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Prevention of Falls on the Level in Occupational Situations: A Major Issue, a Risk to Be Managed

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The terminology used to designate falls on the level is broadly based and the accidents concerned are only very rarely defined explicitly. A definition of falls on the level in occupational situations is therefore proposed. We attempt to define the issue represented by the prevention of such accidents on the basis of statistical data, prior to explaining the twin objectives focused on in the field of their prevention. We then propose a summary of unbalance risk factors in occupational situations. These factors are associated with different components of the occupational situation they concern: individuals, their tasks, the equipment used, or the working environment. The diversity of accident contexts and different in-company prevention possibilities are thereby highlighted. Finally, we discuss a number of consequences in prevention terms.

falls on the level   unbalance   occupational accident   prevention

1. INTRODUCTION

Literature concerning falls on the level in occupational situations introduces statistical data that reveal the magnitude and seriousness of this risk. The terminology used for these accidents is broadly based: slips, trips, or falls on the level (Health and Safety Executive, 1985); accidents on the level (Caisse Nationale de l’Assurance Maladie, 1995); falls (Leamon & Murphy, 1995); falls on the level (Balance, Morgan, & Senior, 1985); underfoot

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accidents, that is, accidents in which the first unforeseen event is an interaction between the victim's foot and a support (Manning, Ayers, Jones, Bruce, & Cohen, 1988) or, again, slips (Gronqvist & Roine, 1993). The accidents analyzed are not defined explicitly, except in the case of underfoot accidents studied by Manning et al. (1988).

Most research and studies have focused on prevention of the slipping event, which occurs when walking normally (cf. Leclercq, 1999a, referring to many of these studies). Kemmlert and Lundholm (1998) and Haslam and Bentley (1999) have considered a combination of contributing events in their analysis of slips, trips, and falls. The present study also adopts a global approach to preventing falls on the level in occupational situations. Research into slip prevention has effectively shown the twofold necessity (cf. Leclercq, 1999b) of

- taking into account a wider range of accidents: Those triggered not only by the slip but, more generally, by the victim's unexpected loss of balance;
- considering the accident within its dynamic context: In other words, not concentrating solely on the loss of balance triggering event, but considering events that take place both upstream and downstream of the loss of balance.

We will define falls on the level in occupational situations as accidents during which victims unexpectedly lose their balance while performing tasks that cannot be viewed as working "at a height." Victims subsequently recover their balance or fall, suffering injuries in either case. We will consider surfaces featuring either no abrupt change of level or abrupt changes of level, such as sidewalk, curbs and steps, or a gradual change of level, such as a slope.

2. THE ISSUE

National classification systems for occupational accidents do not permit accurate assessment of the issue represented by preventing falls on the level. Lortie and Rizzo (1999) show that these accidents are in fact underestimated in these systems. Notably, they question the lack of a conceptual definition of loss of balance. Anderson and Lagerlöf (1983) call into question the unicausal model underlying classification of occupational accidents when explaining the underestimation of slips in national statistics.

In France, occupational accidents are listed under 40 or so headings. The first of these headings consolidates cases of accidents on the level and is the most relevant to grading falls on the level. Consequently, we will analyze the statistical data on these accidents in order to raise the issue represented by prevention of falls on the level. In 1977 and 1997, accidents on the level represent respectively 18 and 22% of occupational accidents leading to a stoppage along with 18 and 23% of days lost due to temporary disablement. Eighteen percent (in 1977) and 20% (in 1997) of accidents leading to permanent disablement are accidents on the level (cf. Table 1). These accidents are therefore not only frequent but their consequences are no less serious than those of other occupational accidents considered as a whole. They are fatal in some cases and they involve all sectors of activity. The increase in the statistical indicators between 1977 and 1997 may be explained notably by the fact that efforts as far as occupational accident prevention is concerned essentially involve accidents featuring a specific task- or tool-related component, for example (cf. Table 2). Actions in prevention terms are usually based on this specific component. The diversity of fall contexts and the absence of a specific component constitute the main difficulties encountered when approaching the prevention of such accidents.

TABLE 1. Changes in Some Statistical Indicators Reflecting the Magnitude and Seriousness of the Risk of Accidents on the Level, of Concern to the Caisse Nationale d'Assurance Maladie (French National Health Insurance Fund), Between 1967 and 1997

Statistical Indicator	1967	1977	1987	1997
Number of OAs leading to a stoppage	1,098,793	1,025,968	662,800	673,513
Number of AOLs leading to a stoppage	195,030	189,255	130,947	144,803
% of AOLs among OAs leading to a stoppage	**17.8**	**18.4**	**19.7**	**21.5**
Number of fatal OAs		1,709	1,004	713
Number of fatal AOLs		60	19	10
% of AOLs among fatal OAs		**3.5**	**1.9**	**1.4**
Number of OAs leading to PD		112,146	63,152	46,782
Number of AOLs leading to PD		19,655	11,760	9,389
% of AOLs among OAs leading to PD		**17.5**	**18.6**	**20.1**
Number days lost due to TD resulting from OAs	26,542,501	28,496,598	21,989,297	26,346,226
Number days lost due to TD resulting from AOLs	4,409,098	5,241,429	4,510,326	5,939,475
% of days lost due to TD resulting from AOLs	**16.6**	**18.4**	**20.5**	**22.5**
Number of employees		13,756,444	13,305,883	15,056,174

Notes. OA—occupational accident, AOL—accident on the level, PD—permanent disablement, TD—emporary disablement.

TABLE 2. Changes in Some Statistical Data on Different Occupational Accident Classes, of Concern to the Caisse Nationale d'Assurance Maladie (French National Health Insurance Fund), Between 1977 and 1997

Statistical Data	1977	1997	Change
Number of OAs leading to a stoppage	1,025,968	673,513	–34.3%
Number of AOLs leading to a stoppage	189,255	144,803	–23.5%
Number of OAs listed under the heading "objects being handled"	289,851	173,942	–40.0%
Number of OAs listed under the headings "machines"	90,713	31,108	–65.7%
Number days lost due to TD resulting from OAs	**28,496,598**	**26,346,226**	**–7.5%**
Number days lost due to TD resulting from AOLs	**5,241,429**	**5,939,475**	**+13.3%**
Number days lost due to TD resulting from OAs listed under the heading "objects being handled"	**6,944,030**	**5,855,644**	**–15.7%**
Number days lost due to TD resulting from OAs listed under the headings "machines"	**2,689,874**	**1,145,460**	**–57.4%**
Number of employees	13,756,444	15,056,174	+9.5%

Notes. OA—occupational accident, AOL—accident on the level, PD—permanent disablement, TD—temporary disablement.

3. TWIN OBJECTIVES IN THE PREVENTION FIELD

The event common to falls on the level is the victim's unexpected loss of balance. This event precedes the fall or recovery of balance. In both cases, the seriousness of the injuries depends on the victim's immediate environment. In the first case, injuries result from the individual coming into contact with the physical environment. In the second case, individuals, who have unexpectedly lost their balance, will furnish a partially reflex response aimed at restoring their balance. At that moment, an injury provoking action is possible, even if there is a visible risk of injury. The seriousness of the accident will then depend on the presence of hostile elements in the environment. For example, an accident account reads, "the victim hit the pedal of the electropneumatic press and lost his balance. He first held himself with his right hand on the press table, then in the tooling."

Consequently, twin objectives in the field of falls on the level in occupational situations will be focused on simultaneously: preventing loss of balance and limiting the seriousness of injuries.

4. THE FALL ON THE LEVEL: A SYSTEMIC ACCIDENT

All sectors of activity taken into account, accident situations are highly varied (activity at time of accident, place at which accident occurred, etc.). This is noticeable when reading accident accounts contained in the EPICEA database (a database containing occupational accidents, more than half of which are fatal; Ho, Bastide, & François, 1986). Loss of balance arises during an occupational activity, which may (disrupted displacement) or may not (disrupted posture) involve a displacement within an occupational environment, while the individual may or may not be wearing personal protective gear (safety shoes, helmet, glasses, antinoise protection). These accidents are considered commonplace and are rarely subjected to analysis. In most cases, they are attributed to "carelessness," to the behavior of the victim, whereas associated risk factors are linked to the different components of the work situation. We adopted the systemic corporate model described by Monteau (1974) to argue this view. In this model, the company is considered to be a system featuring four independent components: the individual (I), the task he or she performs (T), the equipment he or she uses (Eq) and the working environment in which he or she circulates (En). Any disruption in one of the system components or in the relationships between components may cause an accident and therefore constitutes a risk factor. Thus, the four system components constitute four simple risk factors. Notation (X, Y) will be used to symbolize the risk factor corresponding to improper functioning of component Y caused by component X (Monteau, 1974). Risk factors identified from accident analysis, literature, or known factors likely to influence balancing mechanisms are associated with the relevant components in Table 3. Studies referring to the link between these factors and the risk of loss of balance are included as references.

Table 3 clearly shows that loss of balance risk factors are associated with all components of the occupational situation and that the systemic approach is indeed relevant to preventing falls on the level. However, it raises a question regarding the weighting of risk factors in an occupational situation. The literature concerning analysis of these accidents throws some light on this issue of weighting:

1. In common with occupational accidents in general, faulty design, poor maintenance and fitting out, unsuitable tools and accessways, defective task structuring, lack of ergonomic concern are all factors that are almost always referred to in cases of falls occurring in working environments.

TABLE 3. Loss of Balance Risk Factors Linked to Occupational Situation Components

Type of Factor	Risk Factors in Relation to Loss of Balance or to Injury Aggravation if Balance Is Lost	References
I	Effect on balancing mechanisms of	
	• age	
	• alcohol consumption	Kemmlert and Lundholm (1998)
	• taking certain drugs	Gronqvist (1999)
	• various illnesses	Perrin and Lestienne (1994)
	Effect of individual risk appraisal linked to experience and to the atypical nature of the risk of fall on the level	Guillermain, Favaro, and Guyon (1991); Swensen, Purswell, Schlegel, and Stanevich (1992)
T, I	Influence of task on	
	• the individual's "functional" state linked to posture control[1] (assumption)	
	• risk detection[2]	
	• stability of balance and possible postural responses if balance is lost[3]	Grieve (1983); Leclercq (1999c)
	Effect of time constraint	Haslam and Bentley (1999)
T, T	Effect of work team interference	Caisse Nationale Suisse en cas d'Accidents (1994)
I, T	Effect of knowledge or ignorance of the environment[4]	Leclercq (1999c); Ryynänen (1993)
Eq, I	Effect of wearing personal protection on risk detection	
En, I	Effect of congestion, design, maintenance, fitting-out, and state of the environment on the risk of loss of balance and on the nature and seriousness of injuries if balance is lost	Albin and Adams (1989); Fothergill, Driscoll, and Hashemi, (1995); Kemmlert and Lundholm (1998); Pierdet (1996)
Eq, T	Unsuitability of equipment for the task	Kemmlert and Lundholm (1998); Pierdet (1996)
Eq, En, I, T	Lack of in-company safety organization	Haslam and Bentley (1999)

Notes. I—individual, T—task, Eq—equipment, En—environment. Risk factors corresponding to improper functioning of component X or Y, caused by component X, are symbolized by notation X or X, Y. For example, line 6 of the table corresponds to factors reflecting disrupted functioning of the individual caused by the working environment. Studies referring to the link between these factors and the risk of loss of balance are included as references.

[1] An assumption tested within the scope of a study entitled "Effects of repetitive movements and prolonged static postures on neuromuscular system reactivity." Executing a movement is effectively always preceded by a reorganizing of muscle cooperation plans. Confirmation of the assumption that these anticipatory activities are "put to sleep" by monotonous repetition of movements or prolonged maintenance of static postures would provide at least a partial explanation of certain accidents that have occurred following loss of balance during the transition from a monotonous situation to a more dynamic activity. This study concludes that the assumption of "reaction inertia" requires confirmation. This same question is raised by the many falls experienced by bus drivers at the end of their shift, when they leave their vehicle after several hours driving.

[2] The activity may prevent detecting a risk of falling, for example due to carrying a load or because the individual's attention is focused on the task in hand.

[3] An active individual is in a more or less stable balance situation. The accident report analysis shows that some disruptions to balance occurring during specific activities can lead to irreversible loss of the individual's balance ("when tightening the last bolt, one of the wrenches slipped causing the victim to lose his balance.").

[4] For example, experience of the working environment results in the individual knowing the "risky locations." This knowledge then constitutes a safety factor. It can however become a risk factor when something changes in the environment (a new step, etc.) because knowledge of the location makes the individual less able to perceive the change.

These aspects condition the person's activity as well as the possibility of risk detection. The literature is unanimous as to the priority they should be given in the field of preventing falls on the level (Albin & Adams, 1989; Caisse Nationale Suisse en cas d'Accidents, 1994; Fothergill, Driscoll, & Hashemi, 1995; Kemmlert & Lundholm, 1998; Pierdet, 1996).

2. Regarding the impact of individual factors influencing falls on a level, such as age, drugs and alcohol consumption or, again, sleeping disorders, it would seem that

   - whereas among the active working population, falls are more frequent and their consequences more serious for persons over 45, the factors contributing to these accidents remain the same whatever the considered age group (Kemmlert & Lundholm, 1998). Prevention actions to be implemented would therefore be identical whatever the age of the persons employed, even if it is all the more urgent to execute them when the personnel's average age is higher;
   - feelings of faintness or sickness are very rarely mentioned in cases of falling in the occupational environment (Kemmlert & Lundholm, 1998);
   - consumption of drugs or alcohol and sleeping disorders are falling risk factors. However, no link has yet been established between these factors and falls on the level in occupational situations. Whereas we may wonder about the impact of these individual factors on the occurrence of falls on the level at work, the adopted systemic approach and the stress placed on interactions between the different components of the situation appear all the more relevant and operational from a prevention standpoint.

3. Kemmlert and Lundholm (1998) have shown that the factors contributing to falls on the level in occupational situations differ depending on the sector of activity. Prevention possibilities are therefore multiple and should be adapted to the different contexts. These observations highlight the importance of seeking a typology for these accidents and certain specific characteristics through this typology.

5. CONSEQUENCES IN PREVENTION TERMS—CONCLUSION

Falls on the level are rarely approached as true occupational accidents. They occur in highly varied contexts that are only exceptionally examined in depth. For all these reasons, prevention of in-company falls on the level calls for in-depth analysis of the circumstances in which these falls occur. In fact, these circumstances and thus the resulting preventive actions probably present specific characteristics associated with the sector of activity of the company concerned, as the results of Kemmlert and Lundholm (1998) suggest. We have shown that the systemic approach is entirely suited to analyzing falls on the level occurring in occupational situations. This approach will allow all components of the situation, not only the individual, to be looked at. It will also enable the diversity of accident contexts and different in-company prevention possibilities to be appreciated. Detailed analysis of falls on the level offers a company the advantage of understanding these accidents and of being capable of better preventing them. Beyond the immediate interest to the companies involved, capitalization of in-depth analyses in the scope of research and studies would specifically enable one to

- enjoy a synthetic vision of the different contexts involving falls on the level in occupational situations;
- seek prevention actions of general scope.

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