaction to an appropriate drug.

We adopted the definition that a medication error is defined as any preventable event in the medication use process that may cause or lead to patient harm while the medication is in the control of the healthcare professional, patient, or consumer. In an attempt to provide focus and definitions to medication errors, the workgroup developed 2 consensus decisions: (1) as the primary focus is to identify medication errors by healthcare professionals, medication errors caused by the patient or consumers will need to be explicitly stated, and (2) DRPs that can be defined as medication errors will be additionally classified.

The types of medication errors were adapted from NCC MERP and defined:

A. Hazards/Risks (events that have capacity to cause error/harm)
B. Near-misses (error occurred but did not reach patient)
C. Actual Error (reached patient but no harm)
D. Actual Error (reached patient and require monitoring/ intervention to confirm no harm)
E. Actual Error (caused temporary patient harm requiring intervention)
F. Actual Error (caused temporary patient harm requiring initial/prolonged hospitalisation)
G. Actual Error (caused permanent patient harm)

Due to varying reporting needs, some of these medication errors, particularly categories E to G, may be reported only in the incident reporting systems of the respective institutions.

We adopted a pragmatic approach in the design and testing of the classification system, and acknowledge that inter-rater reliability and external validity could be evaluated for future research. This DRP classification system will be incorporated in the Next Generation Electronic Medical Record system, which will be progressively deployed across the National Healthcare Group and National University Health System. Further work and improvements to this classification may be needed for other public and private healthcare institutions to adopt the new DRP categorisation system. The harmonisation will allow institutions to build a common framework to identify gaps for innovative care and to characterise the value of pharmacy.

Over time, the collection of large quantities of DRP data with harmonised categorisation, together with natural language processing and machine learning, will form the foundation to establish an accurate algorithm and automate the classification of DRPs by analysing the SBAR documentation. With a better understanding of the DRPs across the Singapore healthcare system, decision support systems based on machine learning can be designed to prevent the occurrence of DRPs at the point of prescribing.
Table 2. Drug-related problem (DRP) categories, actions taken to address “indication”, “adherence”, “safety” and “efficacy”, and process-related causes of DRP

| DRP categories                                      | Actions taken (in bold)                                                                 | Process-related causes (non-bold) |
|-----------------------------------------------------|----------------------------------------------------------------------------------------|-----------------------------------|
| Drug selection (dosage form, strength, better or safer choice) |                                                          |                                   |
| Stopped drug – No indication                        | Restarted drug for untreated indication – Indication                                  | Process-related causes (non-bold) |
| Transcribing error                                  | Transcribing error                                                                     |                                   |
| Inaccurate medication history                       | Inaccurate medication history                                                          |                                   |
| Wrong patient                                       | Other slips and lapses                                                                  |                                   |
| Other slips and lapses                              | Labs/cultures not noted                                                                |                                   |
| Dosage regimen (frequency, timing, rate, quantity, duration, add “once order”) | Dose/frequency increased – Efficacy                                                  |                                   |
| Rate of infusion increased – Efficacy               | Duration or quantity increased – Efficacy                                             |                                   |
| Dose or frequency reduced – Safety                  | Rate of infusion reduced – Safety                                                      |                                   |
| Duration or quantity reduced – Adherence            | Dose or frequency changed for cost savings – Adherence                                |                                   |
| Dose or frequency changed for cost savings – Adherence |                                                       |                                   |
| Transcribing error                                  | Transcribing error                                                                     |                                   |
| Inaccurate medication history                        | Inaccurate medication history                                                          |                                   |
| Other slips and lapses                              | Other slips and lapses                                                                  |                                   |
| TCU mismatch                                        | Other slips and lapses                                                                  |                                   |

Process-related causes:
- Not in formulary
- Out of stock
- Other slips and lapses
- Affordability
Table 2. Drug-related problem (DRP) categories, actions taken to address “indication”, “adherence”, “safety” and “efficacy”, and process-related causes of DRP (Cont’d)

| DRP categories                        | Actions taken (in bold)                                                                 | Process-related causes (non-bold) |
|---------------------------------------|----------------------------------------------------------------------------------------|-----------------------------------|
| Preparation and administration (route, site, diluent, container, dilution) | **Route or site of administration changed**<br>– Efficacy<br>**Diluent or dilution or container changed**<br>– Efficacy | **Route or site of administration changed**<br>– Safety<br>**Diluent or dilution or container changed**<br>– Safety |
|                                        | Transcribing error<br>**Incompatibility**<br>**Drug concentration**<br>Inaccurate medication history<br>**Other slips and lapses** | Transcribing error<br>**Drug concentration**<br>Inaccurate medication history<br>**Other slips and lapses** |
| Monitoring                             | **Adverse drug reaction or allergy monitoring**<br>– Safety<br>**Drug interactions or precautions**<br>– Safety<br>**Test added to see therapeutic response**<br>– Efficacy<br>**Test added for undiagnosed condition**<br>– Indication | Remove unnecessary test<br>– Operational<br>**Other slips and lapses**<br>Other slips and lapses |
| Adherence and education               | **Drug administration instructions reinforced**<br>– Adherence<br>**Provide compliance aids or tools**<br>– Adherence<br>**Improve health literacy**<br>– Adherence<br>**Shared decision-making goals made**<br>– Adherence<br>**Provide specialised counselling**<br>– Adherence | **Provide information**<br>– Adherence |
| Operational¹                          | **No original prescription**<br>**Missing or incomplete dosage regimen or signature**<br>**Inappropriate storage conditions**<br>**Routine specialised counselling** | **Referral or update to HCP**<br>Illegible handwriting<br>Removed expired/unnecessary medications |

ADR: adverse drug reaction; HCP: healthcare professional; TCU: “to see you” for an appointment between patient and prescriber following mis-match of prescription duration and next visit date

In bold: descriptors describe each action taken. Non-bold: descriptors describe process-related causes.

¹ Operational DRPs will not be linked to “actions taken” and “process-related causes”. The 9 sub-categories are described in the table.
REFERENCES

1. Williams M, Peterson GM, Tenni PC, et al. DOCUMENT: a system for classifying drug-related problems in community pharmacy. Int J Clin Pharm 2012;34:43-52.

2. Naples JG, Hanlon JT, Schmader KE, et al. Recent literature on medication errors and adverse drug events in older adults. J Am Geriatr Soc 2016;64:401-8.

3. Salvi F, Marchetti A, D’Angelo F, et al. Adverse drug events as a cause of hospitalization in older adults. Drug Saf 2012;35:29-45.

4. López MP, Saliente MT, Company ES, et al. Drug-related problems at discharge: results on the Spanish pharmacy discharge programme CONSULTENOS. Int J Pharm Pract 2010;18:297-304.

5. Toh MR, Teo V, Kwan YH, et al. Association between number of doses per day, number of medications and patient’s non-compliance, and frequency of readmissions in a multi-ethnic Asian population. Prev Med Rep 2014;1:43-7.

6. Chia HS, Ho JA, Lim BD. Pharmacist review and its impact on Singapore nursing homes. Singapore Med J 2015;56:493-501.

7. Yeo QQ, Chong JBK, Chung WL, et al. Drug Related Problems Detected During a Brown Bag Review by a Pharmacist-Initiated Octo-Pills Programme in Singapore. J Appl Pharm 2017;9:1-4.

8. Ang F, Pau JE, Koh EW, et al. Drug-related problems associated with community-dwelling older persons living alone in Singapore. Int J Clin Pharm 2019;41:719-27.

9. Cheong ST, Ng TM, Tan KT. Pharmacist-initiated deprescribing in hospitalised elderly: prevalence and acceptance by physicians. Eur J Hosp Pharm 2018;25:e35-9.

10. Ng TM, Teo CJ, Heng ST, et al. Impact of round-the-clock pharmacist inpatient medication chart review on medication errors. J Am Coll Clin Pharm 2020;3:1437-43.

11. Woon J, Choo R, Yeo S, et al. Prevalence and Associated Cost of Hospitalization Arising from Preventable Drug-Related Problems in Singapore: A Cross-Sectional Study. Sch J App Med Sci 2019;7:312-22.

12. Hawes EM, Maxwell WD, White SF, et al. Impact of an outpatient pharmacist intervention on medication discrepancies and health care resource utilization in posthospitalization care transitions. J Prim Care Community Health 2014;5:14-8.

13. Basger BJ, Moles RJ, Chen TF. Application of drug-related problem (DRP) classification systems: a review of the literature. Eur J Clin Pharmacol 2014;70:799-815.

14. Basger BJ, Moles RJ, Chen TF. Development of an aggregated system for classifying causes of drug-related problems. Ann Pharmacother 2015;49:405-18.

15. Patient-Centered Primary Care Collaborative. The Patient-Centered Medical Home: Integrating Comprehensive Medication Management to Optimize Patient Outcomes resource guide, Second Edition, June 2012. PCPCC: Washington, DC.

16. van Mil JW, Westerlund LO, Hersberger KE, et al. Drug-related problem classification systems. Ann Pharmacother 2004;38:859-67.

17. Pharmaceutical Care Network Europe Association. Classification for Drug Related Problems V9.1. Available at: https://www.pcne.org/upload/files/417_PCNE_classification_V9-1_final.pdf. Accessed on 18 April 2021.

18. De Meester K, Verspuy M, Monsieurs KG, et al. SBAR improves nurse-physician communication and reduces unexpected death: a pre and post intervention study. Resuscitation 2013;84:1192-6.

19. van Mil JWF, Westerlund T, Brown L, et al. Medical care and drug-related problems: Do doctors and pharmacists speak the same language? Int J Clin Pharm 2016;38:191-4.

20. Hartwig SC, Denger SD, Schneider PJ. Severity-indexed, incident report-based medication error-reporting program. Am J Hosp Pharm 1991;48:2611-6.