Assessing the risks of repetitive work

Other than draft standard prEN 1005 on the biomechanics of manual handling[1], there is no European standard on either assessing or preventing repetitive strain injury (RSI). And yet it is a burning issue on which instruments useful to health and safety practitioners do exist.

This article suggests guidelines to help develop a risk assessment methodology for RSI, based on the basic principles of EN 1050[2]: risks are first **identified** to determine those which are relevant, then **estimated** to ascertain the frequency and severity of the harm, and finally **evaluated** to check their acceptability.

PrEN 1005 - Biomechanical aspects of the handling of loads

This draft standard of CEN TC/122 will comprise five parts. The first three are:
prEN 1005-1: Safety of machinery **-** Human physical performance **-** Part 1: Terms and definitions
prEN 1005-2: Safety of machinery **-** Human physical performance **-** Part 1: Manual handling of objects associated to machinery
prEN 1005-3: Safety of machinery **-** Human physical performance **-** Part 1: Recommended force limits for machinery operation
Part four deals with the evaluation of work postures associated with machinery.
CEN/TC 122 has recently adopted a work topic on "Risk assessment for repetitive handling at high frequency", which could constitute a **fifth part** of this standard.

RSI: a complex reality

RSI (repetitive strain injuries) have grown to epidemic proportions in workplaces and become a central challenge in the prevention of work-related diseases in Europe. RSI covers a wide range of injuries to muscles, joints, tendons and nerves. In fact, RSI has become a catch-all for a varied mix of diseases, among the best-known of which are carpel tunnel syndrome, epicondylitis or "tennis elbow", shoulder tendinitis or "swimmer's shoulder", etc.

Despite the vast body of literature and sporadic scientific work carried out to establish the causes of RSI, it remains difficult to pin down the significant variables which describe the problem and their respective values to draw the line between a safe and an unsafe workplace. Postures, repetition patterns and loads are just some of the complex factors to be controlled whose acceptable limit-values are hard to calculate.

In fact, all these variables interact giving rise to complicated non-linear models. Add to that the extremely variable and multifactorial human response, and the basic conventional analysis of related data rapidly proves useless in most cases. Difficult as it is to model such a multifactorial and complex problem, it is essential to provide prevention practitioners with procedures for assessing the risks related to repetitive strain at work.

Active rather than passive surveillance

One way of controlling and assessing risks is to establish passive surveillance through an analysis of data like sick leave, compensation records, etc. The problem here is the lack of reliable data on RSI (which is underreported, masked and distorted). So active surveillance seems to be the keystone in the prevention of RSI.

TUTB ergonomics guide: first draft due in late June

Following on from its guide on *"Integrating ergonomic principles into C Standards"*, the TUTB is continuing its research into the assessment of workplace ergonomic risks which result in musculoskeletal disorders. A working group of experts has been set up, comprising Aleid Ringelberg (CEN/TC 122, Netherlands) (project leader), Enrico Occhipinti (Italy), Hanna Zieschang (KAN, Germany), Bart Indesteege (INRCT, Belgium) and the TUTB's own staff.

The group is approaching the matter from an assessment based on six individual sources of risk:

- static positions;
- body movements;
- handling - lifting;
- pushing/pulling and carrying loads;
- use of a localised force;
- repeated efforts;
- energy expenditure.

The guide will first consider the relevance of these six sources of risk by devising a series of simple questions to identify the "overriding risk factors" as envisaged in the OSHA draft ergonomic standard. It will then guide the user through an estimate of the risks attaching to each source identified in the form of checklists (consisting of qualitative and quantitative questions based on current knowledge and tried and tested procedures).

The group initially proposed the RULA method for estimating and assessing the risks associated with repetitive strain - one of the main causes of upper limb musculo-skeletal disorders - as being a yardstick in this field. But this is more an overall assessment method than one referable specifically to repetitive strains. It is now also looking at an alternative method recently developed in Milan, presented by Mr. Occhipinti.

The guide will also include an annex, setting out the most advanced quantitative methods with guidelines for using them. An initial draft will be put forward for the working group's comments at the end of June.

The TUTB welcomes all contributions from those interested in this guide. If you would like information about the project and/or to propose a contribution to the working group, contact Vicente Verde Peleato or Giulio Andrea Tozzi at the TUTB.

1. Identification of risks

The first step is to identify the risks in every workplace. Checklists can be useful here. A general checklist is used first to identify the main risks; more exhaustive checklists will then usually be required to pinpoint more specific aspects. A good reference here is the ERGOWEB (1) Internet site, which has detailed checklists for specific RSIs.

2. Estimation of risks

Severity: relation between symptoms and workplaces

Estimation means "measuring" the incidence of RSI on workers. That means asking: where is the RSI situated? how often does it occur? how severe it is? Knowledge of the symptoms related to the workplace is crucial here.

Relating symptoms to the workplace for wide populations requires a standardised symptom definition system through which to conduct a comparative analysis of different workplace configurations using the responses from different groups of workers, etc. In 1976 Corlett and Bishop (2) introduced the *body map discomfort diagram*, which was an innovative and simple method for determining symptoms. Other survey tools have since been developed, like:

- The ***NMQ*** (*Nordic Musculoskeletal Questionnaire*) (Kuorinka et al. 1987) (3) - a monitoring method comprising general questions on the whole body and body part-specific questions (neck, shoulders and lower back). A body "map" is used to make it easier for users to pinpoint problems in each body area. It also asks whether the problem has occurred in the last year and/or in the past week.
- The ***NIOSH*** [3] ***Symptom Survey*** (4) is similar to the NMQ but with a more detailed procedure for determining the severity of the discomfort.

A symptom survey to analyse RSI factors should contain:

* Information about the worker: age, sex, medical history, chronic physical stress.
* A description of working conditions: workplace dimensions, postures, environment, tools, etc.
* A questionnaire on body segments like the NMQ (including body maps).
* Open questions for any other comments

Frequency: the relative importance of postures

Symptom surveys to estimate the incidence of RSI can usefully be supplemented by observational techniques to determine the workers' postural patterns, i.e., how long the worker remains in each one of the relevant postures.

Video technology or simple observation can be used to tabulate the frequencies of postures and postural changes. Foreman et al. (5) have proposed a mnemonic method for inputting postures to a portable computer. The OWAS (an evaluation procedure described below) breaks down activities into postures for determining their relative duration.

Using these procedures depends on first devising a set of reference postures. These observation techniques can be combined with symptom surveys and with the procedures described below.

3. Risk evaluation: quantitative evaluating methods

Biomechanical models

Methods based on biomechanical knowledge suggest tolerances or limit values within which working conditions are acceptable. They use different parameters to define working conditions (independent variables), from which conclusions are drawn in the form of a diagnosis (i.e. acceptable/non acceptable risk) or limit-value(s) for the dependent variable(s) (e.g., a value for the maximum acceptable load).

Among the best-known are:

- ***RULA*** (*Rapid Upper Limb Assessment*) (6). This is a screening tool that assesses workers' exposure to different occupational risk factors, like postures, forces, muscle use and movement (inputs). The outcome is a rate that indicates if further action is required.
- ***The NIOSH Equation*** (7) which is a tool to evaluate the risk of two-handed manual lifting tasks. The RWL (Recommended Weight Limit) is estimated from the parameters depicting each situation. The model takes account of psychophysical criteria as well as the biomechanical and physiological aspects.
- ***OWAS*** (8). The working postures analysing system was developed in the Finnish steel industry in the 70s. The method collects simple observational information on postures and loads according to a breakdown of working activities. These data are then standardised and the individual activities are rated into four action categories according to their strain (no harmful effect, some harmful effect, distinctly deleterious effect and extremely deleterious effect).

Direct measurement of workers' responses

In some cases, biomechanical techniques can be successfully used to directly measure "worker responses" during working time.
Instruments commonly used in workplace evaluations include:

- Electromyographs record electrical signals from relevant muscles involved in the work. The signal is analysed to determine the level of muscular exertion.
- Electrogoniometers attached to the body provide a dynamic measurement of the relative position of body segments. This gives an accurate measurement of postures.

The great advantage of these instruments is that, hooked up to a computer, they can be used to continuously record human responses to working conditions. The downside is that they are invasive and alter the working conditions being measured. Although of undeniable scientific value, they also require specialised equipment which can only be used with expert help. And the recorded signals have to be interpreted properly, otherwise it becomes a pointless exercise.

The OSHA draft ergonomic protection standard: a normative approach

The OSHA[4] (9) published an industry-wide ergonomics standard in 1991, which has not yet been adopted. Although less far-reaching than the original proposal, one of its main aims is to bring in rules for employers to follow in preventing RSI. We feel it goes some way to enlightening a normative approach to RSI by using some of the tools described above.

The OSHA draft attempts to be consistent with international quality assurance procedures (ISO 9000). It incorporates the concept of continuous improvements in working conditions, and provides complementary materials. A step by step procedure is built up as follows:

1. The first stage is for the employer to identify “problem jobs” using different sources:
   - records;
   - symptom surveys answered by workers;
   - risk factor checklists, based on workers' answers, to score jobs. A job which scores over the “action level” is considered as a “problem job”.
2. Once the “problem jobs” have been identified, the employer must control them and introduce a “job improvement process” to identify the causes of the problems and put them right.
3. The employer must evaluate the effectiveness of the process in an iterative way.

Workers in problem jobs must also be given training and medical surveillance provided to monitor RSI. Both training and medical management are promoted through compliance assistance materials provided by the draft standard.

Bibliography and references

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RSI campaign in Spain:
CC.OO risk assessment scheme

The CC.OO (Comisiones Obreras) trade union confederation has set up a programme to devise a methodology for risk evaluation of musculo-skeletal disorders from repetitive movements. The project was backed by a local industrial injury protection and indemnity association (Union de Mutuas) and implemented with technical assistance from the IBV (Institute of Biomechanics of Valencia).

The IBV has developed a method based on multivariate statistical analysis to calculate a discriminant function for identifying hazardous working conditions. The discriminant function is based on a set of factors pre-identified as key elements of the working conditions (postural data, loads, number of years in the workplace, etc.). A related classification function is used to devise a probabilistic index to predict the likelihood of a musculoskeletal disorder occurring in the given working conditions. Because this function is expressed as a dependent variable of discretised significant bio-mechanic parameters checked against friendly tables, a simple prevention strategy is feasible. Neck and upper limb disorders correlate highly with the predictive assessment using the tables.

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[1] See also, "Musculoskeletal disorders: a European prevention strategy", in *TUTB Newsletter* No 4, November 1996, p. 20-21.

[2] EN 1050: Principles for risk assessment

[3] National Institute of Occupational Safety and Health (USA)

[4] Occupational Safety and Health Administration (USA)