Original Article

Medication stewardship in the operating theatre in Malaysia: A quality improvement project

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ABSTRACT

Background and Aims: A quality improvement project ('Safe Anaesthesia for ALL-SEAL') was implemented to reduce preventable medication errors and drug wastage in the operating theatre (OT) of a tertiary hospital. The primary objective of this quality improvement project was to prevent the incidence of medication errors, and the secondary objective was to reduce the wastage of unused drugs. **Methods:** A pre-intervention questionnaire and an audit survey were performed, and multidirectional interventions were designed post-survey. A post-intervention survey was conducted to evaluate effectiveness. The incidence of medication errors, including near misses, was assessed for root causes. Unused drugs drawn or diluted in syringes were recorded daily in each OT. The weekly drug orders and mid-week reordering frequency were also monitored. The data were reported as simple means and percentages. **Results:** Ninety-eight anaesthesia care providers participated in the survey (72.4% doctors and 27.6% anaesthetic nurses). Pre-intervention, 76.1% of respondents had experienced medication errors during their practice. Common errors included misidentification of ampoules or vials (65.2%), miscalculation of dosages (65.2%), improper syringe labelling (56.5%), accidental drug omission (54.3%) and wrong prescriptions (39.1%). The main sources of errors were fatigue/overwork (80.4%) and a hectic OT environment (71.7%). Post-intervention, no incidents of medication errors were reported. In addition, there was a significant reduction in drug wastage. **Conclusions:** The SEAL project positively prevented medication errors and reduced drug wastage, which should be further validated in other clinical settings.

Keywords: Anaesthesia, cost-effectiveness, drug wastage, medication error, medication safety, quality improvement

INTRODUCTION

The highly stressful perioperative care environment can lead to medication errors among anaesthesiologists. A medication error is defined as any preventable event of inappropriate medication use that may cause or lead to patient harm.[1] According to the United States Food and Drug Administration databases, more than 100,000 medication errors are reported annually.[1] It is the most common preventable cause brought up in the medico-legal court.[2] Standardisation of the anaesthetic practice of drug preparation and administration effectively reduces cost and prevents medication errors.[2] However, these measures can cease over time without a constructive sustainability plan.[2]

Anaesthesiologists are always prepared to treat emergency conditions with pharmacological treatment in the perioperative period. In many hospitals, these emergency drugs need to be prepared and diluted beforehand. Often, these drugs will end up unused. As a result, the wastage of anaesthetic drugs has

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been recognised as a significant problem in hospitals worldwide.[3,4] The anaesthetic drugs and emergency medications for surgery and intensive care use occupy 10%–15% of the hospital's pharmacy budget. As much as 50% of the prepared drugs were not used during surgery, and those drugs were discarded due to contamination issues.[4,5] Generally, the most commonly wasted drugs were muscle relaxants,[6-11] vasoactive drugs[10,12] and induction agents.[6,8-11] The estimated annual loss of healthcare costs due to drug wastage was approximately USD 185,250.[10]

We hypothesised that injudicious use of anaesthetic drugs, low awareness of drug cost and lack of standardisation on drug handling by trainees caused drug wastage and medication errors. The primary objective of this quality improvement project was to reduce the incidence of medication errors. The secondary objective was to reduce the wastage of unused drugs.

METHODS

The Medication Stewardship–Safe Anaesthesia for ALL (SEAL) project was conducted from July 2020 to October 2020 in all the operating theatres (OTs) of a university hospital, except two paediatric OTs, two cardiothoracic OTs and two obstetric OTs. This study was approved by the Medical Research Ethics Committee of the University of Malaya Medical Centre (ethics approval number: 20201023-9162. Written informed consent was obtained from all the participants before enroling them in the study and using their data for research and educational purposes. The study was conducted in accordance with the Declaration of Helsinki, 2013 and good clinical practice.

The study site is a tertiary medical centre for undergraduate and speciality training, internship training, allied health and subspecialty training. At any point, there are at least 2000 trainees of various disciplines in the hospital,[13] each trainee being in the hospital for 6 months to 4 years. The anaesthesia care providers in the OTs consist of physicians (consultants and specialists hired by the hospital and academic staff of the university, medical officers who are mostly anaesthesiology speciality trainees, who spend at least 2 years in the department, with new trainees arriving every 6 months from various Ministry of Health hospitals in the country, each with their practices) and nurses who are permanently in the hospital.

This project was initiated to find value-driven solutions for medication errors and waste in OTs. A multidisciplinary team of anaesthetists, anaesthetic nurses and pharmacists was made to implement measures and monitor compliance to reduce drug wastage and error in OTs. Following the 'Plan–Do–Study–Act' cycle, the project started with a pre-intervention survey to explore the awareness of anaesthesia care providers (doctors, nurses and medical assistants working in OTs) on the cost of anaesthetic drugs, medication safety and error. Based on the findings of the pre-intervention surveys, multidirectional interventions were implemented to raise awareness and standardise the process of drug preparation, labelling and drug administration. The impact of these interventions on drug wastage and drug error was audited throughout the intervention period and documented as post-intervention outcomes.

A pre-intervention self-administered bilingual questionnaire comprised 37 questions divided into three main domains: drug wastage, medication error and drug cost. Thirteen questions for medication error were formulated following the literature and expert-based recommendations by Wahr *et al*.[14] The questionnaire contents for drug wastage and drug cost were created based on the reports by Chaudhary *et al*.[15] and Barbariol *et al*.[4] The questionnaire was validated via face validation, and 90% agreement was achieved for each question by 10 randomly selected respondents before disseminating the survey [Supplementary Appendix 1]. In the same setting, a pre-interventional audit survey also recorded the weekly use of anaesthetic drugs ordered from the pharmacy stores in the OTs. The pharmacists allocate the amount of each drug supplied to OTs based on the average number of cases performed in a week. The nurse in charge of restocking the drugs in OTs liaises with the pharmacist at the end of every weekday to ensure an adequate supply of these drugs for the following week. Mid-week drug restocking is required when there is a high volume of drug usage exceeding the amount supplied or when lower than 20% of the drugs are available in OTs.

Root cause analyses were performed using the pre-intervention audit and survey findings. Based on these findings, multidirectional interventions were designed to address the issues related to drug wastage and error at our centre. The investigators implemented a multipronged intervention called 'The Medication Stewardship Project' from August 2020 to October 2020 to improve safety and reduce waste practices through

education, standardised workflow and creating a medication registry [Supplementary Appendix 2]. This project recorded all the unused intravenous drugs for all cases performed in OTs. The usage of inhalational agents was excluded. Anaesthetists had the discretion to choose anaesthetic drugs and their dosages. The anaesthesia care providers of the OTs documented the amount of drugs loaded in the syringes and left unused at the end of each case.

Attendance to all continuing medical education (CME) and continuing nurse education (CNE) was compulsory and recorded for all the survey participants during this study period. The education arm of the intervention included formal and informal channels that are described below:

1. Posters and flyers that included the costs of drugs and cognitive aids for drug preparation, according to the standardised procedures, disseminated via closed group media communication platforms [namely WhatsApp Inc. (Facebook, Inc.), 2020] [Supplementary Appendices 3–7].
2. Induction workshops to introduce care providers to the new standardised procedures, and their place in medication safety and waste reduction were held for 5 days in interdisciplinary small group sessions, each lasting about 1 h. Participants were provided with the session schedule and protected time to attend, and their attendance was captured.
3. Video tutorials on medication preparation are available on the department website on demand (asynchronous), allowing for self-directed learning.
4. Inclusion of Medication Stewardship in care providers' CME and CNE calendars, annually.
5. Compulsory synchronous sessions for new members of the department during orientation week, occurring at six-monthly intervals.

In addition, the new standard operating procedures (SOPs) were implemented to standardise the practice of drug preparation among anaesthesia care providers [Supplementary Appendix 3]. This aimed to reduce the variability in drug handling and minimise drug error and drug wastage, as most of the trainees came from different backgrounds in the working environment.

The third arm of this intervention was a medication registry, which captured medication errors and near misses to facilitate future root cause analyses, promote patient safety and promote a no-blame culture.

To support project sustainability and promote teamwork during the intervention, volunteer medical officers and nurses were appointed and empowered as medication safety officers (MSOs). Their main role is to support and monitor compliance by ensuring the availability of cognitive aids and adherence to SOPs. Issues encountered and deviations from SOPs were highlighted to the medication stewardship team for troubleshooting and intervention. A total of 168 nurses were trained as MSOs in the contents of cognitive aids, data collection and escalation techniques.

A post-intervention survey was performed over 16 weeks from August 2020 until October 2020. Each of the OTs recorded the number of unused drugs wasted daily. The number of medications ordered per week and the frequency of mid-week reordering were also monitored. The incidence of medication errors reported in the registry was evaluated for root cause analysis.

The total number of healthcare providers present during the audit period was 300. With the implementation of these interventions, a performance level of 90% was expected, and 5% inaccuracy would be accepted. By applying a 95% confidence interval, the sample size to be included in this survey was 95.[16] The data for this quality improvement project were reported as simple means and percentages.

RESULTS

Ninety-eight anaesthesia care providers participated in the survey. More than 70% were doctors, and the rest were anaesthetic nurses. The majority had working experience in anaesthesia for more than 5 years, and only 1% had less than 1 year of experience.

Our survey found that 76.1% of the respondents had experienced medication errors throughout their years of practice. The respondents also thought that medication errors commonly occurred during both the preparation of drugs and drug administration at equal proportions. The types of medication errors experienced by the respondents and the potential source of medication errors among the respondents are presented in Table 1. Misidentification of ampoules or vials, miscalculation of drug dosages, improper labelling of syringes, accidental omission of the drugs

Table 1: Types of medication errors experienced by the respondents and the potential source of occurrence of medication errors (*n*=46)

	n (%)
Types of medication error	
Misidentification of ampoules or vials	30 (65.2)
Miscalculation of drug dosages	30 (65.2)
Improper labelling of syringes	26 (56.5)
Accidental omission of drug prescribed	25 (54.3)
Wrong prescription	18 (39.1)
Wrong route of administration	14 (30.4)
Incorrect timing of drug administration	12 (26.1)
Repetition of similar drug at a short interval	9 (19.6)
Accidental swapping of syringes	7 (15.2)
Substitution of drug	5 (10.9)
Wrongly identified patient	2 (4.3)
Source of medication error	
Fatigue or overworked	37 (80.4)
Hectic Operation Theatre environment	33 (71.7)
Inattention or carelessness	29 (63.0)
Poor communication	28 (60.9)
Distraction	28 (60.9)
Haste	27 (58.7)
Messy and crowded workstation	24 (52.2)
Unfamiliarity of the environment	22 (47.8)
Poor labelling of the syringes	22 (47.8)
Demanding or difficult case	18 (39.1)
Inexperience or inadequate training	17 (37.0)
Failure to perform a routine check	16 (34.8)
Excessive dependency on other personnel	15 (32.6)
Insufficient planning or preparation	14 (30.4)
Sharing of medication trays among patients	11 (23.9)
Lack of supervision or guidance	10 (21.7)
Visual field restriction	4 (8.7)

prescribed and wrong prescription were among the common errors reported. The two most common sources of medication error reported were fatigue/overwork and a hectic OT environment.

Our survey also demonstrated an alarming and poor level of awareness of drug costs among all the participants. Figure 1 shows the respondents' answers to the questions on drug cost. The respondents underestimated the drug cost in 10 out of 14 questions. The majority of the care providers agreed that drug wastage occurrence is common in OTs. In our survey, the common drugs in OT that were found to be frequently wasted in descending order were atropine, phenylephrine, ephedrine and propofol.

A total of 2039 surgical cases were included during the 16-week study period, with an average of 500 cases done per month. The pre-intervention survey found that the most wasted drug was ephedrine, followed by atropine, propofol, adrenaline, suxamethonium, fentanyl, phenylephrine and rocuronium [Table 2]. After the interventional period, there was a significant reduction in the medication ordering trend for vasoactive drugs, usually prepared as standby drugs, followed by neuromuscular blocking agents.

The post-interventional survey showed a wastage reduction of 80% for rocuronium (~MYR 1480 saving), 75% for suxamethonium (~MYR 660 saving), 75% for atropine (~MYR 225 saving), 60% for phenylephrine (~MYR 684 saving) and 50% for ephedrine (~MYR 130 saving), as presented in Table 2. The estimated overall cost savings over 16 weeks were MYR 4683. No medication error was reported in the registry after educational posters and workshops were conducted.

DISCUSSION

This audit demonstrated that the Medication Stewardship–Safe Anaesthesia for ALL (SEAL) project, which included education, standardised workflow, and the creation of a medication registry, prevented medical errors and markedly reduced drug wastage.

Medication errors are high in anaesthesia, as the OT is a highly stressful and time-sensitive work environment.[17] However, most medication errors are often underreported in hospitals. The most common contributors to medication errors are hectic and crowded environments, fatigue and exhaustion, ineffective communication and miscommunication.[18-20] Introducing a new SOP for medication stewardship to all providers effectively eliminates process-based medication errors and reduces drug wastage. In addition, our medication stewardship registry allows for anonymous self-reporting and second-person reporting by the stewardship officer to minimise the typical bias of self-reporting due to providers' reluctance and failure to recognise errors they have made. We also elected MSOs to monitor compliance with implemented measures by care providers to minimise process-based errors, which were attributed to crowded workspace, improper syringe labelling, lapses and near misses during drug administration and miscalculations of drug dosages. However, our tertiary educational hospital centre cannot implement the bar code-assisted syringe documentation system.[17]

Our participants had low awareness of drug costs. Bailey *et al*.[21] and Qin *et al*.[22] also reported a lack

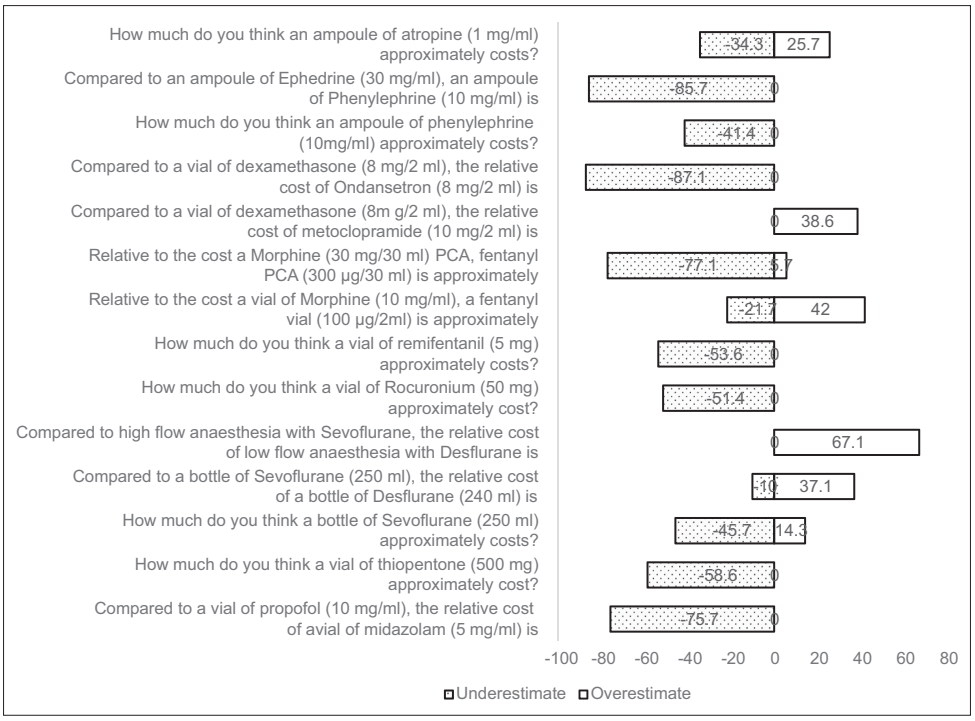

Figure 1: Respondents' knowledge of drug costs (n = 70). The respondents' median cost estimate is expressed as a percentage of true cost, that is, 0 = correct estimate. PCA = patient-controlled analgesia

Table 2: Percentage of drug wastage and post-intervention reduction of medication ordering and cost saving

Drugs	Price per vial (MYR)	Amount of drug ordered every week pre-intervention (*n*)	Amount of drug wasted *n* (%)	Amount of ordering reduction (%)	Amount saved (MYR)
Rocuronium	7.4	250	1 (2.5)	200 (80.0)	1480
Suxamethonium	4.4	200	2 (5.0)	150 (75.0)	660
Atropine	1.5	200	9 (22.5)	150 (75.0)	225
Atracurium	4.3	300	1 (2.5)	200 (67.0)	860
Adrenaline	1.65	150	2 (5.0)	100 (67.0)	165
Phenylephrine	11.4	100	1 (2.5)	60 (60.0)	684
Ephedrine	1.3	200	11 (27.5)	100 (50.0)	130
Fentanyl	2.8	400	2 (5.0)	50 (25.0)	140
Propofol	3.4	250	3 (7.5)	50 (20.0)	170
Ondansetron	13.3	50	1 (2.5)	10 (20.0)	133
Morphine	1.2	200	1 (2.5)	30 (17.0)	36
				Total saving =	4683

MYR=Malaysian Ringgit

of cost-consciousness about anaesthetic drugs among the providers. Rinehardt and Sivarajan[5] showed no correlation between the lack of cost-consciousness among the providers and the number of years of anaesthesia practice. It is believed that adequate knowledge of peri-anaesthetic drug costs will empower a change in clinical practice towards cost reduction without affecting the quality of care.[22,23]

Similar to the findings of Atcheson *et al*.,[10] our findings showed that the most wasted drugs were vasoactive agents. The wastage is attributed to the crisis preparedness behaviour of anaesthesiologists in handling emergencies during surgery.[10] This practice can lead to significant drug wastage if all the elective and emergency OTs prepare their drugs. Hence, this quality improvement project reserved the practice of emergency drug preparation only for emergency OTs or certain indicated haemodynamically unstable patients. For elective OTs, a clean syringe sharing of emergency drugs is available at the designated area. The providers were allowed to place an atropine or ephedrine vial in the medication tray along with an empty syringe and water for injection to expedite the drug preparation process when necessary, which is also recommended by More *et al*.[11] In our setting, we

allow split doses of diluted phenylephrine to be shared among all elective OTs following a strict protocol to prevent cross-contamination among users. Weinger also recommends a split-dose strategy.[24] A similar trend was also observed in neuromuscular blocking agents. Kaniyil *et al*.[8] opined that the wastage of muscle relaxants was the highest financial burden. Our implementation measures were estimated to positively contribute almost MYR 20,000 per year of cost savings from preventable drug wastage in OTs.

The strength of this study was the successful prevention of medication error and reduction of drug wastage through education and standardisation of SOPs. Standardisation of care has successfully minimised the potential source of error and allows an effective symphony of communication. With adequate knowledge of peri-anaesthetic drug costs, a change in practice towards cost reduction is empowered. As a result, our centre has incorporated specific drug decision support and alerts into the electronic prescribing system to minimise the risk of medication error.

Nevertheless, this project has several limitations. First, a longer interventional period and post-interventional phases are needed to collect larger data for cost-effectiveness analysis. Second, our centre regularly changes anaesthesiology trainees every six months. Therefore, this project needs to be reimplemented periodically to ensure the continuous provision of safe anaesthesia for all patients. To address this limitation, we created a pre-recorded video of medication stewardship SOPs, which is compulsory for the new trainees to attend as part of their orientations in our centre.

CONCLUSION

In conclusion, this quality improvement project successfully prevented medication errors and reduced drug wastage in a tertiary training hospital in a developing country with limited resources.

Study data availability

De-identified data may be requested with reasonable justification from the authors (email to the corresponding author) and shall be shared after approval as per the authors' institution policy.

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Conflicts of interest

There are no conflicts of interest.

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SUPPLEMENTARY MATERIALS

Appendix 1: Questionnaire

DRUG WASTE

1) Job title
   - Consultant
   - Specialist
   - Medical Officer
   - Nurse
2) Years of practice in anaesthesia
   - 0–1
   - 2–3
   - 4–5
   - >5
3) Is medication wastage a problem in your setup?
   - Yes
   - No
   - Maybe
4) In which situation does medication wastage commonly happen?
   - Emergency case
   - Elective case
   - Both
5) How many unused diluted medications have you discarded daily?
   - 0
   - 1
   - 2
   - 3
   - 4
   - 5 or more
6) Can you guess how much is the cost of medication wastage daily in the OR you are in charge?
   - About RM10
   - Less than RM50
   - Between RM50 and RM100
   - More than RM100
7) Which of the following drugs are most commonly wasted?
   - Propofol
   - Midazolam
   - Thiopentone
   - Remifentanil
   - Fentanyl
   - Morphine
   - Suxamethonium
   - Rocuronium
   - Atracurium
   - Sevoflurane
   - Desflurane
   - Atropine
   - Adrenaline
   - Ephedrine
   - Phenylephrine

- Dexamethasone
- Ondansetron
- Metoclopromide (Maxalon)

DRUG COST

1. Compared to a vial of propofol (10 mg/ml), the relative cost of a vial of midazolam (5 mg/ml) is
   - 1/2 of the price of propofol (10 mg/ml)
   - The same price of propofol (10 mg/ml)
   - 2 times the cost of propofol (10 mg/ml)
2. How much do you think a vial of thiopentone (500 mg) approximately costs?
   - About RM5
   - About RM10
   - About RM20
3. How much do you think a bottle of sevoflurane (250 ml) approximately costs?
   - About RM200
   - About RM400
   - About RM600
   - About RM800
4. Compared to a bottle of sevoflurane (250 ml), the relative cost of a bottle of desflurane (240 ml) is
   - same as the cost of sevoflurane
   - 2 times the cost of sevoflurane
   - 3 times the cost of sevoflurane
   - 4 times the cost of sevoflurane
5. Compared to high-flow anaesthesia with sevoflurane, the relative cost of low-flow anaesthesia with desflurane is
   - Same cost as high-flow anaesthesia with sevoflurane
   - 2 times the cost of high-flow anaesthesia with sevoflurane
   - 3 times the cost of high-flow anaesthesia with sevoflurane
   - Lower than the cost of high-flow anaesthesia with sevoflurane
   - Low-flow anaesthesia (<1 l/min)
6. Using a standard intubation dose for an 80 kg adult, please rank the cost of following neuromuscular blockers from the most expensive to the least expensive (one selection allowed per column)

Most expensive Intermediate Least expensive
   - 6 - Atracurium
   - 7 - Rocuronium
   - 8 - Suxamethonium

9. How much would a vial of rocuronium (50 mg) cost approximately?
   - About RM1
   - About RM3
   - About RM5
   - About RM7
10. How much do you think a vial of remifentanil (5 mg) approximately costs?
   - About RM50
   - About RM100
   - About RM150
   - About RM200
11. Relative to the cost of a vial of morphine (10 mg/ml), a fentanyl vial (100 μg/2 ml) is approximately
   - The same price as morphine (10 mg/ml)
   - 2 times the cost of morphine (10 mg/ml)

- 3 times the cost of morphine (10 mg/ml)
- 6 times the cost of morphine (10 mg/ml)

12. Relative to the cost of a morphine (30 mg/30 ml) PCA, fentanyl PCA (300 μg/30 ml) is approximately
    - The same price as PCA morphine (30 mg/30 ml)
    - 3 times the cost of PCA morphine (30 mg/30 ml)
    - 6 times the cost of PCA morphine (30 mg/30 ml)
    - 9 times the cost of PCA morphine (30 mg/30 ml)
13. Compared to a vial of dexamethasone (8 mg/2 ml), the relative cost of metoclopramide (10 mg/2 ml) is
    - The same price as dexamethasone (8 mg/2 ml))
    - 2 times the cost of dexamethasone (8 mg/2 ml)
    - 3 times the cost of dexamethasone (8 mg/2 ml)
    - 4 times the cost of dexamethasone (8 mg/2 ml)
14. Compared to a vial of dexamethasone (8 mg/2 ml), the relative cost of ondansetron (8 mg/2 ml) is
    - The same price as dexamethasone (8 mg/2 ml)
    - 5 times the cost of dexamethasone (8 mg/2 ml)
    - 10 times the cost of dexamethasone (8 mg/2 ml)
    - 13 times the cost of dexamethasone (8 mg/2 ml)
15. How much do you think an ampoule of phenylephrine (10 mg/ml) approximately costs?
    - <RM1
    - About RM1
    - About RM5
    - About RM10
16. Compared to an ampoule of ephedrine (30 mg/ml), an ampoule of phenylephrine (10 mg/ml) is
    - The same price as ephedrine (30 mg/ml)
    - 3 times the cost of ephedrine (30 mg/ml)
    - 7 times the cost of ephedrine (30 mg/ml)
    - 10 times the cost of ephedrine (30 mg/ml)
17. How much do you think an ampoule of atropine (1 mg/ml) approximately costs?
    - <RM1
    - About RM2
    - About RM3
    - About RM5

RM = **Malaysian ringgit**

MEDICATION ERROR

This section has 13 questions. Kindly read through the definitions below before answering Questions 1–7.

DEFINITION OF TYPE OF ERROR

MEDICATION ERROR: Any preventable event that may cause or lead to inappropriate medication use or patient harm while the medication is in the control of the healthcare professional, patient or consumer

NEAR MISS: The occurrence of an error that did not result in harm

SLIP: A failure to execute an action due to routine behaviour being misdirected

LAPSE: A failure to execute an action due to a lapse in memory and a routine behaviour being omitted

MEDICAL ERROR: The failure of a planned action to be completed as intended or the use of a wrong plan to achieve an aim

ADVERSE DRUG EVENT: Any injury related to the use of a drug

PREVENTABLE ADVERSE DRUG EVENT: Harm that could have been avoided through reasonable planning or proper execution of an action

Questions 1–7: Based on the above definitions, match the situation to the type of error that has occurred.

(One selection allowed per column) Near Miss Lapse Slip Medical Error Medication Error Adverse Drug Event Preventable Adverse Drug Event

1. Dr. K has syringed out fentanyl into a 3-ml syringe and wrongly written the unit in milligrams instead of micrograms
2. Dr. A has already planned to prescribe patient X with midazolam premedication, but he has forgotten to write the prescription. Hence, premedication is not served
3. A young and fit patient not known to have an allergy developed a generalised rash following an antibiotic
4. Dr. G administered IV morphine 4 mg to a 3-year-old patient (weight: 15 kg) whereas the maximum total morphine dose for the child is 3 mg
5. An 80-year-old was given sedation for OGDS with IV midazolam 5 mg and IV fentanyl 100 μg and developed an apnoea episode with desaturation
6. Dr. F accidentally took an atropine vial instead of adrenaline from the drawer and realised his mistake before drug administration
7. Dr. Q did not prescribe aspiration prophylaxis for an obese parturient who is planned for elective caesarean section because he is unaware of increased aspiration risk among obstetric patients
8. Have you ever experienced a medication error throughout your career?
   - Yes
   - No
   - Unsure
9. Based on the type of medication error you have experienced or witnessed previously, please rank (1–7) the type of medication error from the most common (1) to the rarest (7)./.
   (One selection allowed per column)

1. (most common) 2 3 4 5 6 7 (rarest)
   - Near miss
   - Lapse
   - Slip
   - Medical error
   - Medication error
   - Adverse drug event
   - Preventable adverse drug event

10) Which of the following medication errors has occurred or witnessed by you before?
   - Wrong prescription
   - Misidentification of ampoules
   - Wrongly labelled the syringes
   - Miscalculation of the drug doses
   - Wrong patient identification
   - Syringe swap
   - Wrong route of administration
   - Incorrect timing of administration
   - Omission of drug to be given
   - Repetition of drug to be given
   - Substitution of drug to be given

You can choose more than one answer

11) Based on your personal experience, choose the reason that could have precipitated the occurrence of 'medication error'?
   - Inadequate total experience or training
   - Inadequate familiarity with equipment or device

- Poor communication with team
- Haste
- Inattention or carelessness
- Fatigue or overworked
- Excessive dependency on other personnel
- Failure to perform routine check
- Lack of enough supervision
- Hectic operating room environment
- Visual field restriction
- Distraction
- Poor labelling of drugs
- Confusion of the drug dose or concentration
- Demanding or difficult case
- Sharing of drug tray between patients
- Insufficient planning or preparation
- Messy and narrow workstation

You can choose more than one answer

12) At which stage of drug handling, medication error most commonly occurred?
- During drug preparation
- During drug administration
- During the recording of the delivered drug

13) Why do you think medication error is underreported?
- Adverse event not recognised
- Reluctance among doctors to admit the error
- Failure to report an error during medication handling

IV = intravenous, OGDS = oesophagogastroduodenoscopy, PCA = patient-controlled analgesia

Appendix 2:

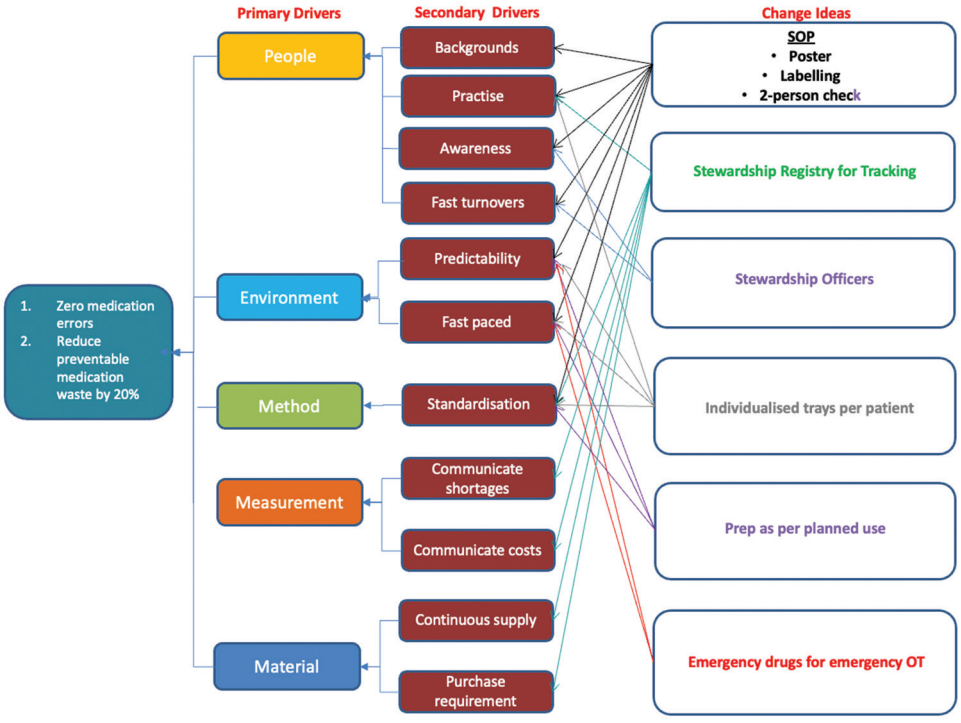

Figure: Targeted Medication Stewardship Strategies

OT = operation theatre, SOP = standard operating procedure

Appendix 3:

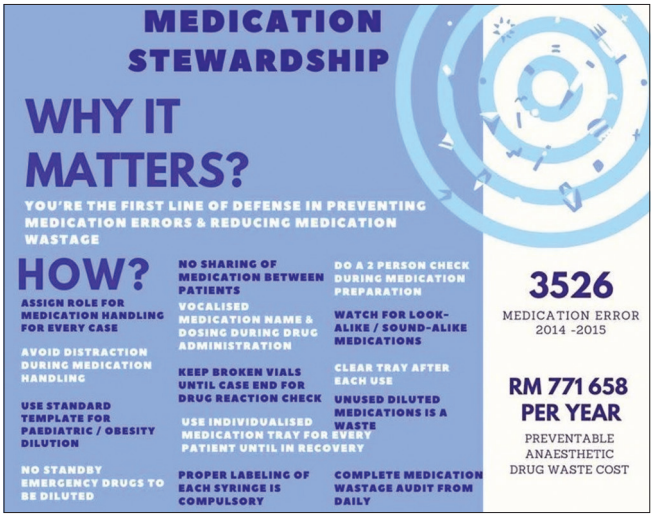

Figure: Medication stewardship SOP poster

SOP = standard operating procedure

Appendix 4:

Figure: Drug cost education poster

Appendix 5:

Figure: Educational poster on look-alike sound-alike medications

Appendix 6:

Table: Standardisation of drug dilution		
	Name of medication	**Dilution**
Hypnotics	Propofol	Neat in 2×syringes 10 ml
	Ketamine	10 mg/ml in syringe 5/10 ml
	Midazolam	1 mg/ml in syringe 5 ml
	Thiopentone	25 mg/ml in 2×syringe 10 ml
Opioids	Morphine	1 mg/ml in syringe 10 ml
	Remifentanil	1 mg/ml in vial
		50 µg/ml diluted as needed
		20 µg/ml (paediatrics)
Neuromuscular Blockade Drug	Atracurium	Neat in syringe 5 ml
	Rocuronium	Neat in syringe 5 ml
Emergency	Ephedrine	6 mg/ml in syringe 5 ml
	Atropine	0.2 mg/ml in syringe 5 ml
	Phenylephrine	100 µg/ml in 100 ml normal saline
Antiemetics	Dexamethasone	Neat in 2×syringes 3 ml
	Ondansetron	Neat in 2×syringes 3 ml

Appendix 7: Paediatric/Obesity Drug Dose Calculation and Dilution Template

Template for Paediatric/Obesity Drug Dilution

Name/Sticker :
Age :
Weight/Height :
Adjusted body weight (BMI) :
ETT size :

Induction Agent
Propofol (2–4 mg/kg) :
Midazolam (0.1–0.2 mg/kg) :
Ketamine (1–2 mg/kg) :

Muscle Relaxant
Atracurium (0.5–0.6 mg/kg) :
Rocuronium (0.5–1 mg/kg) :
Suxamethonium (1–1.5 mg/kg) :

Analgesia
Fentanyl (1–2 µg/kg) :
Morphine (0.1–0.2 mg/kg) :
Paracetamol; IV < 10 kg (7.5 mg/kg) :
IV > 10 kg (15 mg/kg) :
Supp (30–40 mg/kg) :
Voltaren; Supp (1–2 mg/kg) :
Local anaesthetic: Bupivacaine (2 mg/kg) :

Resuscitation Drug
Atropine (10–20 µg/kg) :
Adrenaline 1:10,000 (0.1 ml/kg) :

Antiemetic/antisialagogue
Dexamethasone (0.15 mg/kg) :
Ondansetron (0.1 mg/kg) :
Glycopyrrolate (4 μg/kg) :

Fluids

Total blood volume :
Deficit :
Maintenance :
Loss :
BMI = body mass index, IV = intravenous