ORIGINAL ARTICLE

Development of a standardised method to recommend protective measures to handle hazardous drugs in hospitals

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ABSTRACT

Purpose Healthcare professionals frequently have to handle hazardous drugs in the hospital setting. Data on the inherent toxicity of drugs cannot be directly applied to occupational exposure. We developed a standardised method to evaluate occupational risks and to recommend protective measures.

Methods Step 1: evaluation of chronic and acute toxicities and toxicity for reproduction. Step 2: toxicity weighting according to risk of exposure related to drug formulations. Step 3: definition of protective measures. Step 4: toxicity assessment of drugs used in our institution and comparison with hazardous drug lists published in the literature.

Results The whole process resulted in a standardised evaluation algorithm. Risks of exposure were determined by a panel of experts to balance intrinsic toxicity of each drug formulation or administration route. Protective measures were recommended. 80 substances (109 drug formulations) were screened for toxicity. Centralisation of compounding in the pharmacy was recommended for 12/24 (50%) of intravenous liquids, 19/32 (60%) of intravenous powders and 7/26 (27%) tablets (crushing). We found a slightly different estimation of risk for only two products (prednisone and mycophenolate mofetil) compared with the literature lists (National Institute for Occupational and Safety in Health Alert and University Health System Consortium Consensus).

Conclusions We developed a simple standardised method to generate a list of hazardous drugs in our hospital according to the risk of exposure. We determined reasonable protective measures that could be easily introduced into practice to protect healthcare workers.

INTRODUCTION

Occupational exposure to hazardous drugs during drug compounding and administration is a real problem in the hospital setting.[1–4] According to American Society of Health System Pharmacists, a chemical should be considered as a health hazard if it shows carcinogenicity, genotoxicity, teratogenicity, toxicity for reproduction or evidence of serious organ or other toxicity at low doses.[5] The occupational risk when handling hazardous drugs is complex to appreciate and depends on different parameters.[6]

Numerous lists of hazardous drugs have been elaborated internationally, some distinguishing only hazardous from non-hazardous substances, as in the National Institute for Occupational and Safety in Health (NIOSH) list,[7 8] and others categorising drugs as high or low risk or having reproductive risk, as in the University Health System Consortium (UHC) list.[9] In Switzerland, the official guidelines for handling hazardous drugs are edited by the 'Schweizerische Unfallversicherungsanstalt' (SUVA).[10] This publication includes a list of drugs that should be considered as antineoplastic agents, but some of them have no real cytotoxic activity or are used in a way that do not expose healthcare workers to a significant risk. In addition, Swiss summary of product characteristics (SPC) are sometimes in contradiction with these rules regarding protective measures to be taken for drugs handling.[11]

The intrinsic toxicity of traditional antineoplastic drugs is well established. In contrast, literature for other categories of drugs such as monoclonal antibodies is very scarce. Historically, they have been included in hospital hazardous drug lists due to the disease states for which they are used. However, it was recently reported that they do not represent a significant risk to healthcare workers given their specific modes of action and their very large molecular size, which prohibits dermal absorption.[9]

Compliance with safe handling procedures can be poor.[12 13] For this reason, it is important to recommend simple and easy-to-apply safety measures for healthcare workers in hospitals. Choosing to apply a maximum 'principle of precaution' in the absence of data can be deleterious, as too constraining measures can increase the risk of poor compliance.

Creation of a local list of hazardous drugs has been proposed in the USA. To the best of our knowledge, there are no published data on hospitals describing a methodology to create a list of hazardous drugs and elaborating rationale protective recommendations for their handling. The objective of this paper is to develop a simple standardised method to assess drug toxicity in the context of how the drug is used in the hospital and to determine easily applicable recommendations for healthcare workers' protection.

METHOD

A standardised method was developed to evaluate occupational risks and to recommend applicable protective measures in the hospital setting using the following steps.

- Determination of the intrinsic toxicity of drugs (chronic and acute toxicity).
- Weighting of intrinsic toxicity according to the risk of exposure considering the drug formulation.
- Assessment of protective measures corresponding to each type of risk using a panel of experts (two hospital pharmacists, one physician specialised in clinical pharmacology and toxicology).
- Assessment of toxicity of drugs used in our institution (oral cytotoxics, monoclonal antibodies, tyrosine kinase inhibitors, immunosuppressive drugs). Classical parenteral cytotoxics were considered in the analysis only when they also had an oral or topical drug formulation.
- Comparison with hazardous drug lists published by the NIOSH and UHC consensus.[7 9]

RESULTS

The whole process resulted in a standardised evaluation methodology that is summarised in figure 1.

Step 1: evaluation of intrinsic toxicity

The following sources of information were determined to be useful to build the evaluation algorithm:

- The medication safety data sheets (MSDS), obtained on MSDSonline (http://www.msdsonline.com/) or by searching 'MSDS' and the drug name on Google.
- The International Agency for Research on Cancer (IARC) classification.[14]
- The Swiss SPC published in the 'Swiss Compendium'.[11]
- US Food and Drug Administration (FDA) categories for reproductive toxicity, obtained by Micromedex, on Reprotox and Drugdex.[15]

Based on these sources of information, criteria were determined for each type of toxicity.

Chronic toxicity

Chronic toxicity was assessed using carcinogenicity and mutagenicity data. A product was identified as a carcinogen when at least one of the risk phrases R45 or R49[16] was included in the MSDS or when it was classified in IARC groups 1, 2A and 2B (products in group 3 were evaluated individually according to their pharmacological action) or when SPC mentioned risks of carcinogenicity in its preclinical data chapter. A product was identified as a mutagen when risk phrase R46 was included in the MSDS or when the official Swiss SPC mentioned risks of mutagenicity in its preclinical data chapter.

Acute toxicity

Acute toxicity was estimated based on the MSDS and Swiss SPC in relation to risks of skin, eye and respiratory tract irritations. A product was considered to be an irritant for the skin if at least one of the risk phrases R21, R24, R27, R34, R35, R38, R43 or security phrases S24, S28, S37 was included in the MSDS or when skin irritation was described in the Swiss SPC. A product was considered to be an irritant for the eyes when at least one of the risk phrases R36, R41 or security phrases S25, S26, S39 was present in the MSDS or when eye irritation was described in the Swiss SPC. A product was considered to be an irritant for the respiratory tract when at least one of the risk phrases R20, R23, R26, R37, R42 or security phrases S22, S23, S38, S51 was included in the MSDS or when respiratory tract irritation was described in the Swiss SPC.

Reproductive and developmental toxicity

This toxicity was estimated based on the MSDS data, the Swiss SPC and FDA categories. A risk for pregnant women was considered when at least one of the risk phrases R60, R61, R62, R63 was included in the MSDS, when the FDA category was D or X or when pregnancy and preclinical data in the Swiss SPC revealed risks of teratogenicity or reproductive risks. FDA categories A and B were considered free of risks. Category C drugs were considered as requiring protective measures for pregnant women or for those who wish to become pregnant in accordance with the principle of precaution. Drugs toxic for reproduction and with a risk of exposure were not considered safe to be handled by pregnant women or those who wish to become pregnant.[15]

The different criteria selected for the assessment of the intrinsic toxicity of substances are summarised in table 1.

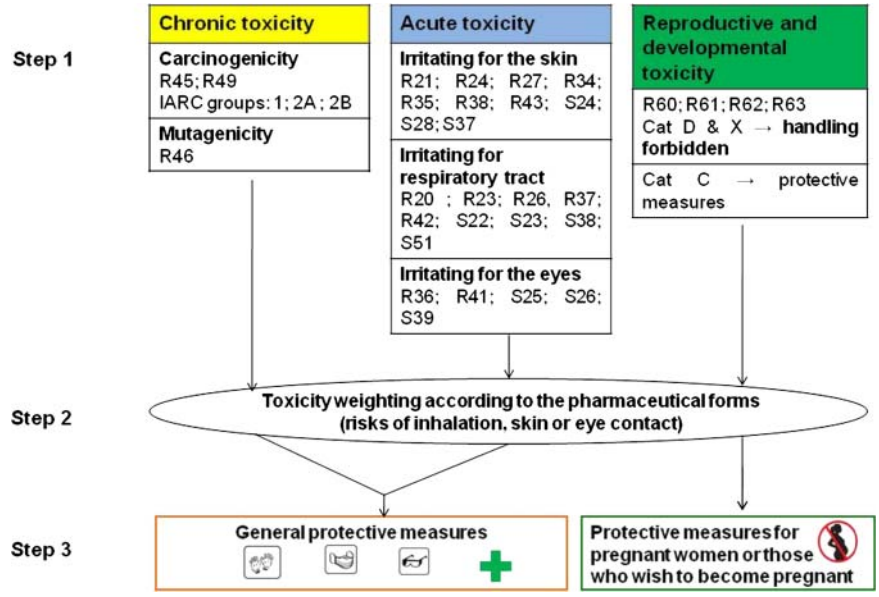

Figure 1 Algorithm for occupational risk evaluation. IARC, International Agency forResearch on Cancer.

Table 1 Criteria for toxicity evaluation (see reference 16 for meaning of R/S phrases)

	Carcinogenicity	Mutagenicity	Reproductive and developmental toxicity	Irritating potential
Risk phrases	R45, R49	R46	R60, R61, R62, R63	Skin: R21, R24, R27, R34, R35, R38, R43 Eyes: R36, R41 Respiratory tract: R20, R23, R26, R37, R42
Security phrases				Skin: S24, S28, S37 Eyes: S25, S26, S39 Respiratory tract: S22, S23, S38, S51
Swiss SPC	Preclinical data	Preclinical data	Pregnancy data Preclinical data	Chapter 'Remarks'
Other	IARC classification in groups 1, 2A and 2B (group 3: should be discuss individually)		FDA pregnancy categories X, D (category C: wear protective measures)	

IARC, International Agency for Research on Cancer; SPC, summary of product characteristics.

Step 2: toxicity weighting according to the risk of exposure

The risks of exposure to active ingredients included in the final drug formulation were estimated by the panel of experts. The results are summarised in table 2.

Solid drug formulations used orally may pose a risk of direct occupational exposure only when the drug formulation is altered, typically in the case of administration by feeding tubes or to patients unable to swallow. In these cases, tablet crushing or opening of capsules is the source of a risk of exposure. Risk of inhalation was considered to be higher with powder for intravenous or oral administration than with liquids or other drug formulations.

Step 3: assessment of protective measures

The intrinsic risk of chronic and/or acute toxicity was weighted by the risk of exposure related to drug formulation.

When a risk of exposure was identified for a drug with chronic and/or acute toxicity, the expert group were advised to wear gloves to protect against skin contact, a mask to protect against particle inhalation and glasses to protect against eyes contact.

Centralisation of drug compounding in a secured area of the pharmacy, using an isolator for sterile drugs and a biological safety cabinet (class I) for non-sterile drugs, was proposed as an organisational protective measure for all drugs identified as mutagens or carcinogens. For these products, administration to the patient should be performed using personal protective measures (gloves, mask, glasses).

For drugs identified as carcinogens or mutagens, or conveying the risk of acute toxicity, it was not recommended to centralise drug compounding at the pharmacy and similar personal protective measures were proposed for nurses during compounding and administration (gloves, mask, glasses). Table 3 summarises the final protective measures recommended to deal with chronic and acute toxicities.

The risk of reproductive and developmental toxicity was also weighted by the risk of exposure according to the drug formulation, in the same way as chronic toxicity. Pregnant women or those who want to be pregnant should not handle drugs

Table 2 Risk of exposure according to drug formulation

Drug formulation	Potential risk of chronic toxicity through skin contact	Potential risk of acute toxicity through skin contact	Potential risk of chronic toxicity through inhalation	Potential risk of acute toxicity through inhalation	Potential risk of acute toxicity through eyes contact
Oral administration					
Uncoated tablets	Yes	Yes	No (except crushed)	No (except crushed)	No (except crushed)
Coated tablets	No (except crushed)	No (except crushed)	No (except crushed)	No (except crushed)	No (except crushed)
Capsules	No (except opened)	No (except opened)	No (except opened)	No (except opened)	No (except opened)
Powder for oral solution	Yes	Yes	Yes	No	No
Oral solution	Yes	Yes	No	No	No
Parenteral administration					
Powder for intravenous solution	Yes	Yes	Yes	No	No
Intravenous solution	Yes	Yes	No	No	No
Local administration					
Cream, gel	Yes	Yes	No	No	No
Topic solution	Yes	Yes	Yes	Yes	Yes
Spray	Yes	Yes	No	No	No
Solution for inhalation	Yes	Yes	Yes	Yes	Yes

Table 3 General protective measures according to weighted chronic and acute toxicities

	Weighted chronic toxicity (carcinogen or mutagen)	Weighted acute toxicity	Protective measures required
	+	+	
	+	–	
	–	+	
	–	–	Ø
	+	+	
	+	–	
	–	+	
	–	–	Ø
	+	+	
	+	–	
	–	+	
	–	–	Ø
	+ + (carcinogen and mutagen)		 (compounding)
			 (administration)

 wear gloves;  wear mask;  wear glasses;  compounding centralised at the pharmacy, administration wearing gloves, mask and glasses.

identified as toxic for reproduction and with a risk of exposure. Drugs classified in FDA category C should at least be handled with gloves by pregnant women. The general protective measures recommended for acute and chronic toxicity should be applied in all cases, regardless of reproductive toxicity.

Step 4: screening of different drugs and comparison with the NIOSH and UHC consensus lists

Eighty substances used in our hospital representing 109 different brand names and 109 drug formulations (24 intravenous liquids, 32 intravenous powders, 36 tablets/capsules, 17 others) were screened for toxicity.

According to our algorithm, centralisation of compounding in the pharmacy's secured area was recommended for 38/109 (35%) drug formulations (12/24 (50%) intravenous liquids and 19/32 (60%) intravenous powders). Seven of twenty-six (27%) tablets should be crushed in the pharmacy's protected safety cabinets (eg, valganciclovir) and 41/109 (38%) drug formulations do not require any personal protective measures. Monoclonal antibodies were found not to cause a risk of mutagenicity or carcinogenicity.

A total of 78/109 (72%) drug formulations were identified as toxic for reproduction. No 'class effect' was found (eg, only a few antivirals were found to be hazardous).

The final recommended protective measures for the 109 drug formulation are listed in online supplementary table 4.

Comparison with NIOSH and UHC lists showed little differences. Only two products (prednisone and mycophenolate mofetil) led to a slightly different estimation of risk. Four out of the 80 (5%) substances (alemtuzumab, erlotinib, gefitinib, interferon) were different from the NIOSH list but similar to the UHC assessment whereas 9/80 (11%) (tamoxifen, zidovudin, pentamidin, ribavirin, chlormethin, gemtuzumab, medroxyprogesteron, ganciclovir, flutamid) were slightly different from the UHC results but similar to the NIOSH assessment.

DISCUSSION

We developed a structured method to assess the toxicity of drugs in the context of their use in hospitals. The final objective was to ensure healthcare workers' protection with the implementation of recommendations applicable in daily practice. The main characteristic of the method was to balance the intrinsic toxicity of the drug with the effective risk of exposure considering drug formulations and route of administration.

The method resulted in a list of protective measures to recommend to healthcare workers. The comparison with lists published by the NIOSH and UHC revealed a strong global consistency, with slight differences.

As NIOSH noticed in its response to public comments,[17] the consequences of misclassifying a drug as hazardous (cost, communication, administrative burden etc) and proposing protective measures that cannot be applied in everyday practice could decrease the credibility of the hazardous drugs list and generate difficulties with risk communication.

Monoclonal antibodies are an interesting example as they were considered for a long time as hazardous drugs.[7 10 18 19] Recently, NIOSH carefully re-evaluated the inclusion of monoclonal antibodies as hazardous drugs because of their specific targeted mechanisms of action and their high molecular weight which prevent skin penetration and accidental inhalation. In our evaluation, monoclonal antibodies have not been considered as hazardous drugs for healthcare practitioners and only gloves have been recommended for their handling. The UHC consensus list also considered monoclonal antibodies and some immune modulators do not represent a significant exposure risk to healthcare workers. This confirms that hazardous drug evaluation is a continual process and updating the list is important. Moreover, each drug must be assessed individually and results cannot be automatically generalised to a whole drug class. The antiviral drug class is a good example, with some substances being hazardous, like ganciclovir, and others presenting no significant risk.

Evaluation of risks of occupational exposure to the toxic effects of antineoplastic drugs in the hospital setting was well described in the literature. However, no safety programme considering occupational exposure to other drugs was published before the UHC consensus statement. Some safety programmes were described but they did not focus on evaluation of drug toxicity by occupational exposure. They used the NIOSH list as a reference and did not describe a standard way to evaluate drug toxicity in specific contexts.[20] The drug formulation, route of exposure and standard drug preparation practices all mitigate the risk of occupational exposure. The UHC consensus statement also gives recommendations that consider healthcare employees' potential exposure to hazardous drugs which institutions may view as practical and reasonable. Similarly to our method, the UHC consensus statement introduces different levels of risks (high risk, low risk and reproductive risk). For example, 'low risk' in the UHC consensus statement is comparable to our method in which no risks were identified with coated tablets or capsules but high risk occurred when they were crushed or opened.

Finally, the UHC consensus statement gives protective recommendations in its appendix D. Categories of employees are separated and specific recommendations are given for low-risk and high-risk hazardous drugs. Toxicity evaluation considers the global drug process, separating preparation, administration and transport, and manipulated, repackaged and normal drugs. In our study, different recommendations were given for preparation and administration, but only for mutagenic and carcinogenic drugs.

Our results are also mostly congruent with the NIOSH list but are presented in a different way in that toxicity for reproduction was treated separately. Because women of child-bearing age account for a large proportion of hospital employees, declaring all of them unable to handle drugs that have not proved to be absolutely safe for breastfeeding or pregnancy would dramatically limit their capacity of work. It may be more appropriate to recommend universal precautions to specific populations rather than enforcing restrictions more broadly. This is the reason why reproductive toxicity has been considered in a separate way. Pregnant women or women who want to become pregnant would receive special instructions to protect themselves or their unborn child. When the risk is not clearly identified (category C), use of gloves was recommended for pregnant women or women who wish to become pregnant when handling these drugs. In the same way, the UHC consensus statement defined the 'reproductive category employees' and provided specific recommendations for this category. Reproductive risks were similarly appreciated by UHC and our method.

Differences observed in the protective measures recommended by our method and the NIOSH and UHC consensus may be explained by the fact that acute toxicity was not considered in their evaluations.

Some methodological limitations in our study should be discussed. The risk of exposure according to the drug formulation was determined according to a consensual decision by the professionals. It was based on available data and on the need to provide applicable and realistic recommendations appropriate for the hospital. Weighting the risk of exposure according to the drug formulation is subjective. However, the fact that our results were in line with those of the UHC consensus demonstrates the appropriateness of the method we used to assess toxicity.

The mutagenic or carcinogenic potential of several drugs has not been tested in preclinical studies and no data are available. Some drugs have a pharmacological mechanism of action that probably represents no risk, whereas others tend to prove their toxicity. For some products, a more detailed analysis based on the mechanisms of action or pharmacological effects are suggested.

Our study did not evaluate the level of exposure, which depends on the frequency and the duration of exposure for each individual. For a specific individual, it would be possible to calculate a value similar to the cytotoxic contact index, but this is not possible for general handling guidance in a hospital.[21] The use of the occupational exposure limits in the healthcare setting would require an immense amount of work and the relevant information may not be available.

The results of this study have been discussed institutionally to implement guidelines for healthcare workers. Crushing of hazardous drugs will be centralised on request at the pharmacy in a non-sterile safety cabinet dedicated to this task. In the pharmacy, the developed algorithm is now used to evaluate the toxicity of each new drug entering the stock and the list of hazardous drugs will be continuously updated. Procedures for the storage and for handling of spillage have also been implemented based on the list. As recommended by NIOSH and UHC, additional efforts should now be directed to the education of professionals (clinical and non-clinical staff) to increase awareness about risks associated with hazardous drugs.

CONCLUSION

Handling of hazardous drugs is frequent in the hospital setting and different factors could affect the occupational risk for healthcare employees. Even if the inherent toxicity of an active ingredient is known, the real occupational risk of exposure to a drug formulation is still difficult to assess.

We developed a simple standardised method to provide a list of hazardous drugs in which the inherent toxicological risk of a drug was weighted according to the risk of exposure (eg, drug formulation, administration route, nature of employee's reproductive status). We applied this method to local products, drug formulations, practices and facility characteristics to provide recommendations that could easily be implemented in the daily practice of our hospital workers.

Our method used a tiered approach as in the NIOSH 'list of antineoplastic and other hazardous drugs in healthcare settings 2010' and recommends applicable and simple protective measures for healthcare workers that is in line with the recent UHC consensus statement.

Key messages

- Data on drugs' inherent toxicity cannot be directly applied to occupational exposure of healthcare workers.
- A standardised method to evaluate occupational risks and to define protective measures should be developed in the hospital setting.
- An algorithm to evaluate drugs' inherent toxicity and to balance risk of exposure related to drug formulations was created by a panel of experts.
- Eighty drugs used in our hospital were assessed and protective measures recommended.
- Our results were compared with two hazardous drug lists published in the literature.

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REFERENCES

1 Sanborn RE, Sauer DA. Cutaneous reactions to chemotherapy: commonly seen, less described, little understood. *Dermatol Clin* 2008;26:103–19.
2 McDiarmid M, Egan T. Acute occupational exposure to antineoplastic agents. *J Occup Med* 1988;30:984–7.
3 Hemminki K, Kyyronen P, Lindbohm ML. Spontaneous abortions and malformations in the offspring of nurses exposed to anaesthesic gases, cytostatic drugs, and potential hazards in hospitals, based on registered information of outcome. *J Epidemiol Community Health* 1985;39:141–7.
4 Selevan SG, Lindbohm ML, Hornung RW, *et al*. A study of occupational exposure to antineoplastic drugs and fetal loss in nurses. *N Engl J Med* 1985;313:1173–8.
5 Anon. ASHP technical assistance bulletin on handling cytotoxic and hazardous drugs. *Am J Hosp Pharm* 2006;63:1172–91.

6 Mason HJ, Blair S, Sams C, *et al*. Exposure to antineoplastic drugs in two UK hospital pharmacy units. *Ann Occup Hyg* 2005;49:603–10.
7 Centers for Disease Control and Prevention. NIOSH Alert. *Preventing Occupational Exposures to Antineoplastic and Other Hazardous Drugs in Health Care Settings*. Cincinnati: NIOSH, Publication No. 2004-165, 2004. http://www.cdc.gov/niosh/docs/2004-165/ (accessed 14 Dec 2011).
8 Centers for Disease Control and Prevention. *NIOSH List of Antineoplastic and Other Hazardous Drugs in Healthcare Settings 2010*. DHHS (NIOSH) Publication No. 2010-167. http://www.cdc.gov/niosh/docs/2010-167/pdfs/2010-167.pdf (accessed 14 Dec 2011).
9 University HealthSystem Consortium (UHC). UHC consensus statement: model hazardous drug safety plan for institutions. *Am J Health-Syst Pharm* 2010;67:1545–6.
10 Jost M, Rüegger M, Liechti B, *et al*. *Sécurité dans l'emploi des cytostatiques*. 3rd edn. Luzern: SUVAPro, 2004.
11 Compendium suisse des medicaments. Bâle: Documed 2011. http://www.kompendium.ch/ (accessed 22 Nov 2012).
12 McDiarmid MA, Condon M. Organizational safety culture/climate and worker compliance with hazardous drug guidelines: lessons from the blood-borne pathogen experience. *J Occup Environ Med* 2005;47:740–9.
13 Gambrell J, Moore S. Assessing workplace compliance with handling of antineoplastic agents. *Clin J Oncol Nurs* 2006;10:473–7.
14 International Agency for Research on Cancer. IARC's monographs on the evaluation of carcinogenics risks to humans. List of all agents evaluated to date (listed by CAS numbers). http://monographs.iarc.fr/ENG/Monographs/vol100A/index.php (accessed 14 Dec 2011).
15 Reprotox®, Drugdex®. Micromedex healthcare series, 1974–2008. Thomson Healthcare. http://www.thomsonhc.com/home/dispatch (accessed 14 Dec 2011).
16 Anon. Risk and safety phrases. Wikipedia. http://en.wikipedia.org/wiki/Risk_and_Safety_Statements (accessed 14 Dec 2011).
17 Anon. NIOSH response to public comments. 2009. http://www.cdc.gov/niosh/review/public/105-a/pdfs/ResponsetoPublic.pdf (accessed 14 Dec 2011).
18 Alemany C, Kaestli LZ, Fonzo-Christe C, *et al*. *Université Genève*. 2005. http://pharmacie.hug-ge.ch/ens/travmaitrise/2005_ca_eval_risq_manip_antico_monocl.pdf (accessed 14 Dec 2011).
19 Pigneret-Bernard S, Saint-Lorant G, Divanon F. Safety of monoclonal antibodies for the technician : myth or realityAbout a survey of professional practice. *J Pharm Clin* 2008;27:227–33.
20 Massoomi F, Neff B, Pick A. Implementation of a safety program for handling hazardous drugs in a community hospital. *Am J Health-Syst Pharm* 2008;65:861–5.
21 Rousselin X. Les médicaments cytostatiques en milieu de soins. 1. Toxicité et risques professionnels. 2. Recommandations pour la prévention des risques professionnels. Dossier médico-technique TC36 INRS, Paris, 1991. http://mtriay.free.fr/Textes_officiels/tc36.pdf (accessed 14 Dec 2011).

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