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Guidelines for the Prevention of Work-Related Musculoskeletal Disorders: The Italian Experience

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INTRODUCTION

Introduction in Italy, in 1994, of general and more ergonomically oriented norms, derived from a series of UE Directives in OS&H, at the workplace (European Directives 391/89, 269/90, 270/90), called the attention of several stakeholders (employers, trade unions, OH&S professionals, and public authorities) to work-related musculoskeletal disorder (WMSD) prevention issues.

In particular, acknowledgment of European Directive 269/90 (1990) concerning manual handling of loads resulted in the adoption of spinal risk assessment and management procedures affecting over 4 million workers engaged in physically heavy tasks (about 20% of the laborforce).

On the other hand, the increasing reports of occupational upper-limb WMSDs (by now in second place among most frequently reported work-related diseases) induced the national and regional authorities, in the absence of a specific regulation on the subject, to issue guidelines for assessing and managing the risk from upper-limb repetitive movements potentially involving about 6 million workers (30% of general workforce), mainly from the manufacturing industry.

On this basis, the major points of the following Italian guidelines are summarized and discussed:

- The guidelines for the application of European Directive 269/90 on manual handling of loads, prepared by the Authors and officially adopted by the Conferenza dei Presidenti delle Regioni Italiane (1996) and by the National Institute for Safety and Prevention at Work (ISPESL)
- The guidelines (and a related application program) for prevention of upper-limb WMSDs connected to repetitive movements and exertions, prepared by the Authors and officially adopted by the Lombardy Regional Government (2004). In this view, it is worth underlining that so far no national governmental guidelines have been issued and, of the Italian

regions, Lombardy is the most densely populated (9 million inhabitants) and industrialized (more than 4 million workers).

GUIDELINE CONTENT

Manual Handling of Loads (Directive EC 90/269)

Exposure Assessment

Risk assessment, that is, the individual or collective probability of contracting dorsolumbar spinal disorders due to manual load handling, is one of the pillars of preventive measures required by new European regulations and intervention methodologies in the field of ergonomics.

It is worth recalling that an extremely simplified interpretation of the assessment concept has become standard practice in workplaces and in other applications according to which, for example, load handling may be assessed solely on the basis of the load weight (as stated in old national regulations and standards).

This was widespread practice in Italy: In fact, a weight limit (30 kg) was introduced in the legislation to incorporate the EC Directive in Italian law, hence, the simplification that all objects weighing less than 30 kg may be handled in “safety”!

With such a scenario, when defining the appropriate tools for risk (or, better, exposure) assessment, the Authors had to redefine the requirements for assessment validity and applicability, not only leaving aside the rigors of a sophisticated scientific approach as a prerogative of research elites but also opposing the oversimplification demanded by operators in the field (often as a pretext; Grieco, Occhipinti, Colombini, & Molteni, 1997)

Assessment of Lifting Tasks. As regards assessment of manual lifting, the models proposed by the guideline are based on the revised NIOSH equation (Waters, Putz Anderson, Garg, & Fine, 1993). Obviously, this occurs via major adaptations and changes in the original model as, on the other side, was suggested by a prEN draft standard (prEN 1005-2; CEN, 2002).

For large-scale application of the model, it seemed (and actually was) useful to propose graphic and procedural simplifications as reported in Table 17.1, which shows a sheet for collection and processing of all the data required for calculating the lifting index. Note that on the proposed sheet, reference is made to a weight whose details are to be identified according to local situations and the degree of protection that is to be assured to adult working population in accordance with the Directive.

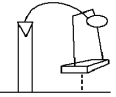
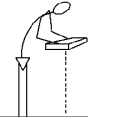

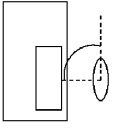
The sheet, and so the underlying operating procedure, has been widely appreciated in Italy, and it is similar to the one reported in the final version of prEN 1005-2 (CEN, 2002). It is important to underline that this document, on account of the impossibility of achieving a univocally established load constant (maximum recommended weight under ideal lifting conditions), proposes a range of possible constants indicating, as required, the relevant “target” population as well as the degree of its presumed protection.

It should be further stressed that adopting the NIOSH model to make assessments in the field of manual load lifting tasks did, however, pose some problems that can be schematically described in the following.

1. The American authors themselves (Waters et al., 1993) emphasize that the procedure is not applicable in some situations: Such caution is quite understandable from a strictly scientific viewpoint, but in some cases caution may be overcome by making assumptions based on empirical data. When, for example, the load is lifted with one arm only, the prEN 1005-2 proposes introducing a further multiplier of 0.6. If lifting is carried out by two or more operators, it was proposed to consider, as the weight actually lifted, the weight of the object divided by the number of operators, and for the recommended weight to introduce a further

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TABLE 17.1
Datasheet for the Evaluation of a Lifting Task (Adapted from Italian Guidelines)

		USER POPULATION			MALE		FEMALE																														
LOAD CONSTANT (KG)										LC																											
VERTICAL MULTIPLIER (VM)																																					
	<table border="1" style="font-size: small;"> <tr><th>HEIGHT (cm)</th><td>0</td><td>25</td><td>50</td><td>75</td><td>100</td><td>130</td><td>150</td><td>>175</td></tr> <tr><th>FACTOR</th><td>0.78</td><td>0.85</td><td>0.93</td><td>1.00</td><td>0.93</td><td>0.84</td><td>0.78</td><td>0.00</td></tr> </table>	HEIGHT (cm)	0	25	50	75	100	130	150	>175	FACTOR	0.78	0.85	0.93	1.00	0.93	0.84	0.78	0.00			VM															
HEIGHT (cm)	0	25	50	75	100	130	150	>175																													
FACTOR	0.78	0.85	0.93	1.00	0.93	0.84	0.78	0.00																													
DISPLACEMENT MULTIPLIER (DM) <i>VERTICAL LOAD DISPLACEMENT DISTANCE BETWEEN ORIGIN AND DESTINATION OF LIFTING</i>																																					
	<table border="1" style="font-size: small;"> <tr><th>DISTANCE (cm)</th><td>25</td><td>30</td><td>40</td><td>50</td><td>70</td><td>100</td><td>170</td><td>>175</td></tr> <tr><th>FACTOR</th><td>1.00</td><td>0.97</td><td>0.93</td><td>0.91</td><td>0.88</td><td>0.87</td><td>0.86</td><td>0.00</td></tr> </table>	DISTANCE (cm)	25	30	40	50	70	100	170	>175	FACTOR	1.00	0.97	0.93	0.91	0.88	0.87	0.86	0.00			DM															
DISTANCE (cm)	25	30	40	50	70	100	170	>175																													
FACTOR	1.00	0.97	0.93	0.91	0.88	0.87	0.86	0.00																													
HORIZONTAL MULTIPLIER (HM)																																					
	<table border="1" style="font-size: small;"> <tr><th>DISTANCE (cm)</th><td>25</td><td>30</td><td>40</td><td>50</td><td>56</td><td>60</td><td>>63</td></tr> <tr><th>FACTOR</th><td>1.00</td><td>0.83</td><td>0.63</td><td>0.50</td><td>0.45</td><td>0.42</td><td>0.00</td></tr> </table> <i>HORIZONTAL DISTANCE BETWEEN HANDS AND MIDPOINT OF ANKLES</i>	DISTANCE (cm)	25	30	40	50	56	60	>63	FACTOR	1.00	0.83	0.63	0.50	0.45	0.42	0.00			HM																	
DISTANCE (cm)	25	30	40	50	56	60	>63																														
FACTOR	1.00	0.83	0.63	0.50	0.45	0.42	0.00																														
ASYMMETRIC MULTIPLIER (AM) <i>ANGULAR DISPLACEMENT OF LOAD (IN DEGREES)</i>																																					
	<table border="1" style="font-size: small;"> <tr><th>ANGLE</th><td>0°</td><td>30°</td><td>60°</td><td>90°</td><td>120°</td><td>135°</td><td>>135°</td></tr> <tr><th>FACTOR</th><td>1.00</td><td>0.90</td><td>0.81</td><td>0.71</td><td>0.62</td><td>0.57</td><td>0.00</td></tr> </table>	ANGLE	0°	30°	60°	90°	120°	135°	>135°	FACTOR	1.00	0.90	0.81	0.71	0.62	0.57	0.00			AM																	
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FREQUENCY MULTIPLIER	<table border="1" style="font-size: small;"> <tr><th>FREQUENCY</th><td>0.20</td><td>1</td><td>4</td><td>6</td><td>9</td><td>12</td><td>>15</td></tr> <tr><th>CONTINUOUS < 1 HOUR</th><td>1.00</td><td>0.94</td><td>0.84</td><td>0.75</td><td>0.52</td><td>0.37</td><td>0.00</td></tr> <tr><th>CONTINUOUS 1-2 HOURS</th><td>0.95</td><td>0.88</td><td>0.72</td><td>0.50</td><td>0.30</td><td>0.21</td><td>0.00</td></tr> <tr><th>CONTINUOUS 2-8 HOURS</th><td>0.85</td><td>0.75</td><td>0.45</td><td>0.27</td><td>0.15</td><td>0.00</td><td>0.00</td></tr> </table>	FREQUENCY	0.20	1	4	6	9	12	>15	CONTINUOUS < 1 HOUR	1.00	0.94	0.84	0.75	0.52	0.37	0.00	CONTINUOUS 1-2 HOURS	0.95	0.88	0.72	0.50	0.30	0.21	0.00	CONTINUOUS 2-8 HOURS	0.85	0.75	0.45	0.27	0.15	0.00	0.00				FM
FREQUENCY	0.20	1	4	6	9	12	>15																														
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CONTINUOUS 2-8 HOURS	0.85	0.75	0.45	0.27	0.15	0.00	0.00																														
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multiplier of 0.85. Such adjustments tend to reply to widespread applicative problems that would remain unsolved. In this sense, further proposals aimed at favoring an everincreasing practical applicability of the method are no doubt to be encouraged.

2. In many working situations, the same group of workers has to carry out different lifting tasks often in the same workshift. The different lifting tasks may be irregular in a given period of time in the workshift (e.g., in a warehouse with picking activities) or according to established

time sequences (e.g., when an operator works every 1–2 hours on an assembly line, first loads the line, then unloads the finished products, and then packs them). In such cases, the analytical procedure for each task is not suitable to summarize the overall exposure of the individual worker (or of the group of) to lifting. Therefore these cases require an analytical procedure for multiple tasks which is obviously more complex (Waters, Putz Anderson, & Garg, 1994).

3. The NIOSH assessment procedure is not well suited to application in various working sectors (typically nonindustrial sectors), sometimes on account of the characteristic of the lifted load, the great variability of lifting tasks, their frequent association with other manual handling tasks (trolley pulling or pushing), and finally the presence of other risk factors for the lumbar spine (e.g., whole-body vibrations). Agriculture, transport and delivery of goods, and assistance to individuals who are not self-sufficient (at home or in the hospital) are typical examples. In these situations, though the NIOSH lifting index is useful, validated procedures for integrated exposure assessment are not yet available, hence, the need for further research and proposals of specific simplified exposure assessment procedures aimed also at managing risk factors.

Assessment of Other Manual Handling Activities (Pulling, Pushing, and Carrying).

No equally consolidated procedures, based also on multidisciplinary approaches, like the NIOSH procedure for lifting, are available in the literature for the assessment of exposure to manual load handling such as pulling, pushing, or carrying. Considering this aspect, it was decided to use the data derived from the specific application of psychophysical methods summarized by Snook and Ciriello (1991). This was mainly due to three reasons:

1. Such data were also expressed with reference to the percentiles of potentially satisfied (even if not necessarily protected) population. In particular, where it was possible to select data on “satisfaction” of 90% of population, we were able to provide reference values that had a “cover” value comparable to that resulting from the application of lifting index.
2. Data from psychophysical studies were also used to develop the NIOSH formula (NIOSH, 1981; Waters et al., 1993) to assess lifting tasks: In particular, they were also used to evaluate the degree of “protection” or better “satisfaction” associated with use of the recommended weight limit.
3. The data from psychophysical studies were expressed by Snook and Ciriello (1991) with reference not only to the two genders but also to structural variables (height of pushing and carrying areas and distance) as well as to organizational variables (frequency and duration of tasks) which produced well-defined application methods according to the different working situations.

Manual Handling Index and Its Consequences. We have seen that it is always possible to calculate, albeit with a variety of assessment procedures according to the kind of analyzed manual handling activity, a synthetical exposure index (manual handling index = MHI), as follows:

$$MHI = \frac{\text{actually handled weight (force)}}{\text{recommended weight (force) as a function of major situation variables}}$$

Such a synthetical manual handling index, even if determined by semiquantitative assessment procedures, may become an effective tool not only, and not so much, for defining the exposure level of one worker (or group of workers) involved in manual handling, but also for defining the consequent preventive measures in accordance both with Community regulations and, more generally, with correct prevention strategies.

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To reach the latter goal, it is convenient to classify MHI results at least according to a model having more than two levels. This is because the level of approximation (both intrinsic and in conditions of application) of the suggested methods and procedures calls for a certain amount of caution, in particular as regards borderline results around the value of 1. This three-zone model (or traffic light model), appeared to be useful in this sense: accordingly, the MHI results could be classified as follows:

- MHI up to 0.75 = *Green zone*: There is not a particular exposure for the working population and therefore no collective preventive actions are required
- 0.76 = MHI = 1.25 = *Yellow zone*: This is the borderline zone where exposure is limited but may exist for some of the population. Prudent measures are to be taken especially in training and health surveillance of operators. Wherever possible, it is suggested to limit exposure so as to return to the green zone.
- MHI higher than 1.26 = *Red zone*: Exposure exists and is significantly present. The higher the MHI value, the higher the exposure for increasing numbers of the population. MHI values may determine priority of prevention measures that must in any case be taken to minimize exposure toward the yellow zone. Training and active health surveillance of operators must be undertaken in any case.

Health Surveillance Strategies. This paper is aimed at ergonomists; therefore health surveillance problems are discussed only considering the general aspects they may be of interest to our readers.

The guideline provides reference rules synthetically reported:

- Active health surveillance should regard all thoracolumbar spinal diseases.
- Active health surveillance of spinal work-related musculoskeletal diseases (WMSDs) can be performed in different steps:
 - (a) The first step envisages, for all exposed subjects, administration of questionnaires or anamnestic interviews according to models that are already available in the literature.
 - (b) The second step envisages a clinical examination of the spine only for subjects classified as positive ones in the previous anamnestic survey. This examination can be made by the occupational physician in the company medical department using a standardized set of specific clinical tests and maneuvers reported in the literature.
 - (c) The third step applies to those subjects, identified in the two previous steps, requiring more specialistic tests (neurological, orthopedical, etc.) or instrumental tests (image diagnostics, Electromyography, etc.) in order to complete the individual diagnostic procedure.
- The frequency of health surveillance (first + second step) checks may be established according to relative exposure indices as well as health results obtained in the latest “round” of examinations. Generally speaking, because health surveillance is concerned with slowly evolving chronic degenerative diseases, 3- to 5-year checks are adequate in most cases.
- One of the goals of health surveillance, from a collective viewpoint, is to check whether in a given working population, exposed to a specific risk, the occurrence of spinal WMSDs is other than expected. In order to make such comparisons, adequate reference data on the whole working population are needed. The guideline report data on the prevalence of positive cases (defined according to established criteria) for cervical, thoracic, and lumbar-sacral spine in a group of workers with low or zero, present or past, exposure to occupational risk factors for the spine (manual materials handling, fixed postures, and whole body vibrations). Data are subdivided by gender and 10-year age classes.

- Another goal of specific health surveillance at individual level is the earliest possible identification of subjects affected by spinal disorders for whom it would not be advisable to allow exposure levels that were defined as permissible for healthy subjects. The guideline gives detailed criteria to manage those cases.

Risk Management and Workplace (Re)design. The guideline gives full details regarding criteria and examples of task and workplace (re)design for reducing the need or almost the risks connected to manual handling activities. Because the issues presented are very common in the international literature and in other specific guidelines, they are skipped in this presentation.

Prevention of WMSDs Connected to Upper limbs' Repetitive Exertions and Movements

Program for Implementation. These guidelines come jointly with a 3-year experimental plan (Regione Lombardia, 2004) involving its application in approximately 2,000 manufacturing industries of Lombardy, identified on the basis of kind of production (mainly in mechanical, electromechanical and electronic, textile, clothing, food and meat, and plastics and rubber processing) and number of employed workers (over 50).

The plan as well as the guidelines were agreed on between Public Authority (with functions of Labour Inspectorate), Employers' Associations and Trade Unions. The plan defines the general goal of risk assessment and management actions application in identified companies as well as a series of actions to be carried out by the different protagonists involved. They can be summarized as follows:

- Definition of regional guidelines agreed on between Prevention Regional System and social actors
- Start and finalizing of an education and training programme of all public operators (laborinspectors) and operators from OSH services of concerned companies
- Assistance provided by laborinspectors in applying guidelines
- Preliminary risk assessment and possible consequent actions in accordance to guidelines carried out by enterprises
- Monitoring of the state of progress of the project
- Implementing of the recording regional system of reported WMSDs
- Implementing of a regional data Web site on risks and injuries caused by upper-limb repetitive movements and, more specifically, on preventive solutions adopted to the benefit of all potential users
- Critical check of the outcome of the experimental project and revision of guidelines in view of a generalized application in all manufacturing sectors.

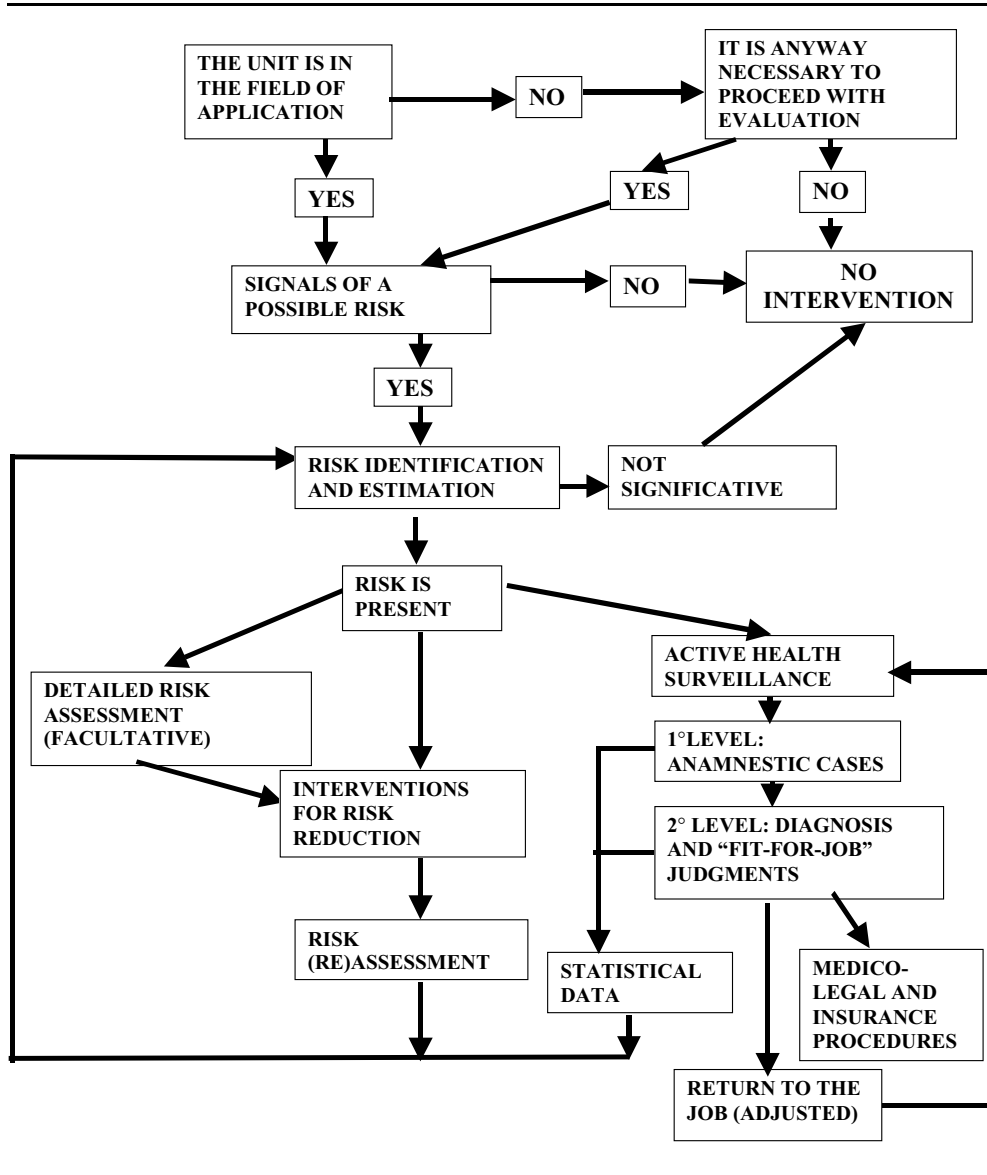
Last, the plan defines process, output, and outcome indicators to check trend and results with time.

Guidelines. The guidelines, taking into account the general indications in European Directive 391/89, state that each employer shall also consider the risk associated with upper-limb repetitive movements when generally assessing work-related risks. If such a risk is present, a specific program is to be started to reduce the risk.

Therefore guidelines, after providing the (epidemiologic, legal, technical) state of the art on this subject, provide indications on:

- Risk identification
- Risk estimate and assessment

TABLE 17.2
General Flowchart for the Application of the Guidelines



- Health surveillance
- Medical–legal and insurance consequences
- (re)Design of tasks, workplaces, and working facilities in view of risk reduction

The general process as indicated in the guidelines is summarized in Table 17.2. A preliminary assessment of possible risk develops along three successive steps:

- Identification of “problematic jobs”
- Risk assessment
- Analytical risk assessment (in selected cases)

Risk Assessment

As to *identification of “problematic jobs,”* whose exposure assessment shall be carried out in the concerned working sectors, the following criteria hold valid:

- The worker/s has/have a nearly daily exposure to one or more indicators of possible exposure reported in Table 17.3
- There are reported cases (one or more also taking into account the number of workers involved) of diagnosed WMSDs of upper limbs.

As to *exposure estimate,* all workplaces and processing already identified as “problematic” are to be first analyzed through simplified assessment tools. With this purpose, use can be made of appropriate investigation tools, available in the literature mostly as checklists that have to be filled in by specially trained staff. An OCRA checklist is enclosed as well as the related instructions for use and interpretation of results (Colombini, Occhipinti, & Grieco, 2002).

As to exposure, the final score of the OCRA checklist can be interpreted according to the classification scheme (based on the so-called traffic light model) reported in Table 17.4. As to *risk analytical assessment,* it may be necessary in some specific situations. There is not a precise rule fixing when a task or a workplace needs a more detailed investigation: As a consequence, this decision is up to discretion and individual fortuitous requirements.

TABLE 17.3
 Signals of a Possible Exposure to Repetitive Movements and Exertions of the Upper Limbs
 (“Problem Job” When One or More Signals Are Present)

1. Repetitiveness. Task(s) organized in cycles lasting up to 30 seconds or requiring the same upper-limb movement (or brief group of movements) every few seconds, for at least 2 hours in the shift.
2. Use of force. Task(s) requiring the repetitive use of force (at least once every 5 minutes), for at least 2 hours in the shift. To this, consider the following criteria: handling of object weighing more than 2.7 kg; the handling, between thumb and forefinger, of objects weighing over 900 g; the use of tools requiring the application of quite maximal force.
3. Bad postures. Task(s) requiring the repetitive presence of extreme postures or movements of the upper limbs, such as, uplifted arms, deviated wrist, or rapid movements, for at least 1 hour continuously or 2 hours in the shift.
4. Repeated impacts. Task(s) requiring the use of the hand like a tool for more than 10 times in a hour, for at least 2 hours in the shift

TABLE 17.4
 Classification of OCRA Checklist Results Into Four Areas for
 Risk Exposure Level Assessment

<i>Checklist Score</i>	<i>Ocra Index</i>	<i>Risk Classification</i>
Up to a 7.5	2.2	Green, yellow/green = no risk
7.0–11.0	2.2–3.5	Yellow = low risk
11.1–22.5	3.6–9	Medium red = medium risk
≥ 22.6	≥ 9.1	High red = high risk

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Nevertheless the decision orientation criteria are reported in the following:

- More detailed investigation can be excluded when the results and data from risk assessment are sufficiently sound, coherent with the other contextual information and, in particular, more able to address in sufficient detail the consequent actions with respect to different risk determinants.
- Risk-detailed investigation should be carried out in all the cases when the risk estimate results are uncertain or do not correspond to other contextual information (e.g., WMSD occurrence), or when more data are required to define the consequent preventive actions, or when it is necessary to establish more precisely a connection between risk and damage in acknowledging a upper-limb (UL)-WMSD as an occupational disease.

The preferential tool for investigating in detail the risk is the so-called OCRA Index method (Occupational Repetitive Action; Colombini et al., 2002). A special enclosure includes some considerations concerning the OCRA index use as a probabilistic prediction tool of induced health effects (UL-WMSD) and for risk classification.

Health Surveillance Strategies. The guidelines provide detailed indications and tools for implementing and managing active health surveillance and developing all the medical-legal and insurance fulfillments resulting from identification of fully diagnosed UL-WMSDs cases. This handbook being addressed to ergonomists and health surveillance strategies being similar to those summarized for spine disorders, details on this aspect are not reported.

Task and Workplace (Re)design. When both exposure assessment and the study of UL-WMSDs have revealed a significant risk associated with repetitive or strenuous movements of the upper limbs, the need arises to implement specific measures aimed at re-designing tasks, procedures, workplaces, and equipments. These measures are often urgent and complex and are generally based on three types of co-ordinated and virtually simultaneous actions being carried out: structural modifications, organizational changes, and personnel training, as reported in Table 17.5. Although the structural measures are almost universally accepted and widely recommended, actions involving organizational changes do not always meet with unanimous consent, nor does the scientific literature provide concrete examples. The guidelines provide

TABLE 17.5
General Description of Different Kinds of Preventive Actions

<i>Structural Modifications</i>
The use of ergonomic tools
An optimal arrangement of the work station, furnishings, and layout
Improve aspects related to the excessive use of force, awkward posture, and localized compressions
<i>Organizational Modifications</i>
An ergonomically designed job (pace, breaks, and alternating tasks)
Improve aspects related to:
Movements performed frequently and repetitively for prolonged periods
Absence or inadequacy of recovery periods.
<i>Training</i>
Suggestions concerning breaks
Appropriate information on specific risks and injuries
Concrete methods for performing tasks and utilizing proper techniques
Are additional to the other interventions

TABLE 17.6
Brief Recommendations for Reducing the
Frequency of Technical Actions (but not
Productivity)

Avoid Useless Actions:
Added arbitrarily by the worker
Due to manufacturing flaws
Due to obsolete technologies
Distribute Actions Between Both Limbs
Reduce the Repetition of Identical Actions
By processing preassembled pieces
By introducing semiautomatic steps
By replacing manual tasks with hi-tech solutions
Reduce Auxiliary Actions
By creating intersections between the conveyor belt and the work bench

criteria and some concrete examples for re-designing jobs and preventing disorders caused by repetitive movements of the upper limbs. Reference is made to the three areas mentioned previously, and specific indications are given for each area, based on the abundant literature already available on structural modifications. A section is also devoted to the subject of possible organizational changes, already investigated and applied in some field experiments and whose criteria, regarding the reduction of pace (without reducing productivity), are synthetically reported in Table 17.6. Last, guidelines are supplied for training programmes designed to support the previous two classes of actions (i.e., structural and organizational) and devoted to workers.

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**Au: Please
clarify edits.**