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Banding the World Together; The global growth of Control Banding and qualitative occupational risk management.

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ABSTRACT:

The use of control banding (CB) strategies to prevent work-related illness, disease, and injury for the approximately 2.5 billion workers that do not have access to occupational safety, health, and hygiene (OSHH) professionals has seen an exponential growth during the last decade. CB originates from the pharmaceutical industry to control active pharmaceutical ingredients that did not yet have a complete toxicological basis and therefore did not have occupational exposure limits. CB applications have broadened into chemicals in general - including new emerging risks like nanomaterials- and recently even further into topics like ergonomics and injury prevention. In general, CB is an action-oriented qualitative risk assessment strategy offering solutions and control measures to users through “toolkits”. Chemical CB toolkits have been developed into user-friendly formats and are being used to achieve workplace controls in the absence of firm toxicological and quantitative exposure information. The model (technical) validation of these toolkits are well described, however firm operational analyses (implementation aspects)) are mostly lacking. As a consequence, it is often not known if toolkits in use lead to successful interventions at individual workplaces. This might lead to *virtual safe* workplaces without knowing if workers are *truly protected*. Upcoming international strategies from the WHO Collaborating Centers, ICOH and IOHA request assistance in developing AND evaluating action-oriented procedures for workplace risk assessment and control. It is expected that to fulfill the goals of this strategy, CB approaches will play an even more important role in protecting workers as compared to the last decade.

Key Words: control banding, occupational risk management, qualitative risk assessment, action-oriented toolkits, prevention, workplace solutions

Introduction

Two very different events occurred in Europe in June 2011, but both shared a goal of preventing work-related illness, disease, and injury for the approximately 2.5 billion workers that do not have access to occupational safety, health, and hygiene (OSHH) professionals. These two meetings were the Planning Committee of the Global Network of Collaborating Centers for Occupational Health (WHOCC) in Oslo, Norway and the EU Conference “Perspectives in Control Banding” sponsored by the Federal Institute of Occupational Safety and Health (BAuA) in Dortmund, Germany. A topic in common was Control Banding (CB), a simplified process for controlling worker exposures and achieving primary prevention. The essence of how this topic unites these two events can be seen within CB research occurring in Southern India [1]. This article sought to implement and evaluate CB action-oriented toolkits in a region where exposure prevention is most needed, addressing needs in the WHOCC Workplan’s Priority 2.1 discussed in Oslo and Workshop 3 in Dortmund. Our article seeks a bold and more global objective, the assistance of you, the reader, in achieving the authors’ goal.

Basics of Control Banding

CB originates from the Industrial Hygiene (IH) profession and represents a qualitative risk assessment process to generate solutions and control measures. CB strategies are most useful in preventing worker exposures in the absence of firm toxicological and exposure information. These strategies are often found in “toolkits” with categories, or “bands”, of health hazards, combined with exposure scenarios to determine the desired controls. CB originated as an alternative approach for controlling chemical exposures. This historical progression of research-based programs promoting solutions began with successive OSHH initiatives through the ILO Work Improvement in Small Enterprises (WISE) and Work Improvement in Neighborhood Development (WIND), and the WHO and International Occupational Hygiene Association (IOHA) Prevention And Control Exchange (PACE) [2,3,4]. It relies on decision rules derived from prior quantitative studies of various exposure factors. CB allows users to make meaningful inferences about likely exposures and controls, reducing them within 4 or 5 hazard bands (Figure 1). Thus CB represents qualitative risk assessment and risk management approaches.

[Insert Figure 1]

An important application for CB is where uncertainty is high, such as when no occupational exposure limits exist but substances can be reliably grouped based on similarity to better studied substances. Such risk assessment is necessarily generic, so banding yields precautionary assumptions. While OSHH professionals have viewed CB and its simplification as a lesser option to quantitative methods, recent application of CB to nanomaterial exposure control has altered that view significantly [5,6,7,8]. CB has grown significantly worldwide and is now seen as an excellent risk communication method for workers and professionals alike. CB strategies have expanded to ergonomics and injury prevention and now address multidisciplinary topics like Occupational Health and Safety Management Systems and the construction trades [9,10,11,12].

Existing toolkits and evaluations

Your assistance will be necessary for expanding the use and evaluation of CB toolkits, therefore a brief discussion is necessary. For generic chemicals, existing toolkits are divided into two families:

- a) COSHH Essentials (UK) and adapted/translated versions like Silica Essentials (UK), International Chemical Control Toolkit (ICCT), Korean CB Toolkit, ICCT translations and sector versions in e.g., Chinese, Spanish, Portuguese, and EMKG –Expo-Tool (Germany);
- b) Tools based on the conceptual exposure model [13,14]: Stoffenmanager (The Netherlands, with versions in Dutch, English, German and Finnish (end 2011)) and Chemirisk (Kjemirisk - Norway).

Based on the same “family division,” CB Toolkits have also been developed for nanomaterials: the CB Nanotool (USA) [5,6,11] and Stoffenmanager Nano (Dutch, English and Finnish (end 2011)).

This non-exhaustive list of existing toolkits might be confusing for stakeholders in answering the questions: which tool to adopt and should the tool be adapted for any specific needs? However, the bottom line reflects only one important issue for toolkit users: how to arrive at a controlled use of chemicals. In order to help stakeholders/users make a decision on “which tool is best fitted for my exposure scenario”, a kind of consumer guide might help. A consumer guide ideally should compare all currently available tools based on a defined set of criteria for comparison. The backbone for such a comparison should be based on two principles:

- a) Model validation (technical):
Addresses conceptual or internal validation (theoretical model structure and corresponding uncertainties) and external validation (comparison of model outcome with independent measurement data).
- b) Operational analysis (implementation):
Addresses variability of exposure estimates caused by tool application with different users. Simply put: are users able to perform a complete and reliable assessment and ensure safe use?

In general, when looking at the literature, model validations of toolkits are (well) described. On the contrary, operational analyses are - to our knowledge - very rarely found in peer-reviewed literature. Tool developers mostly have an idea about implementation aspects, but this idea is based on ad-hoc information rather than on a thorough analysis. This means that a “plan, do, check, act, verify cycle” in the development process and toolkit implementation is most often incomplete: the “check and act” in operational analyses is missing, as is “verify” to ensure recommended controls remain functionally in place. As a consequence, it is often not known if toolkits in use lead to successful interventions at individual workplaces. Not unraveling this puzzle might lead to *virtual safe* workplaces without knowing if workers are *truly protected*.

To elucidate, four examples of operational analyses will be presented. The first example is from an International Commission on Occupational Health (ICOH) newsletter [1] where three different toolkits were evaluated in Southern India. The authors concluded that “as could be expected, no one toolkit can provide solutions for all types of work settings and exposures, especially in complex and resource limited work environments prevalent in developing countries. In view of the resources needed for traditional exposure assessments, such approaches may be the only kind feasible for risk management. The lack of endorsement for such toolkits by local regulation is perhaps a bigger challenge and likely to be the single largest obstacle for wider adoption of such approaches by local industry. “

The second example is from the Netherlands, where a series of technical evaluations [15,16,17] led to an operational analysis of the Stoffenmanager tool. In this latest analysis three phases were distinguished:

- a) is the tool understandable and of practical value for the users?
- b) is there a match between the tool and the users?
- c) is a quality check at user level i.e, at the individual workplace?

Results from the first two phases showed that the tool is being used both by experts and non-experts (all kinds of job titles) and that about half of the users work at Small and Medium-sized Enterprises (14% thereof at micro-companies with 1-10 employees). The main conclusion is that the tool’s aim (i.e., being a personal coach for SMEs in “Do-It-Yourself” chemicals management) was fulfilled. In parallel the tool shifted from solely a technical exposure assessment model towards a broader tool for risk communication and raising awareness. In addition to the quality check at the user level, the Stoffenmanager consortium has started an implementation workshop project in 45 companies to improve and study both the tool’s implementation, and sound chemical management in general. The idea is to improve and study both the implementation of the tool itself, as well as a sound chemical management in general. For this, a 7-step implementation evolutionary ladder has been defined and the ambition is helping companies to progress at least one distinct level of the ladder.

The third example is the CB Nanotool, where a thorough evaluation was published of both the risk matrix input criteria and a successful comparison of this toolkit's outcomes against IH professionals [5]. Finally, following ongoing research on the EMKG [18,19], a new EU project coordinated by the German BAuA institute has started validating Tier 1 exposure models under EU-REACH. In the project, the tools mentioned in the REACH guidance (i.e., ECETOC TRA, EMKG-Expo-Tool and Stoffenmanager) will be compared both on technical and operational aspects. The project results are expected to become available Q3 2012.

Request for your assistance

In the ICOH 2009-2012 Workplan, President Kazutaka Kogi lists in his plan-of-action:

- advancing proactive risk assessment and control at work; and
- developing action-oriented toolkits for field use.

He emphasized “in all these domains, we need to develop action-oriented procedures for workplace risk assessment and control” [20]. Today, CB approaches have become a leading focus for researchers worldwide [9,11,21]. This has led to a significant increase in OSHH publications emphasizing primary prevention, and modern day CB applications are seen by some as the best occupational risk management approach to control exposures. Therefore, on behalf of the WHOCC, ICOH, and IOHA, we would sincerely appreciate if you would add to this vital research. Please let us know if we can be of any assistance.

Conclusion

The use of CB approaches in OSHH has increased significantly during the last decades. This growth has been a tremendous aid in international goals of preventing work-related disease and illness by offering simplified approaches to deliver workplace solutions directly to workers with minimal OSHH professional assistance. The development of chemical-based CB toolkits continues to escalate and its applications in both developed and developing countries has served to provide a necessary link of risk communication and control solutions to prevent work-related exposures, where historically it has been mostly, if not completely, absent. However, the next steps of ensuring that the CB toolkits are used appropriately in individual workplaces and that their control solutions are verified, in practice, has become a necessity on the global scale. These next steps are beyond the capability and reach of the professionals developing CB toolkits, so the assistance of OSHH professionals around the world will be essential to ensuring that workers are indeed protected. This assistance will also ensure that required improvements to CB toolkits, as well as the path forward to further research requirements, will become an excellent method for bringing together the world of OSHH professionals into a singular multidisciplinary effort with a shared purpose of protecting workers. Preceded by firm research on development and, more recently, on evaluation of toolkits, CB now plays a vital role in long-term strategies of the international efforts of the WHOCC, ICOH and IOHA. Most importantly, CB provides a clear method and approach for the world of occupational health and safety to come together in delivering solutions and control strategies to prevent work-related illness, disease, and injury for the approximately 2.5 billion workers that do not have access to occupational OSHH professionals.

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Internet Resources - Control Banding Toolkits

CB Nanotool [download]:

<http://www.controlbanding.net/Services.html>

COSHH Essentials [web-based]:

<http://www.coshh-essentials.org.uk/>

COSHH Essential Sector guidance sheets (e.g., silica) [web-based]:

<http://www.hse.gov.uk/pubns/guidance/>

EMKG-Expo tool [download]

<http://www.reach-clp-helpdesk.de/reach/en/Exposure/Exposure.html>

(download)

ECETOC TRA [download]

<http://www.ecetoc.org/tra>

KOSHA Control Banding chemical classification and engineering controls

<http://www.kosha.or.kr/bridge?menuId=1475>

International Chemical Control Toolkit (ICCT) [web-based]:

http://www.ilo.org/legacy/english/protection/safework/ctrl_banding/toolkit/icct/index.htm

Stoffenmanager [web-based]:

<https://www.stoffenmanager.nl/default.aspx>

Stoffenmanager Nano [web-based]:

<http://nano.stoffenmanager.nl>

References

1. Balakrishnan K, Sankar S, Mukhopadhyay K, Surianarayanan M, Swaminathan G. Application of control-banding approaches in Southern India for safe chemical management: challenges and opportunities. ICOH newsletter - Volume IX - Number I - March 2011 - ISSN 1795-0260
2. Kawakami T and Kogi K (2001). Action-oriented support for occupational safety and health programs in some developing countries in Asia. *Int J Occup Saf Ergon*. 2001;7(4):421-34.
3. Kogi K. Integrating occupational hygiene and health: the effectiveness in improving small-scale workplaces. *Italian J Occupational and Environmental Hygiene*, 2010;1(2):69-75
4. Swuste P, Hale A, Pantry S. "Solbase: a databank of solutions for occupational hazards and risks." *Ann Occup Hyg*. 2003;47(7): 541-7.
5. Zalk DM, Paik S, Swuste P. Evaluating the Control Banding Nanotool, a qualitative risk assessment approach for controlling nanomaterial exposure. *J Nanopart Research*. 2009;11:1685-704.
6. Paik S, Zalk DM, Swuste P. Application of a pilot control banding tool for risk level assessment and control of nanoparticle exposures. *Ann Occup Hyg*. 2008;52:419-28.
7. Van Duuren-Stuurman B, Vink SR, Verbist KJM, Heussen GAH, Brouwer DH, Kroese DED, Van Niftrik MFJ, Tielemans ELJP, Fransman W. Stoffenmanager Nano version 1.0: a web-based tool for risk prioritization of airborne manufactured nano objects. *Ann Occup Hyg* (accepted for publication)

8. NIOSH. Qualitative risk characterization and management of occupational hazards: Control Banding (CB); a literature review and critical analysis, 2009. Department of Health and Human Services, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 2009-152.
9. Zalk DM, Nelson DI. History and evolution of control banding: a review. *J Occup Environ Hyg.* 2008;5:330-46.
10. Zalk DM, Kamerzell R, Paik S, Kapp J, Harrington D, Swuste P. Risk level based management system: a control banding model for occupational health and safety risk management in a highly regulated environment. *Indust Health.* 2010;48:18-28.
11. Zalk DM. Control Banding; a simplified, qualitative strategy for the assessment of risks and selection of solutions. TU Delft publisher. 2010. p. 220
12. Zalk DM, Spee T, Gillen M, Lentz TJ, Garrod A, Evans P, Swuste P. Review of qualitative approaches for the construction industry: designing a risk management toolbox. *Saf Health Work.* 2011;2(2):105-21.
13. Cherrie J, Schneider T, Spankie S, Quinn M. A new method for structured, subjective assessments of past concentrations. *Occup Hyg.* 1996;3(3):75-83
14. Cherrie J and Schneider T. Validation of a new method for structured subjective assessment of past concentrations. *Ann Occup Hyg.* 1999;43:235-45.
15. Marquart H, Heussen H, Le Feber M, Noy D et al. 'Stoffenmanager', a web-based control banding tool using an exposure process model. *Ann Occ Hyg.* 2008;52(6):429-42
16. Schinkel J, Wouter F, Heussen H, Kromhout H, Marquart H, Tielemans E. Cross-validation and refinement of the Stoffenmanager as a first tier exposure assessment tool for REACH. *Occup Environ Med.* 2010;67:125-32
17. Tielemans E, Noy D, Schinkel J, Heussen H et al. Stoffenmanager exposure model: development of a quantitative algorithm. *Ann Occup Hyg* 2008;52(6):443-54
18. Packroff R, Tischer M. Control banding in Germany. In: Harris RL, editor. *Patty's industrial hygiene.* 6th. 2008. New York: John Wiley & Sons.
19. Tischer M, Bredendiek-Kamper S, Poppek U, Packroff R. How safe is control banding? Integrated evaluation by comparing OELs with measurement data and using Monte Carlo simulation. *Ann Occup Hyg.* 2009;53 (5):449-62.
20. ICOH Report. Message from the President. June 2009, http://www.icohweb.org/site_new/ico_reports_president_pres_address_200906.asp
21. Fingerhut M. Global qualitative risk management (control banding) activities. *Industr Health* 2008;46:305-07.

Figure 1 A generic Control Banding Risk Level (RL) matrix as a function of severity and probability.

		Probability Score			
		Extremely Unlikely	Less Likely	Likely	Probable
Severity score	Very High	RL 3	RL 3	RL 4	RL 4
	High	RL 2	RL 2	RL 3	RL 4
	Medium	RL 1	RL 1	RL 2	RL 3
	Low	RL 1	RL 1	RL 1	RL 2

Control bands by risk level:

RL 1: General Ventilation

RL 2: Fume hoods or local exhaust ventilation

RL 3: Containment

RL 4: Seek specialist advice