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Full Length Research Paper

The survey of look alike/sound alike (LASA) drugs available in hospitals in Thailand

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A cross-sectional survey was designed to study look-alike, sound-alike (LASA) drugs in hospitals in Thailand. The questionnaires were developed and mailed to 1,380 hospitals throughout Thailand. The return rate was 11.16% or 154 hospitals, consisting of 5 tertiary hospitals (3.25%), 3 university hospitals (1.95%), 16 secondary hospitals (10.39%), 96 primary hospitals (62.34%), 26 private hospitals (16.88%) and 8 others (5.20%). A total of 5,327 pairs of drugs were identified as LASA drugs, including 3,695 tablets/capsules (Ranitidine-Roxithromycin pair in the highest frequency), 944 injections (Diazepam-Furosemide pair in the highest frequency), 307 liquid dosage forms (Alum milk-Milk of magnesia pair in the highest frequency), 367 external drugs (0.02% Triamcinolone cream and 0.1% Triamcinolone cream pair in the highest frequency) and 14 pairs of chemotherapeutic agents. This LASA report could be integrated into a suitable program used in hospitals in order to identify and prevent medication errors in the future.

Key words: Look-alike, sound-alike, look-alike, sound-alike (LASA), hospital, Thailand.

INTRODUCTION

The confusion of similar drug names is one of the most common causes of medication errors worldwide that threatens patients' safety (WHO, 2007a; Lambert et al., 2001, 1999; Basco et al., 2010; Phatak et al., 2005). With tens of thousands of drugs currently available, both of brandname and generic in the market, the potential for medication error due to confusing drug names is significant (WHO, 2007a; The Joint Commission, 2001). Causes of look-alike, sound-alike (LASA) medication errors were identified; and include illegible handwriting, unfamiliarity with drug names, similarity in the spelling and/or pronunciation of drug names, newly available products, similar packaging or labeling, similar clinical use, similar strength, dosage forms, frequency of administration, incorrect selection of a similar name from a computerized product list, and the failure of manufacturers and regulatory authorities to recognize the potential for error and to conduct rigorous risk assessments, both for nonproprietary and brand names, prior to approving new product names (WHO, 2007a; Lambert et al., 2001; McCoy, 2005; Hoffman and Proulx, 2003). More than 33,000 trademarked and 8,000 nonproprietary medication names were reported in the United States alone in 2004, and an estimated 24,000 therapeutic health products were reported in the Canadian market (WHO, 2007a). On June 2011, the Institute for Safe Medication Practices (ISMP) (2011a, b) reported a listing of confusing drug names involved in medication errors that were reported through the ISMP National Medication Errors Reporting Program (ISMP MERP) (ISMP, 2011a). The United States Pharmacopeia (USP) also publishes a list of look-alike and sound-alike drug names periodically. Name pairs that have been included in LASA medication error reports are listed alphabetically (Cohen et al., 2007; Carothers, 1995). The aim of our list is to help healthcare providers and the public to determine which medications require special

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Table 1. Affiliation of the hospital.

Organisation	N	(n =154) %
Primary hospitals	96	62.34
Private hospitals	26	16.88
Secondary hospitals	16	10.39
Other hospitals	8	5.20
Tertiary hospitals	5	3.25
University hospitals	3	1.95

safeguards to reduce the risk of errors (ISMP, 2011). Sauberan et al. (2010) reported cases of medication dispensing errors with look-alike, sound alike medication in neonatal care units, where multidisciplinary collaboration within the system helped the pharmacy identify, resolve and prevent errors related to medication storage, labeling, delivery, knowledge, and administration documentation. Santell et al. (2009) found that look-alike, sound-alike drug names is one of the problems associated with computer entry and actions at the university of Pittsburgh Medical, causing of order-entry errors and adverse drug events. Number of errors from brand or generic name look-alike are 887 (1.6%) from Medmarx®, 22 (3.1%) from University of Pittsburgh Medical Center (UPMC). Actions included adding warning notes and mixed-case or uppercase lettering in the pharmacy computer system and informing pharmacy staff through e-mail notices of the potential for drug name confusion errors when drug products are added to the formulary or when drug mix-up errors occur. Additionally, the USP operates MEDMARX, an internet-accessible, anonymous error-reporting program specifically designed for hospital and health care system (Hicks et al., 2004; Nosek et al., 2010). A 2008 MEDMARX report by the USP identified 1,470 drugs involved in LASA errors, including categorizing medication errors (Hicks et al., 2008). A retrospective study revealed that one of the causes of medication errors in the inpatient department of Mahasarakham Hospital, Thailand, was LASA drugs, such as the confusing similar-sound of dobutamine injection and dopamine injection (Pattanajak, 2006).

In 2005, the World Health Organization (WHO) lanched the World Alliance for Patient Safety and identified six action areas which look-alike, sound-alike medication names is one of the inaugural patient safety solutions (WHO, 2007b). Similarly, in Thailand, the Thai Patient Safety Goals 2008 program was developed to improve medication safety with focus on LASA drugs. The program is based on WHO Collaborating Centre for Patient Safety Solutions (2007a, b) and is still used as a guideline in Thailand (The Healthcare Accreditation Institute, 2011). However, there have been few studies specifically addressing look-alike, sound-alike medication in Thailand, therefore this study surveys the pair list of LASA drugs in hospitals in Thailand.

METHODS

This was a cross-sectional survey research. The questionnaires were sent along with an accompanying letter by mail to 1,380 hospitals through out Thailand during December 2009 to January 2010. The questionnaire was designed to gather data in the area of personnel affiliation, the LASA drug list generic/brand name and the form of drug, including tablets/capsules, injectable drugs, liquid preparations, external use preparations and chemotherapy agents, as well as, a medication error categorization index (category A-I) for each LASA pair, according to the National Coordinating Council for Medication Error, Reporting and Prevention (NCC MERP's, 1998-2012) index for categorizing medication errors. Category A represents circumstances or events that have the capacity to cause error, category B indicates that a medication error occurred but it did not reach the patient, categories C and D designate medication errors that reached the patient but did not result in patient harm. The varying level of patient harm is reflected in categories E, F, G and H. Category E refers to errors that may have contributed to or resulted in temporary harm to the patient and required intervention. Category F contains errors that may have contributed to or resulted in temporary harm to the patient and required initial or prolonged hospitalization. Category G labels all errors that may have contributed to or resulted in permanent patient harm. Category H errors require intervention necessary to sustain life and any medication error that resulted in, or may have contributed to a patient's death is classified as category I (NCC MERP, 1998 to 2012; Hartwigh et al., 1991; Dubey et al., 2006). All of the error reports were submitted using voluntary error reporting programs in each hospital, by health care professionals (pharmacists, nurses and physicians).

RESULTS

After a month of distribution, 154 completed questionnaires were returned (11.16% response rate). Data from questionnaires were evaluated. All respondents were affiliated with hospitals of various types, as shown in Table 1. Response was received, with most frequently response from primary hospitals (62.34%). Ninety percent (90.91%) of hospitals found LASA medication errors a relevant problem.

This study identified 5,327 pairs of LASA drugs. Tablet/capsule forms appeared most frequently (3,695, 69.36%), followed by injection preparation (944, 17.72%), external use preparations (367, 6.89%), liquid preparations (307, 5.76%) and chemotherapeutic agents (14, 0.26%), respectively.

The study revealed two distinct types of drug similarity, based on the source of confusion. Similar spelling or pronunciation (LASA) caused visual and auditory confusion, while similar packaging/labeling (LA1) or similar tablets/capsules (LA2) caused visual-only confusion.

The most frequently occurring similarity was LASA stemming from similar spelling or pronunciation, as shown in Table 2. From the surveyed medication error categories, category B error occurred but did not reach the patient and was most prevalently reported (Table 3). No category I (fatal) errors were reported. Harmful medication errors (category F, G) are shown in Table 4. From all the reported drugs, 3,695 pairs were tablets/

Table 2. Types of LASA (n = 6,550, one pair of LASA may have more than one type of LASA).

Preparations	Types of LASA pairs		
	LASA	LA	
	(Similar spelling/pronunciation)	(Similar packaging/labeling)	(Similar tablets/capsules)
Tablets/Capsules	2745	868	1143
Injections	519	540	0
Liquid dosage forms	110	207	0
External use preparations	233	170	0
Chemotherapeutic agents	8	6	1
	3615 (55.19%)	1791 (27.34%)	1144 (17.47%)

Table 3. Cross-tabulation of type of medication by error category index (n = 3,161; some pairs of LASA did not report error category index).

Preparations	Error category (pairs)								
	A	B	C	D	E	F	G	H	I
Tablets/Capsules	435	1469	185	30	14	7	3	0	0
Injections	132	389	57	19	2	0	0	0	0
Liquid dosage forms	40	156	23	1	0	0	0	0	0
External use preparations	33	146	13	0	0	0	0	0	0
Chemotherapeutic agents	2	5	0	0	0	0	0	0	0
	642	2165	278	50	16	7	3	0	0
	(20.31%)	(68.49%)	(8.79%)	(1.58%)	(0.51%)	(0.22%)	(0.09%)	(0.00%)	(0.00%)

Table 4. Harmful medication error (category F, G) of LASA pairs (N = 3,161).

Drug name	Drug name	No. (drug pairs)	%	Preparations	Types of LASA pairs*	Error Category	Affiliation (hospital)
Atarax	Ativan	1	0.03	Tablets/capsules	LASA	G	Private
Clotrimazole	Cotrimoxazole	1	0.03	Tablets/capsules	LASA	G	Private
Voltaren	Ventolin	1	0.03	Tablets/capsules	LASA	G	Private
Clozapine	Carbamazepine	1	0.03	Tablets/capsules	LASA	F	Primary
Haloperidol	Propranolol	1	0.03	Tablets/capsules	LASA	F	Others
Ranitidine	Roxithromycin	1	0.03	Tablets/capsules	LASA	F	Others
Terbutaline (2.5 mg)	Tianeptine (12.5 mg)	1	0.03	Tablets/capsules	LASA	F	Others
Gemfibrozil	Glibenclamide	1	0.03	Tablets/capsules	LASA	F	Primary
Atenolol (50 mg)	Allopurinol (100 mg)	1	0.03	Tablets/capsules	LASA, LA1	F	Primary
Spironolactone (Aldactone)	Methyldopa (Aldomet)	1	0.03	Tablets/capsules	LASA	F	Primary

*Types of LASA pairs: LASA = similar spelling/pronunciation; LA1 = similar packaging/labeling; LA2 = similar tablets/capsules.

capsules (Ranitidine and Roxithromycin pair in the highest frequency) (Table 5), 944 were injections (Diazepam injection and Furosemide injection pair in the highest frequency) (Table 6), 307 were liquid dosage forms (Alum milk and Milk of magnesia pair in the highest frequency) (Table 7), 367 were external drugs (0.02% Triamcinolone cream and 0.1% Triamcinolone cream pair in the highest frequency) (Table 8) and 14 pairs were chemotherapeutic agents (Table 9). There were 323 pairs of high-alert medications, all in injection preparation form. However, the list of potential high-alert medications can vary by individuals and organizations. This study distinquished 6 distinct variations (Warinchumrab hospital, 2009; ISMP, 2011b) shown in Tables 10 to 14; including narrow therapeutic index medications (110, 34.06%), highly concentrated electrolytes (36, 11.15%), emergency

Table 5. Top ten LASA pairs in tablet/capsule form (N = 3,695).

Drug name	Drug name	No. (Drug pairs)	%	Types of LASA pairs	Error Category	Affiliation (hospital)
Ranitidine	Roxithromycin	29	0.78	LASA, LA1, LA2	A,B,C,F	Primary Secondary Private Others
Hydralazine	Hydroxyzine	23	0.62	LASA, LA1, LA2	A,B,D	Primary Secondary Tertiary Private Others
Glibenclamide	Glipizide	19	0.51	LASA, LA1, LA2	A,B,C,D	Primary Secondary Tertiary Private
Propranolol (10 mg)	Propranolol (40 mg)	18	0.49	LASA, LA1, LA2	A,B,C	Primary Tertiary Others
Lasix	Losec	17	0.46	LASA	A,B,C	Primary Secondary Tertiary Private
Loratadine	Lorazepam	17	0.46	LASA, LA1, LA2	A,B	Primary Secondary Private Others
Voltaren	Ventolin	17	0.46	LASA, LA1, LA2	B	Primary Secondary Private
Gliclazide	Glipizide	16	0.43	LASA, LA1, LA2	A,B	Primary ondarySec Tertiary University Private Others
Merislon	Mestinon	14	0.38	LASA	A,B	Secondary University Private Others
Ibuprofen (200 mg)	Ibuprofen (400 mg)	11	0.30	LASA, LA1, LA2	A,B	Primary Secondary

*Types of LASA pairs: LASA = similar spelling/pronunciation; LA1 = similar packaging/labeling; LA2 = similar tablets/capsules.

Table 6. Top ten LASA pairs in injection form (N = 944).

Drug name	Drug name	No. (drug pairs)	%	Types of LASA pairs	Error category	Affiliation (hospital)
Diazepam	Furosemide	38	4.0	LASA, LA1	A, B	Primary Secondary Tertiary Private
Dobutamine	Dopamine	29	3.1	LASA, LA1	A, B	Primary Secondary Tertiary Private Others
Vitamin K1 (1 mg)	Vitamin K1 (10 mg)	27	2.9	LASA, LA1	A, B, C, D	Primary Secondary tiaryTer Private Others
Vitamin K1	Vitamin B complex	16	1.7	LASA, LA1	A,B,C,D	Primary Secondary Private Others
Adenosine	Adrenaline	15	1.6	LASA, LA1	A, B	Primary Secondary Tertiary Private Others
Ceftazidime	Ceftriaxone	15	1.6	LASA, LA1	A, B, C	Primary Private
Lasix	Losec	14	1.5	LASA	A, B, C, D	Primary Secondary Private Others
Vitamin K1 (2 mg)	Vitamin K1 (10 mg)	11	1.2	LASA, LA1	A, B	Primary Secondary Tertiary Private
Ampicillin (500 mg)	Ampicillin (1000 mg)	10	1.1	LASA, LA1	A, B	Primary Private
Ceftazidime (1000 mg)	Ceftriaxone (1000 mg)	10	1.1	LASA	A, B, D	Primary Private

Table 7. Top ten LASA pairs in liquid dosage form (N=307).

Drug name	Drug name	No. (drug pairs)	%	Types of LASA pairs	Error Category	Affiliation (hospital)
Alum milk	Milk of magnesia	8	2.61	LA1	A,B,C	Primary Secondary Tertiary Private Others
Amoxicillin (125 mg)	Amoxicillin (250 mg)	7	2.28	LASA,LA1	A,B,C	Primary Secondary Private
Ammonium carbonate	M.tussis	5	1.63	LASA,LA1	B	Primary Secondary
Amoxicillin	Erythromycin	5	1.63	LA1	A,B	Primary
Amoxicillin	Cloxacillin	5	1.63	LA1	A,B	Primary Private
Domperidone	Hyoscine	3	0.98	LA1	N/A	Primary
Amoxicillin	Amoxicillin + Clavulanic acid	3	0.98	LASA	A,B	Primary
Bromhexine	Brown mixture	3	0.98	LASA	A,B,C	Primary
Domperidone	Hyoscine	3	0.98	LA1	B	Primary Secondary
Miotin	Meptin	3	0.98	LASA	A	Private

drugs (93,28.79%), antidotes (68, 21.05%), high-alert drugs in obstetric medications (15, 4.64%) and high-alert drugs in anesthetic agents (1, 0.31%; Methergin injection and Pancuronium injection which have similar packaging, category B error and were found in a tertiary hospital).

DISCUSSION

Confusing drugs with similar names constitute about 10% of all medication errors. The American Pharmacists Association reported that there are more than 33,000 trademarked medication names in the United States and more than 9,000 generic names (American Hospital Association, 2005). In this study, all participating hospitals reported LASA-related medication errors, both from the governmental and from the private sector. Most participants are affiliated with primary hospitals (62.34%) the most prevalent type of hospitals nationwide (730 hospitals, 91.7%) (Ministry of Public Health, 2011). These institutions provide primary health care for the most patients, resulting in highest workload for physicians in Thailand, followed by physicians in secondary, tertiary, university and private hospitals, respectively. Although most LASA reports came from respondents affiliated with primary or community hospitals, the overall response rate was low (11.16% or 154 completed questionnaires), perhaps due to Thailand's insufficient medication-error-reporting infrastructure, such as MEDMARX® and USP-ISMP and due the voluntary nature of reporting (Ministry of Public Health, 2011; Macagba, 2011). It is also worth noting that there are no comparable data available from specialty hospitals and military hospitals, because they did not return the questionaire. The Joint Commission on Accreditation of Healthcare Organizations now requires that accredited health care organizations develop and maintain programs to minimize these LASA medication risks; a good example of this is the annual report list of

Table 8. Top ten LASA pairs in external form (N = 367).

Drug name	Drug name	No. (drug pairs)	%	Types of LASA pairs	Error Category	Affiliation (hospital)
Triamcinolone cream (0.02%)	Triamcinolone cream (0.1%)	21	5.72	LASA, LA1	A, B	Primary Secondary Private
Chloramphenicol ear drop	Chloramphenicol ED	14	3.81	LASA, LA1	A, B, C	Primary Private University
Berodual MDI	Budesonide MDI	11	3.00	LASA, LA1	A	Pyrimar Secondary Tertiary
Chloramphenicol ED	Chloramphenicol EO	8	2.18	LASA, LA1	B	Primary Secondary Private
Clobetasol cream	Clotrimazole cream	8	2.18	LASA, LA1	B	Primary Secondary
Nasocort nasal spray	Nasonex nasal spray	8	2.18	LASA, LA1	A, B	University Private Others
Hista oph	Dex oph	6	1.63	LASA, LA1	B	Primary Secondary Private
Spersallerg ED	Spersadexoline ED	6	1.63	LASA	A, B	Private, University Others
Clotrimazole cream	Clobetasol cream	5	1.36	LASA, LA1	B	Primary Tertia y
Fucidine	Fucidine H	4	1.09	LASA, LA1	B, C	Private

Table 9. Top ten LASA pairs in chemotherapeutic agents (N = 14).

Drug name	Drug name	No. (drug pairs)	%	Types of LASA pairs	Error category	Affiliation (hospital)
Carboplatin	Cisplatin	3	21.4	LASA, LA1	A	Secondary
Vinblastine	Vincristine	2	14.3	LASA	B	Private
5-FU (500 mg)	5-FU (250 mg)	1	7.14	LA1	N/A	Secondary
Cyclophosphamide	Methotrexate	1	7.14	LA1	B	Private
Cytosar	Vincristine	1	7.14	LA1	B	University
Doxorubicin	Farmorubicin	1	7.14	LASA	N/A	Tertiary
Hydralazine	Hydroxyurea	1	7.14	LASA	N/A	Private
Methotrexate	Multivitamin	1	7.14	LA1	B	Tertiary
Methotrexate	Tamoxifen	1	7.14	LASA	B	Secondary
Mybacin	Myleran	1	7.14	LA1, LA2	A	Primary

Table 10. Top ten of LASA pairs in high-alert narrow therapeutic index medications (N =110).

Drug name	Drug name	No. (drug pairs)	%	Preparations	Types of LASA pairs	Error Category	Affiliation (hospital)
Diazepam	Furosemide	38	34.55	Injections	LA1	A, B	Primary Secondary Tertiary Private
Gentamicin	Metoclopramide	10	9.09	Injections	LA1	A, B	Primary Secondary Tertiary Private
Warfarin (3 mg)	Warfarin (5 mg)	5	4.55	Tablets	LA1, LA2	A, B	Primary Private others
Amikacin	Ampicillin	4	3.64	Injections	LASA	B	Private others
Warfarin (2 mg)	Warfarin (3 mg)	3	2.73	Tablets	LA2	N/A	Secondary
Dimenhydrinate	Diazepam	3	2.73	Injections	LASA	B	Primary
Furosemide	Gentamicin	3	2.73	Injections	LA1	B, D	Primary
Lidocaine (2%)	Lidocaine (2%) + Adrenaline	3	2.73	Injections	LASA, LA1	A	Primary
Gentamicin	Amikacin	2	1.82	Injections	LA1	B	Secondary Tertiary
Cimetidine	Gentamicin	2	1.82	Injections	LA1	B	Primary

LASA drug names (Joint Commission of Accreditation of Healthcare Organizations, 2005).

This study found the source of confusion to include not only drug names but also look-alike product labeling and packaging (LA1), and look-alike tablets/capsules (LA2), confirming earlier reports (McCoy, 2005; Levine and Cohen, 2007; Cohen, 2007b). Category E, F and G (harmful) errors were reported in tablet/capsule preparations; however no category H and I (fatal) errors have been reported in our study. This could be the result of the obstacle of system, especially in light of 2006 MEDMARX® report whose 176,407 examined records 14 cases, where medication errors may have caused or contributed to patient deaths. The report also noted that the percentage of harmful errors has remained above 1% for more than seven years (Hicks et al., 2008). This research identified 5,327 LASA pairs, most of which came from tablet/capsule preparations (3,695 pairs, 69.36%). This could likely be explained by the prevalence of these forms of drugs on the market in general; with 15,404 and 4,287 preparations, tablets and capsules make up 43 and 12% of drugs available on the market, respectively (Thai Drug Control Division, 1999). Of all these, Ranitidine-Roxithromycin pair was reported the most frequently. Reported LASA-related errors fell into categories A, B, C, D, E, F and G. The highest harmful medication error was G, found only in tablet/capsule preparations. The study made a distinction in drug similarity, based on the source of confusion: similar spelling/pronunciation (LASA), similar packaging/labeling (LA1) and similar tablets/capsules (LA2). Two pairs of high-alert tablet drugs with a narrow therapeutic index are Warfarin (3 mg)-Warfarin (5 mg) pair and Warfarin (2 mg)-Warfarin (3 mg) pair; fortunately their LASA-associated error cateogories were only A and B.

From the 944 reported injection LASA pairs, Diazepam-Furosemide pair occurred in the highest frequency (34.55%). Diazepam is a high-alert drug with a narrow therapeutic range; however, the associated error categories were only A and B. From the 307 liquid dosage forms drug pairs, Alum milk-Milk of Magnesia pair was reported frequently. Among the 367 external drug pairs, the one occurred most frequently was 0.02% Triamcinolone cream-0.1% Triamcinolone cream. This study also identified confusing medication names and packaging in oncology medications. The names of several chemotherapy agents can look or sound alike (Carboplatin and Cisplatin, Vinblastine and Vincristine) or

Table 11. Top ten LASA pairs in high-alert highly concentrated electrolytes (N = 36).

Drug name	Drug name	No. (drug pairs)	%	Preparations	Types of LASA pairs	Error category	Affiliation (hospital)
KCl	Dopamine	6	16.67	Injections	LA1	A, B, C	Primary Secondary Private
$MgSO_4$	Dimenhydrinate	5	13.89	Injections	LA1	B	Primary Secondary Tertiary
KCl	Calcium gluconate	4	11.11	Injections	LASA, LA1	A,B	Primary Secondary Tertiary Private
Glucose	Sodium bicarbonate	4	11.11	Injections	LA1	A,B	Primary Private
KCl	Aminophylline	3	8.33	Injections	LA1	N/A	Primary Secondary
$MgSO_4$	Aminophylline	2	5.56	Injections	LA1	B	Primary
$MgSO_4$ (50%)	Dexamethasone (5 mg)	2	5.56	Injections	LA1	B	Primary Private
$MgSO_4$ (10%)	$MgSO_4$ (50%)	2	5.56	Injections	LASA	A,B	Primary Private
$CaCO_3$	Calcium gluconate	1	2.78	Injections	LASA	B	Primary
KCl	Dipotassium chloride (20 mEq)	1	2.78	Injections	LASA	A	Private

can be confused with unrelated medications (for example, Methotrexate and Multivitamin, found in this study), as noted also by Schulmeister (2006). Most of the high-alert drugs were found in injection preparations, a trend also shown in ASHP and other literature reports (ASHP, 2008; Hicks and Becker, 2006; Taxis and Barber, 2003a; Taxis and Barber, 2003b; Parshuram et al., 2008). James et al. (2009) investigated dispensing errors in the UK, US, Australia, Spain and Brazil. The most common dispensing errors identified by community and hospital pharmacies were dispensing the wrong drug, strength, form or quantity, or labeling medication with incorrect directions. They revealed that factors subjectively reported as contributing to dispensing errors were look-alike, sound-alike drugs, low staffing and computer software. High workload, interruptions, distractions and inadequate lighting were objectively shown to increase the occurrence of dispensing errors (James et al., 2009). Other factors associated with dispensing errors may be communication failures, problems related to package labels, work overload, the physical structure of the working environment, distraction and interruption, the use of incorrect and outdated information sources and the lack of patient knowledge and education about the drugs they use (Anacleto et al., 2005). The ISMP's landmark article by Leape et al, 1995. on systems analysis of adverse drug events defined broad categories, where the underlying problems that result in medication errors indentified the following proximal causes of medication errors: lack of knowledge of the drug, lack of information about the patient, violations of rules, slips and memory lapses, transcription errors, faulty identity checking, faulty interaction with other services, faulty dose checking, infusion pump and parenteral delivery problems, inadequate patient monitoring, preparation errors and lack of standardization (Cohen, 2007a).

Risk reduction strategies include being aware of medications which look or sound like other drugs, installing pop-up alerts in computer systems, prescribing medications both by their generic and trade names, placing eye-catching labels and warning stickers on

Table 12. Top ten LASA pairs in high-alert emergency drugs (N = 93).

Drug name	Drug name	No. (drug pairs)	%	Preparations	Types of LASA pairs	Error Category	Affiliation (hospital)
Dobutamine	Dopamine	29	31.18	Injections	LASA, LA1	A, B	Primary Secondary Tertiary Private Others
Adenosine	Adrenaline	15	16.13	Injections	LASA, LA1	A,B	Primary Secondary Tertiary Private Others
Dopamine	KCl	6	6.45	Injections	LASA, LA1	A, B, C	Primary Secondary Tertiary Private Others
Morphine	Pethidine	5	5.38	Injections	LASA, LA1	A, B, C	Primary Tertiary Private
Adrenaline	Atropine	4	4.30	Injections	LASA, LA1	A, B	Primary Secondary Tertiary Private Others
Enoxaparin	Fraxiparine	4	4.30	Injections	LASA, LA1	B, C	Secondary Tertiary Private
Pethidine	Ranitidine	4	4.30	Injections	LASA	B, C	Primary Secondary Private
Regular insulin	Mixtard	3	3.23	Injections	LA1	B, C	Primary
Adrenaline	Vitamin B complex	2	2.15	Injections	LA1	N/A	Primary
Adrenaline	Methergin	2	2.15	Injections	LASA, LA1	A, B	Primary Secondary Tertiary Private Others

storage bins, storing medication in nonadjacent areas, and advising patients to be alert for potential mix-ups with look-alike, sound-alike medications (Schulmeister, 2006). Further strategies could invole the use of uppercase letters which successfully alert health professionals to potential for error with several generic name pairs, for example; acetoHEXAMIDE, acetaZOLAMIDE; lists of similar name pairs (Cohen et al., 2007), annual review and revision of a list of look-alike, sound-alike drugs and a proactive implementation of safety strategies to prevent

Table 13. Top ten LASA pairs in high-alert antidotes (N = 68).

Drug name	Drug name	No. (drug pairs)	%	Preparations	Types of LASA pairs	Error Category	Affiliation (hospital)
Vitamin K1 (1 mg)	Vitamin K1 (10 mg)	27	39.71	Injections	LASA, LA1	A,B,C,D	Primary Secondary Tertiary Private Others
Vitamin K1	Vitamin B complex	16	23.53	Injections	LASA, LA1	A,B,C,D	Primary Secondary Tertiary Private
Vitamin K1 (2 mg)	Vitamin K1 (10 mg)	11	16.18	Injections	LASA, LA1	A,B	Primary Secondary Tertiary Private
Adrenaline	Atropine	4	5.88	Injections	LASA, LA1	B	Primary University
Hyoscine	Neostigmine	2	2.94	Injections	LA1	N/A	Secondary Tertiary
Nalador	Naloxone	2	2.94	Injections	LASA	A	Primary Private
Atropine	Hyoscine	1	1.47	Injections	LASA, LA1	N/A	Primary
Atropine	Oxytocin	1	1.47	Injections	LA1	N/A	Primary
Epinephrine	Atropine	1	1.47	Injections	LA1	N/A	Primary
Vitamin K1	Gentamicin	1	1.47	Injections	LA1	B	Tertiary

medication errors involving these drug combinations. Proactive assessment of potential for LASA medication errors should evaluate for potential look-alike packaging problems in addition to the drug names (McCoy, 2005). Furthermore, organizations could develop and implement process enhancements, including moving and reorganizing shelf storage bins, improving labeling for intravenous medications or other dosage forms with similar packaging, revising processes for selecting and maintaining the list of LASA medications to include real-time review of new medications added to the formulary and changes in packaging resulting from contract changes or drug storage.

Another important factor to consider is multidisciplinary collaboration within the system; increasing organisations' ability to identify, resolve and prevent errors related to medication storage, labeling, delivery, knowledge, and administration documentation (McCoy, 2005; Cohen, 2007a; Sauberan et al., 2010). The World Health Organization is currently developing global patient safety taxonomy that could facilitate consistent data collection and assist the development of error-reduction strategies (James et al., 2009). Little research is available on the topic, but regulators and the industry have begun discussing what level of similarity leads to confusion and errors (Cohen et al., 2007). The Food and Drug Administration (FDA) also has a role in preventing drug confusion. The FDA Office of Drug Safety, Division of Medication Errors and Technical Support (DMETS), reviews all trademarks prior to marketing and disapproves trademarks proposals that are deemed too similar to existing drug names (Cohen et al., 2007). Patient safety clearly requires improved methods for naming pharmaceutical products. FDA, the pharmaceutical industry, USP, ISMP, and others need to reach consensus and collaborate on a guidance document for product naming (Cohen et al., 2007). Such guidance should propose a common nomenclature with

Table 14. LASA pairs in high-alert obstetric medications (N = 15).

Drug name	Drug name	No. (drug pairs)	%	Preparations	Types of LASA pairs	Error category	Affiliation (hospital)
Hyoscine	Terbutaline	6	40.00	Injections	LA1	A	Primary Secondary
Dimenhydrinate	Terbutaline	3	20.00	Injections	LA1	N/A	Primary, Private
Methergin	Adrenaline	2	13.33	Injections	LA1	A	Primary
Atropine	Oxytocin	1	6.67	Injections	LA1	N/A	Primary
Dexamethasone	Terbutaline	1	6.67	Injections	LA1	A	Primary
Methergin	Pancuronium	1	6.67	Injections	LA1	B	Tertiary
Methergin	Vitamin K1	1	6.67	Injections	LA1	N/A	Primary

standardized abbreviations, acronyms, and terms. Although there is no single or simple answer to reducing medication errors, a coordinated effort to research problems associated with drug naming would produce timely and measurable results (Cohen et al., 2007).

Like other voluntary error reporting systems, this study is limited by the voluntary nature in capturing medication errors, therefore significant errors may go unreported and thus may not be reflected in this report, a limitation that is also applicable to UPMC or MEDMARX data (Santell et al., 2009). While a detailed analysis of the of the root causes of LASA medication errors is outside the scope of this study, discernible patterns indicate that the potential for LASA drug errors is present at every step of the patient care process; prescription, dispensing and administration of drugs. Recommendations for preventing LASA medication errors at the prescription stage include maintaining awareness of LASA information, clearly indicating drug name, strength and dosage form on prescriptions, and abstaining from verbal-only orders. At the dispensing stage, pharmacy and therapeutic committees should regularly provide LASA information to health-care staff and consider the possibility of name confusion when adding a new drug product to the hospital formulary, avoiding LASA in both presentation and packaging. Furthermore, when it comes to computerized systems, the appearance of LASA drug names could be emphasized with highlighting, boldface, unique colors, uppercase lettering or a mix of upper and lowercase lettering at different in parts of the name, such as vinCRIStine, vinBLAStine**.** Pharmacy departments could store LASA products in different locations, or use alert stickers on shelves or places where LASA drugs are present. An independent double-check would also be useful to ensure LASA-error prevention at the dispensing process.

At the drug administration step, LASA-errors could be prevened by nurses reading prescriptions more carefully and considering them in the context of patient status and diagnoses. It is also important that appropriate systems for reporting errors and potentially hazardous LASA conditions are present and their use is encouraged. Moreover, professional staff could educate patients and their families about the confusing names and indication of their medication, while encouraging patients to ask about their medication if it is unfamiliar, or looks or sounds different.

Conclusion

A cross-sectional survey was developed to study look-alike, sound-alike (LASA) drugs in hospitals in Thailand. This LASA report could be developed and integrated to suitable programs used in hospitals in order to identify and prevent medication errors in the future.

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REFERENCES

Anacleto TA, Perini E, Rosa MB, Cesar CC (2005). Medication errors and drug-dispensing systems in a hospital pharmacy. Clinical, 60(4): 325-332.

American Hospital Association (2005). Medication safety issue brief, Look-alike, sound-alike drugs. Hosp. Health Netw., 79(10): 57-8.

ASHP reports (2008). Proceedings of a summit on preventing patient harm and death from i.v. medication errors. Am. J. Health-Syst. Pharm., 65: 2367-2379.

Basco WT, Ebeling M, Hulsey TC, Simpson K (2001). Using Pharmacy

Data to Screen for Look-Alike, Sound-Alike Subsitition Errors in Pediatric Prescriptions. Acad. Pediatr., 10(4): 223-237.
Carothers NB (1995). An analysis of medication errors: Look alike and sound alike names. Int. J. Trauma. Nurs., 5: 22-24.
Cohen MR, Domizio GD, Lee RE (2007). The role of drug names in medication errors. In: Cohen MR, editor. Medication errors. Wahihgton, DC: The American Pharmacists Association: pp. 87-110.
Cohen MR (2007a). Causes of Medication Errors. In: Cohen MR, editor. Medication Error. Washington, DC: Am. Pharm. Assoc., pp. 55-66.
Cohen MR (2007b). The role of Drug Packaging and Labeling in Medication Errors. In: Cohen MR, editor. Medication Error. Washington, DC: Am. Pharm. Assoc., pp. 110-152.
Dubey AK, Palaian S, Shankar PR, Mishra P, Prabhu M, Bhandari RB, Chhetri AK (2006). Introduction to medication errors and the error prevention initiatives in a teaching hospital in Western Nepal. Pak. J. Pharm. Sci., 19(3): 244-251.
Hartwig SC, Dener SD, Schneider PJ (1991). Severity indexed, incident report-based medication error-reporting program. Am. J. Health-Syst. Pharm., 48: 2611-2616.
Hicks RW, Becker SC, Cousins DD (2008). MEDMARX Data Report. A Report on the relationship of drug names and medication errors in response to the Institute of Medicine's call for action. Rockville, MD: Center for the Advancement of Patient Safety, US Pharmacopoeia.
Hicks RW, Becker SC (2006). An overview of intravenous-related medication administration errors as reported to MEDMARX, a national medication error reporting program. J. Infus. Nurs., 29: 20-27.
Hoffman JM, Proulx SM (2003). Medication errors caused by drug name confusion. Drug Safety. 26: 445-452.
Institute for Safe Medication Practices (2011). ISMP's list of confused drug names. Available at: http://www.ismp.org/tools/confuseddrugnames.pdf .
Institute for Safe Medication Practices (2011). ISMP's list of High-alert medications. Available at: http://www.ismp.org/tools/highalertmedications.pdf.
James KL, Barlow D, McArtney R, Hiom S, Roberts D, Whittlesea C (2009). Incidence, type and causes of dispensing errors: a review of the literature. Int. J. Pharm. Pract., 17(1): 9-30.
Joint Commission of Accreditation of Healthcare Organizations (2005). Sound-alike drug names produce in risk of medication interchange errors. J. Pain Palliat. Care Pharm., 19(3): 47-53.
Lambert BL, Lin SJ, Chang KY, Gandhi SK (1999). Similarity as a risk factor in drug-name confusion errors: the look-alike (orthographic) and sound-alike (phonetic) model. Med. Care, 37: 1214-1225.
Lambert BL, Chang KY, Lin SJ (2001). Effect of orthographic and phonological similarity on false recognition of drug names. Soc. Sci. Med., 52: 1843-1857.
Leape LL, Bates DW, Cullen DJ, et al. (1995). System analysis of adverse drug events. JAMA, 274(1): 35-43.
Levine S, Cohen MR (2007). Preventing medication errors in pediatric and neonatal patients. In: Cohen MR, editor. Medication Error. Washington, DC: Am. Pharm. Assoc., pp. 469-492.
Macagba RL (2011). Hospital and Primary Health Care: An International Study. London: the International Hospital Federation. Available at: http://www.healthdevelopment.org/pdfs/Hospitals%20and%20Primary%20Health%20Care.pdf Accessed October 28, 2011.
McCoy LK (2005). Look-alike, sound-alike drugs review: include look-alike packaging as an additional safety check. Jt. Comm. J. Qual. Patient Saf., 31(1): 47-53.
Ministry of Public Health (2011). Thailand Health Profile, 2005-2007. Available at: http://eng.moph.go.th/ContentDetails.php?intContentID=8196&strOrgID=001.
National Coordinating Council for Medication Error Reporting and Prevention (NCC MERP). (1998-2012). NCC MERP Index for Categorizing Medication Errors Available at: http://www.nccmerp.org/pdf/indexBW2001-06-12.pdf
Nosek RA, McMeekin J, Rade GW (2010). Standardizing medication error event reporting in the U.S. department of defense. Bethesda (MD): National Center for Biotechnology Information (US). Available at: http://www.ncbi.nlm.nih.gov/books/NBK20623/.
Parshuram CS, To T, Seto W, Trope A, Koren G, Laupacis A (2008). Systematic evaluation of errors occurring during the preparation of intravenous medication. Can. Med. Assoc. J., 178: 42-48.
Pattanajak C (2006). Medication errors on medical ward. Thai J. Hosp. Pharm., Available at: http://www.thaihp.org.
Phatak HM, Cady PS, Heyneman CA, Culbertson VL (2005). Retrospective detection of potential medication errors involving drugs with similar names. J. Am. Pharm. Assoc., 45: 616-621.
Santell JP, Kowiatedk JG, Weber RJ, Hicks RW, Sirio CA (2009). Medication errors resulting from computer entry by nonprescribers. Am. J. Health-Syst. Pharm., 66(9): 843-853.
Sauberan JB, Dean LM, Fiedelak J, Abraham JA (2010). Origin of and solutions for neonatal medication-dispensing errors. Am. J. Health-Syst. Pharm., 67(1): 49-57.
Schulmeister L (2006). Look-alike, sound-alike oncology medications. Clin. J. Oncol. Nurs., 10(1): 35-41.
Taxis K, Barber N (2003). Ethanographic study of incidence and severity of intravenous drug errors. Br. Med. J., 326: 684.
Taxis K, Barber N (2003). Causes of intravenous medication errors: an ethonographic study. Qual. Saf. Health Care, 12: 343-347.
Thai Drug Control Division (1999). Bureau of Drug Control. Amount of drugs (medicine) registered in Thailand categorized by type of dosage forms in 1999. Available at: http://www2.fda.moph.go.th/drug/zone_search/files/sea001_005.asp
The Healthcare Accreditation Institue (Public Organization) (2011). HA Update 2011. Nonthaburi: Nungsee Dee-one Publishing.
Warinchumrab hospital (2009). High Alert Medication Handbook. Ubon Ratchathani.
WHO Collaborating Centre for Patient Safety Solutions (2007a). Look-Alike, Sound-Alike Medication Names. Patient Safety Solution, 1(1): 1-4.
WHO Collaborating Centre for Patient Safety Solutions (2007b). Patient Safety Solutions Preamble.