



Medicines Partnership of Australia

Packaging and labelling of pharmaceuticals and consumer safety – a survey of the literature

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Introduction

Inadequate and ambiguous packaging and labelling of medications is widely perceived as a problem requiring an urgent policy response, and also as a major contributing factor to medication errors. In the Australian context the issue has been raised by multiple stakeholders, including the Consumers Health Forum of Australia, the Western Australia Consumers Health Forum, the Australian Commission on Safety and Quality in Health Care, pharmacists and health professionals, as well as by a broader public (ABC Radio, 2009).

This review is an attempt to examine the concerns of the above mentioned stakeholders and, specifically, to provide factual evidence on the magnitude of the problem – the costs that it poses to the health system, the preponderance of incidents related to labelling/packaging within a broader class of medication errors, and the nature of these incidents in community and hospital pharmacy relevant to the Australian setting. This study also attempts to document the majority of cases, when the labelling/packaging problem is allegedly attributed to faults in the manufacturing process by the pharmaceutical companies.

We aim to support the consensus view in the medical profession (Aronson, 2009, p. 514) that the issue of inadequate labelling/packaging is a multi-factorial problem, present at all stages of the pharmaceutical supply chain (manufacturing, at the point of drug prescription by a physician, at the pharmacy level, as well as during actual administration of the drug by a health worker and consumption by the consumer/patient).

Medication errors, adverse drug events and packaging and labelling problem: incidence and costs

Available data indicates the high occurrence and economic costs of medication errors and adverse drug events/ADE (the former defined as any preventable events that *may* lead to

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inappropriate medication use or inflict harm to the patient/consumer; the latter as *actual* medication-related incidents that caused patient harm).

In the US hospital setting, the report commissioned for the Institute of Medicine (IoM) estimates the frequency of medication errors to stand at one error per hospital patient per day (Kohn, 1999). In the community and outpatient setting, the study by Flynn et al (2003) estimates the number of medication errors to be 50 million per year (out of 3 billion prescriptions dispensed in the US community pharmacies annually). As to adverse drug events, the IoM indicates 1.5 million events (400 000 in hospitals, 800 000 in long-term care settings and at least 530 000 in outpatient clinics), including between 44 000 to 98 000 eventuating in patients' death. The aggregate costs of the events are estimated at US\$3.5 billion, not taking into account the losses in wages and productivity. The frequency of ADEs, stemming from prescription failures in community pharmacies are believed to be lower (50 000 or 0.1% of all medication errors according to Flynn et al), though this number is likely to be a serious underestimate.

The fragmented evidence in Australia suggests that medication errors and adverse drug events were equally widespread. The study of general practice by Miller et al (2006) indicates that almost 2 million people experience ADEs annually (10.4% of all visits to general practitioners), with almost 138 000 ADEs requiring hospitalisation. This is consistent with the estimates by the Australian Commission for Safety and Quality in Health Care, reporting 190 000 medication-related hospital admissions (ACSQHC, 2002). It should be stressed however that the magnitude of medication errors and ADEs is much higher for persons considered at risk of medication misadventure (e.g. taking multiple medications, having compliance difficulties, living alone etc). In a survey of 1000 such persons, Roughead et al (2004) report medication errors identified in 90.2% of persons. As to the acute care and hospital settings, the incident reporting systems in South Australia, Western Australia and NSW indicate respectively 26.5%, 24.4% and 14.1% medication-related incidents, with ADEs ranging from 15% of all incidents in Western Australia to 31% in South Australia (Roughead, Semple, 2009, p. 5).

Regarding the economic burden imposed by ADEs in Australia, the Australian Institute of Health and Welfare estimates ADEs to cost AU\$380 million to the public hospital system alone (AIHW, 2002). Thornton et al (1999), extrapolating the average cost of an ADE in the US (US\$4555) to Australia argues ADE-related hospital admissions to be in a AU\$350- AU\$500 million range. Roughead and Semple (2009, p. 10) estimate ADEs to cost AU\$660 million.

The precise costs of ADEs related to inappropriate packaging and labelling of drugs are unknown. However, taking into account the results of the US Pharmacopeia Medical Error Reporting Program, attributing 33% of medication errors to labelling and packaging issues, the costs of packaging/labelling related ADEs may amount to as much as US\$1.16 billion (USP, 1998). It should be mentioned, however, that not all medication errors contribute equally to the total cost, with their significance to the health system, and economy, varying substantially.

The incidence of labelling and packaging problems in pharmacies

Community pharmacies

The US National Medication Error Reporting Program, administered by the US Pharmacopeial Convention and the Institute for Safe Medication Practices similarly indicates the high frequency of labelling/packaging problems (Edgar et al, 1994). Of 568 actual and potential medication errors reported to the database (mostly by community pharmacists) between August 1991 and April 1993, 300 (or 53%) were caused by product problems (a term which includes inadequate labelling by manufacturer). However, when fatalities and ADEs were concerned the principal factor was a cognitive error on the part of a health care practitioner (20 of 43 fatal incidents, or 47%), followed by a drug overdose (47%). Product problems were responsible for 12 fatalities (12 of 43 fatal incidents, or 28%).

In the UK, a study (Franklin, O'Grady, 2007) of dispensing practices in 11 community pharmacies using different systems of authentication at the point of dispensing (stand-alone; linked to patient medication records /PMR; and linked to electronic transfer of prescriptions/ETP) revealed 46 labelling errors out of 2859 dispensed items (1.6%). Evaluated ex post, the majority of errors were of minor clinical significance and were not life threatening. As to the method of dispensing, it was found that an ETP-linked system would prevent nearly half of all labelling errors, whereas a stand-alone system would hardly prevent any.

Another UK study (Ashcroft et al, 2005) analysed dispensing practices and processes in 35 community pharmacies (9 independent stores and 26 chain pharmacies) over a 4-week period. Of 125 395 prescribed items dispensed, 330 incidents were recorded: selection errors were the most common type of incidents (199 or 60.3% of all cases), followed by labelling (109 or 33%) and bagging errors (22 or 6.6%).

In the Australian setting, a collaborative project between Monash, Sydney Universities and the University of South Australia¹ examined the incidence of dispensing errors in Australian community pharmacies. In a pilot study conducted over a three month period and comprising 31 pharmacies over three states (Victoria, NSW and South Australia), 244 near-misses were detected (i.e. dispensing mistakes that were detected before actual error occurred and reached the patient), 22 of them (9%) were attributed to the inadequate labelling of the product, whereas the majority of near-misses involved the failure to

¹ Profs. Roger Nation, Michael Dooley, Drs. David Kong, Jill Beattie and Ms. Barbara Dixon from Monash University; Prof. Andrew McLachlan, Drs. Romano Fois and Tim Chen and Ms. Wedyan Meshreky from Sydney University; Ms. Naomi Burgess and Ms. Sophie Robinson from the University of South Australia. The results are published in *The Australian Journal of Pharmacy* 2010; Vol. 91, p. 27.

manage the pharmacy computer system (98), and make the right decision about drug selection (38).

Hospital pharmacies

The studies of medication errors, in the hospital setting, report cases of labelling problems due to inadequate manufacturing, and due to over-stickering by hospital pharmacists.

In the UK, a study of frequency and causes of dispensing errors in a hospital pharmacy (Beso et al, 2005) reveals that of 4849 items dispensed in a large NHS Trust hospital over a two week period 104 items contained a total of 130 dispensing errors (2.15% of all items). In total, 60 errors (45% of all errors) were related to over-stickering by the hospital pharmacy (inscription of incorrect dosage, patient name, instructions and warnings). When it comes to labelling faults by the manufacturer, 70 errors (54% of all errors) were classified as content errors, including 11 cases (8.5%), when the incorrect drug was dispensed. While not stated explicitly, this latter error may be attributed to a certain extent to inadequate labelling/packaging by the manufacturer. Other content errors (e.g. dispensing the wrong amount of the correct drug) can also be interpreted this way.

In Australia, medication-related incidents occurring in public hospitals are reported by the Australian Incidents Monitoring System (AIMS), receiving information from public hospitals in all states and territories, except Queensland, Tasmania and certain hospitals in NSW and Victoria. By mid-2002, 7155 medication-related incidents were reported. 2% of all cases were attributed to incorrect labelling by the manufacturer, while wrong dosage (35.5%) and the dispensing of the wrong medicine (9.8%) were attributed to the over-stickering and irregularities in hospital pharmacies (ACSQHC, 2002).

Interpretation of results

Overall, the studies demonstrate a wide dispersion of medication errors and ADEs (including those, attributed to inadequate labelling). Such ambiguous results can be explained by the inherent difficulty or even impossibility of obtaining precise figures. Firstly, the usual sample size of any of the above-mentioned studies is obviously insufficient to extrapolate findings and obtain health system-wide estimates of the problem. Secondly, the studies rely on human observers, who might have failed to detect a true number of dispensing errors; who were aware of the ongoing studies and hence could change their behaviour; and who frequently found themselves in an institutional environment that provides disincentives to report all medication-related incidents. Finally and importantly, the combination of multiple factors leading to medication and labelling errors mean that any estimate will be unique to the specific community and hospital pharmacy setting.

It should be stressed, however, that even a low medication error rate translates into a large aggregate number of errors, given the high volume of medications dispensed in hospital

and community pharmacies. Thus, even a small rate (e.g. 1.6%) may have a great significance for the health system and country-wide patient safety.

The nature and manifestations of packaging and labelling problem

Packaging and labelling failures and the manufacturing process

The instances when flawed manufacturing practices give rise to medication errors are numerous and can be broadly classified into three groups – confusing drug naming practices (look-alike-sound-alike names, umbrella branding); inappropriate packaging practices (the packaging of medications in a format usually reserved for another type of medication, the packaging of medications in a same way as promotional materials and advertisements); and ambiguous and confusing label and package designs. Regarding the latter, several types of manufacturing faults are identified:

- 1). *Ambiguous indication of dosages on the label.* Institute for Safe Medical Practices reports an accidental administration of 31g. of Timentin, which caused a fatality. The medical worker confused 31g. and 3.1g dosage that was not indicated prominently on the label (ISMP, 2002a). A similar case of inadequate spacing between the medication name and the dosage was reported: Tegretol 300mg. has been interpreted as Tegretol 1300mg, resulting in under-dosing, since the package was thought to hold ten times more than it actually did (ISMP, 2002b).
- 2). *Look-alike label and package.* Cohen reports confusion caused by the similar label and package design of imipramine 10mg. and hydrallazine 10mg. In the case of 5% dextrose and 15% potassium hydrochloride, the package and label similarity was combined with a small font of the drug name and text, making the label illegible.
- 3). *Inadequate labelling of blister strips.* On some products, the product name and strength appear only once or randomly over the blister strip (rather than on every pocket of the blister).
- 4). *Inappropriate use of symbols on the label.* In several instances the Roman numeral four (IV) was misinterpreted as “intravenously”. In the case of intravenous (rather than subcutaneous) insulin injection, such labelling could be fatal (Cohen, p.132). Similarly, the symbol IV, standing for schedule 4 controlled substances (narcotics), was confused with intravenous mode of administration. Also, ambiguous symbols, such as a slash through a circle depicting a pregnant woman (the symbol for a teratogenic drug) led a female patient to misinterpret the drug as a birth control pill.
- 5). *Lack of standardised terminology on the label.* Cohen (ibid, p. 133) reports the interchangeable use of “single dose” and “single use” indications on the label. In many cases, the “single dose” indication on the vial led a medical worker to give the entire

contents as a single dose (15 ml. of potassium phosphates instead of correct dose of 1ml). Of particular confusion are multiple unit-of-measure designations, used for certain drugs, e.g. percent (%), milligram (mg), gram (g), millilitre (mL.), milliequivalent (mEq), and milliosmole (mOsm) for magnesium sulphate, making it difficult to recognise excessive dosage.

6). *Lack of contrast in labelling.* Several issues are mentioned (Cohen, *ibid*, p. 125) – the use of ceramic print on clear glass, which has no contrasting background; labelling on aluminium foil-wrapped unit dose products that can be difficult to read because of shininess; the labelling of low-density polyethylene ampoules, with drug information embossed into the plastic in transparent, raised letters, which are almost impossible to read; typing drug information on the carton prone to fading.

7). *A combination of ambiguous packaging and labelling.* This reports the case of valaciclovir (Zelitrex 500), the drug used for the prophylaxis of Herpes zoster infection. The tablets are packed in sets of two tablets per blister with the print on the blister 'Zelitrex 500', making it unclear whether a tablet contains 250 or 500 milligrams (or even micrograms) of valaciclovir (Guchelaar et al, 2004).

8). *Identical packages and colouring schemes, coupled with ambiguous or look-alike names.* There was confusion with Bausch and Lomb's generic versions of two ophthalmic ointments. The names were cumbersome and differed only in the third ingredient (Neomycin/polymyxin B sulphates/bacitracin zinc versus Neomycin/polymyxin B sulphates/dexamethasone), whereas the colouring and company logos were similar (US Pharmacopeia, 2002).

Labelling failures at the pharmacy level

It is worth noting that variability and confusion of labels and packages is not a problem that is unique to manufacturers. The recent study of pharmacy over-stickering (Shrank et al, 2007)² revealed that labels were not designed to optimise patient understanding of medication directions and warnings. The largest item on nearly all of the labels was the pharmacy logo. The average font size was also largest for the pharmacy logo, followed by medication instructions, and drug name. Auxilliary instruction and warning stickers averaged a much smaller font size (6.5 point), too small for many older patients to see without magnification. Also, the labels items that were emphasised were useful to identify the pharmacy and to promote the practice of the pharmacist, but not to help patients safely and appropriately administer medication.

² Data were gathered from identically written prescriptions filled for four commonly prescribed drugs (atorvastatin, alendronate, trimethoprim-sulfamethoxazole and ibuprofen) in 6 different pharmacies in four diverse cities.

Substantial variability has also been seen in the content of the labels, especially on whether or not the warning/instruction stickers were used. Shrank et al (ibid) states that on between 8% and 25% of containers no warning and instruction stickers were attached by the pharmacist. The variability in the content of stickers was also substantial – few necessary warnings were present on more than half of all stickers. For atorvastatin, only 42% of stickers included a warning about pregnancy, and less than 20% included directions about taking with food, about following directions precisely, and about checking with physician before starting other medications. The warnings concerning drug interactions were present on less than a third of stickers.

The pharmacies have also been responsible for confusing and highly variable translation of physician's medication instructions, thereby adding to the ambiguous label content. Wolf et al (2009) investigated how dosage instructions (frequently written in Latin) were interpreted by pharmacists. Among 85 stickers evaluated, dose frequency was omitted on 6% of sticker instructions, while administration timing was mentioned on only 2% of all stickers. For some drugs (alendronate), vital instructions were absent on more than 50% of stickers.

Possible remedies to the problem

Academic advice

The standard setting and regulation of poor packaging and labelling has to address multiple problems, stemming from inadequate labelling by manufactures and inappropriate over-stickering by the pharmacist. Some problems have been directed at the lack of prominent placement of the drug name and strength, the small size and poor readability of printed information, insufficient prominence given to route of administration, poor use of colour to differentiate products or to highlight important information, prominence of company logos relative to other important information about the product, and inadequate warnings about proper drug use. Due to the space constraints on the label, remedying these shortcomings becomes a major technical challenge.

The academic literature suggests two standard setting and regulatory alternatives.

The first specifically concerns the label/instruction design by the drug manufacturer. It attempts to rectify the health literacy and space constraints by means of pictorial aids and indications on the drug label and/or pictorial aids on patient information leaflets and inserts. This approach, recommended by the US National Quality Forum (NQF, 2005) and the US Surgeon General (Carmona, 2003) is based on the casual observation that the small print size that appears on many product labels necessitates a high visual acuity of at least 20/50, and a quite advanced level of health and general literacy.³ As these two conditions

³ While a health literacy problem is a topic that warrants separate investigation, it is worthwhile to point to several facts of profound importance to pharmaceutical industry and to the health sector in general. The

frequently do not hold (specifically in the cases of the elderly, the individuals with unsatisfactory reading and comprehension ability, and the non-native speakers), and as the broken link between manufacturers, physicians, pharmacists and patients gives patients unacceptable room for interpretation of drug information, more user-friendly standards are required. There is overwhelming evidence from psychology and health literacy research that pictorial aids improve recall, comprehension and adherence by patients/consumers. Dowse et al (2005), Mansoor et al (2003) and McKenzie (2010) examined the positive effects of pictogram-containing labels, particularly for the above-mentioned consumers and patients. It was also found that pictorial aids were more effective in the labelling of over-the-counter rather than prescription medicines, as the latter tend to include more technical and scientific information that is not always amenable to graphic representation (McKenzie, *ibid*). Regarding the *best* use of pictorial aids in labels and medication instructions, there is agreement that the combination of textual and pictorial instructions is more effective than using one format alone (Sanggiry et al, 1997; Sojourner, Wogalter, 1998). As to the complex matter of instructions comprehension, it has been proven that any combination of the text and pictures should preferably be accompanied by verbal counselling (Morrow et al, 1996). Hence, even if the label and product information is made user-friendly, closer interaction between physician, pharmacist and patient will still be required to further prevent medication errors. Finally, consensus is reached regarding the content of a pictorial aid – it is found essential to use simple, realistic pictures that convey clear, singular meaning; to apply realistic colours and draw images to scale; and to maintain an uncluttered background to retain focus on the pictorial message (Dowse et al, *ibid*).

The second regulatory alternative deals with over-stickering by pharmacists and unclear prescriptions by the physicians. The essence of the “evidence-based” approach is that it is possible to detail best practices for improving dosage/usage instructions by the prescribing physician and for the format and content of prescription medication container labels designed by the dispensing pharmacy. In contrast to the “pictorial” approach, the functional label, containing the minimum of essential information, is recommended. Shrank et al (2007; 2010) summarised how “evidence-based” container labels should look. The proposed standard urged:

- 1). Use of explicit text to describe dosage/interval in instructions. The explicit frequency of the drug use has to be provided (e.g. “take 4 tablets each day, 2 tablets in the morning, 2 tablets in the evening”).
- 2). Use a recognizable visual aid to convey dosage/use instructions. A matrix has to be provided, identifying time intervals (“2 tablets in 7-9am period, 2 tablets in 4-6pm period”).

Australian study indicates that only about 40% of patient information was appropriate for their target population (Baker, 1997). Also 40-60% of adult Americans had basic or below basic literacy skills, limiting their comprehension of the technical information on labels and product inserts (Cutilli, Bennett, 2009).

3). Organise labels in a patient-centred manner. Patient directed information must be organised in a way that best reflects how most patients seek out and understand medicine instructions. Patient-directed content should be at the top of the label, while provider-directed content should be placed at the bottom. Drug name (generic) and specific dosage should be placed in greatest prominence.

4). When possible, include the indication for use (e.g. "take for diabetes"), including any specific warnings (e.g. "avoid prolonged or excessive exposure to direct sunlight, while taking this medication").

5). Simplify language, avoiding unfamiliar words and medical jargon.

6). Improve typography, use larger (12pt) sans serif font, numeric rather than alphabet characters, bolding and highlighting (especially for patient content), and include only horizontal text on the label.

As put by Shrank et al (ibid), the incorporation of each of the best-practice elements into the label necessitated the minimum dimensions of the label to be 4.6" by 2.5" and the drug container to be a 40 dram vial. No analysis has been conducted on whether the pharmaceutical manufacturers will be required to use larger containers in order to be able to use the best-practice label (which may change the chemical properties and shelf life of a drug), or on whether a larger label will inevitably cover the drug brand name (with negative implications for the marketing of drugs). However, to address this issue Shrank et al (ibid) propose two-sided labels that would reduce the size of the label on each side and presumably allow patients/consumers to see the brand name of manufacturer: the front side of the label would included essential patient (drug name and its quantity, dosage, patient and doctor name and refill information) and provider content (pharmacy name/logo, phone number and national drug code), whereas the back side would contain appropriate warnings and instruction messages.

Corporate responses and legal ramifications

It is common among physicians and the general public to attribute adverse drug events and medication errors (specifically those related to misidentification of drugs) to poor labelling/packaging standards and practices of the pharmaceutical industry. Despite this, the rarely mentioned fact is that pharmaceutical industry has a long history of voluntary corporate responses to the problem of inadequate labelling/packaging.

Serious efforts to uniquely label medications began in 1965, when Eli Lilly voluntarily introduced the Identicode System, imprinting an alphanumeric code on every solid dosage form and thereby helping to reduce the cases of drug misidentification (Berman, 2004, p. 16). Since then bar-coding became part of the regulatory toolkit: the Section 510 of the US Federal Food, Drug, and Cosmetic Act currently stipulates the inclusion on every medication packaging (but not medications themselves) of the 3-part, 10-digit identifier, including

information about the vendor/labeller, product (including drug strength, formulation and dosage) and package size.

Likewise, the manufacturers of ophthalmologic drugs have over the year's standardised labels (American Academy of Ophthalmology, 2000): brightly coloured bottle tops have been used to help patients identify different eye drops. More recently the use of colour has also been standardised: uniform colour-coding schemes were developed, taking into account the medication, its side effects, the disease being treated and the risk of serious complications (if a switch to other medication occurs).

Also, companies producing anaesthetics in the US, Canada, Australia and New Zealand have developed a standardised colour-coded label system for labels for syringes of medications drawn up for use in the operating room. The system applies not only for pre-packaged medications, but also to the labels that are placed on syringes by the anaesthesiologists themselves (Radhakrishna, 1999).

Similar voluntary responses also hold for drugs that may result in deadly outcomes, if administered inappropriately. After numerous problems with potassium chloride for injection (when concentrated potassium chloride was injected instead of 0.9% solution) the conventional labelling "Must be diluted" was proposed and adopted by the industry (Cohen, 2002).

Overall there exists clear evidence that the pharmaceutical industry has been pre-emptive as far as the risk of medication errors was concerned and cooperative when it came to correcting inadequate packaging/labelling practices (numerous cases, when the industry was willing to act upon the recommendations of the regulatory bodies).

As far as the legal liability of the pharmaceutical companies is concerned, it is common in the media and in academic circles to attribute serious adverse drug events (including those resulting in the death of a patient) to inadequate labelling/packaging. For instance, Orser et al (2006) mention the omission of the generic name on a potentially lethal anaesthetic, a violation of Canada's Food and Drugs Act that could have resulted in fatality. The enquiries into the deaths of patients in the acute care setting from overdoses of anaesthetics also point to the misidentification of drugs (Merry, Peck, 1995).

However, proving that a particular ADE is *solely* the fault of the pharmaceutical company and consequently establishing the legal liability is not an easy task. As there exists no mechanisms or procedures to track medication errors, fatal and near-fatal ADEs and serious medication errors are typically considered as instances of medical malpractice. The issue becomes particularly complicated in the ambulatory settings and community pharmacies (when a manufacturer's label is over-labelled by the pharmacist or when a physician's prescription is illegible) or in cases of patients in the aged care and high-risk groups (when carers and health workers are involved).

Consequently two opposing legal doctrines gain prominence. The “learned intermediary rule”, established in 1965 after a pharmaceutical liability suit in the US (Sterling Drug Inc. v Cornish) mandates the physician to communicate drug warnings (including those indicated on the drug packaging) to the patient. A prescription drug manufacturer fulfils its legal obligations to warn a patient by adequately warning the prescribing general practitioner (Gemperli, 2000). In contrast, the more recent suits (MacDonald v Ortho Pharmaceutical Corp in 1985 and particularly Perez v Wyeth Laboratories in 1999) re-evaluated “learned intermediary rule”, claiming that it depended heavily on unrealistic premises that the patient-physician relationship is the focal point of all medical care and that pharmaceutical companies are unable to communicate information about their products directly to patients. While in Australia the path of legal development will undoubtedly be different from the US one, the Perez v Wyeth Laboratories case marks a turning point in the definition of the industry’s legal liability (Gemperli, *ibid*). Worldwide the pharmaceutical industry is expected to participate more actively in warning the consumers and conveying these warnings through improved labelling/packaging. However, the legal controversies as to what constitutes an ‘adequate’ drug label are likely to persist until exhaustive and full government regulations are written.

Conclusion

From the foregoing it is clear that the problem of medication errors and ADEs caused by inadequate packaging/labelling does exist and imposes substantial costs on the health system. There is an adequate realization of the problem by the academic community and regulators; and the pharmaceutical industry has been showing its willingness to act pre-emptively and develop its own mechanisms to deal with the issue.

What needs to be remembered, however, is that the problem of medication safety (of which the labelling issue is a constitutive part) is a *systemic* one, meaning that in the majority of cases the ADE or fatality from the wrong use of medication is a culmination of a chain of events with multiple parties responsible for an adverse outcome. It is also a problem that has *human*, rather than a purely technical dimension. The latter means that in the case of prescription medicines the majority of errors are caused by knowledge deficits (lack of information about patient characteristics and history, about the drug effects), performance setbacks (failure to follow established procedures, slips and memory lapses, calculation errors) and communication breakdowns (between providers of the medication). Indeed, as put by Phillips et al (2001) over 65% of medication errors were attributed to human factors, followed by 16% due to communication problems and another 16% due to product problems (naming, labelling and packaging confusions).

Thus, an adequate response to the medication safety problem in general, and packaging and labelling in particular, is likely to be systemic-organizational one, tackling the above mentioned knowledge, performance, communication and product shortfalls, and including:

- 1). The improvement of health literacy of the ultimate consumers of the drug, and the enhancement of the knowledge of medication errors by pharmacists and physicians;
- 2). The creation of an error-minimization environment at the pharmacy and hospital level, involving in its turn the minimum reliance on human abilities and factors and the maximum use of electronic prescription, recording and monitoring systems;
- 3). The creation of learning and a transparent organizational environment, preventing medication error cover-ups and allowing for collective engagement in medication error identification and prevention.

This does not mean, however, that the pharmaceutical industry will not play any role. By ensuring the quality of labels (through elimination of labelling irregularities and ambiguities mentioned in this paper; and reliance on evidence-based academic advice), the pharmaceutical industry may play a “forcing function” (ISMP, 2002c), i.e. make it difficult or impossible for medication error to occur, even when knowledge, organizational and communication further down the drug supply chain are not up to the task.

Further research that relevant stakeholders (including the pharmaceutical industry) may embark upon could include other aspects of the medication safety problem, such as the proliferation of look-alike sound-alike drug names, “umbrella branding”, as well as the generic vs. proprietary names controversy.

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