

## Early detection of musculoskeletal disorders from computerized alarms: result and applications

*Detección precoz de trastornos musculoesqueléticos mediante alertas informatizadas: resultado y aplicaciones*

RESUMEN / ABSTRACT

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SPMAZ company design a Medical protocol performance with a software tool that detects and report high incidence of pre-job accidents or pre-occupational diseases from overexertion of musculoskeletal disorders. Computerized alarms are generated by extrapolating protocolized information from workers health examinations. These are for those in charge of the area of Ergonomics and Occupational Health Physician who monitor the health of different companies workers. We study 83.961 workers from 1616 different companies. In 5.909 (7.03%) cases pathology is detected and in companies with 15% of cases, 243 (2.807 (3.3%) employees) alerts are generated. The prevalence of disorders and the identification of the jobs in which these accumulate are communicated to the physician and ergonomist's smartphone or e-mail by means of computerized alarms. This system identifies and locates the early pathology and jobs that require ergonomic performance, implements education campaigns and promotes healthcare

*Se diseña un protocolo médico de actuación junto a una herramienta informática que detecta una alta incidencia de trastornos musculo-esqueléticos previos a la declaración de accidente de trabajo por sobreesfuerzo o enfermedad profesional. Extrapolando información de la exploración médica y protocolizada de trabajadores se generan alarmas informatizadas para los responsables del área de ergonomía y Medicina del trabajo de las distintas empresas. Se estudia 83961 trabajadores de 1616 empresas. En 5909 (7.03%) casos se detecta patología y se generan 243 alertas (2.807(3.3%) trabajadores) de empresas que presentan un 15% de casos. Las alarmas informatizadas comunican al Smart-phone o correo electrónico del médico y ergónomo la prevalencia de trastornos e identifican los puestos de trabajo en los que se acumulan. Este sistema identifica y localiza precozmente patología y puestos de trabajo que requieren actuación ergonómica, implantar campañas de formación y promoción de la salud. Extrapola datos epidemiológicos que permiten establecer comparaciones entre puestos de trabajo, empresas y compañías, sectores productivos, regiones e incluso países.*

PALABRAS CLAVE / KEYWORDS

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Musculoskeletal Disorders; Computerized Alarms; Ergonomics; Healthcare; ORP Conference

*Trastornos musculo-esqueléticos; alerta informática; ergonomía*

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## Introduction

Musculoskeletal Disorders are the commonest occupational diseases in the EU-27. Europe's 25% of workers complain about backaches; and 23% claim to suffer from muscle soreness and muscle aches (1).

The EU's 62% of employees are exposed to repetitive motion and overuse of the arms and hands during a fourth part of their working time. Other 46% are also exposed to awkward postures, and other 35%, to carrying heavy loads (1).

This outlook is not promising at all, as it makes bad financial impacts on companies besides the obvious health issues that are involved. Moreover, it prevents competitiveness and thwarts the attempts at efficiency improvements of companies, organizations and public administrations.

In the prevention field, especially in the field of Occupational Medicine, ex-post data and statistics are used to collect information on work accidents (2)(4)(9)(10) and on occupational diseases (3) which reflect, quantify, and compare data when Musculoskeletal Disorders appear.

Some studies such as the 7th National Survey on Working Conditions show that 77.5%(5) of employees suffer aches due to awkward postures and efforts stemming from tasks performed at work. There has been a 3.8% increase in this survey over the year 2007 (5). Among the most frequent body aches and pains we find: lower and upper backaches, and neck and nape aches.

The development of a Basic General Guideline for healthcare monitoring activities for the Risk Prevention at Work dictates (11) the examinations that must take part of a Healthcare Monitoring Plan. This plan must contain four fundamental points (11.5 RD 843/2011):

- Awareness of the employees' health state.
- Assessment of the prevention measures' efficiency.
- Identification of risky or hazardous situations the employee is exposed to.
- Report to adopt new necessary measures.
- Adaptation of tasks to the worker's health state.

In order to solve these problems, the Occupational Medicine Department of MAZ' Society for Prevention intends to create a brand new tool aimed to detect high incidences of Musculoskeletal Disorders (MD). This new tool's methodology consists in a systematic collection of data during the health examinations on workers whose jobs expose them to a higher likelihood of developing MD. These data would then be exported to generate an **Alert System for High Incidences on Musculoskeletal Disorders (ASHIMD)**.

In turn, this **ASHIMD** sends the information to the technician for Work Hazard Prevention and the Occupational physician in charge of the workers' health monitoring. The latter then is able to: identify problems, trace the tasks and posts where MD have a higher rate of incidence; and, finally, to locate them anatomically.

From the medical perspective, this ASHIMD makes health monitoring possible at both, an individual and a collective level. At a globally collective level, this allows for the identification of tasks and jobs in need of training; adjustments of those very tasks; and an even more advanced ergonomic study.

## Methodology

In order to export and generate information for the ASHIMD, a program has been designed which comprises four different functions: modification of SIGMED software; modification of medical action plans; proper training for the medical personnel; and launch of the Alert System. These are now discussed more in detail.

## **Modification SIGMED software**

The first step is to completely modify MAZ' Society for Prevention' SIGMED software. This software is a support tool aiming at the filing of records, medical histories, patients' information and healthcare examinations. This modification would include a new design of further questionnaires, and a linking of the data collected to the Alert System and to the epidemiological reports drawn from the MD's examinations made.

## **Modification of Medical Action protocols**

We adjust, broaden and standardise the protocols of medical performance. These are based on specific healthcare surveillance protocols, which are established by the Comisión de Salud Pública del Consejo Interterritorial del Sistema Nacional de Salud de España. Once the design and adaptation of these protocols have been completed, they need be approved by both the Quality Department, and the Occupational Medicine Directorate Department of MAZ' Society for Prevention.

There are several protocols from which information concerning high incidences of MD can be drawn. They are the following:

- The manual handling of loads (12,13,14).
- Forced postures (15).
- Repetitive motion(16,17,18).
- Neuropathies derived from stress (19).
- Screen reader users(20,21,22,23,24,25)

During the healthcare examination, the software program needs to be consulted to check the hazard assessment and the patient's records in order to contrast all these with their new examination. The facts that are going to be especially relevant for this contrast are:

- Job classification seniority
- Number of hours/day and of hours/week spent at work under conditions which could prompt the development of MD.
- Breaks at work.
- Features of the load.
- Kinds of moves made for their mobilisation (displacements, lifting of loads, etc.).
- Working conditions (use of tools)
- Protective measures (auxiliary means to perform the tasks, etc.).

The worker's time dedicated to the development of his current and former jobs will be taken into consideration as well.

Once this is done, an anamnesis form and a re-recollection of personal antecedences are created. The data collected show the illnesses and congenial disorders that could influence and favour the occurrence of MD. Some could be the following:

- Muscular disorders: contractions, muscle cramps and breakage of muscle fibres (ruptures, tears).
- Tendon and ligament injures: synovitis, tenosynovitis, ruptures, sprains and bursitis.
- Joint diseases: osteoarthritis (OA), arthritis, herniated disks.
- Bone injures: broken bones and fissures.
- Neurological disorders
- Vascular disorders: vasomotor syndromes.
- Injures in the abdominal wall: hernias.
- Cervical rib syndrome.

## Modification of Medical Action protocols (Questionnaires)

There are four kinds of questionnaires that are to be answered:

1. **Indicative Minimum Questionnaire**, which inquires about the existence of three items:
  - Paraesthesias in any of the extremities.
  - Pain in any of the extremities.
  - Loss of strength in any of the extremities.

It also asks whether the patient performs any extra activities outside work that may influence the development of MD.

2. **Subjective Estimation of the Symptoms Questionnaire**, which inquires about:
  - Whether the worker has been suffering from any musculoskeletal discomforts in the last 12 months, and if so, where? –cervical spine, shoulders, elbows, hands, dorsal spine, lumbar spine, hips, knees, ankles or feet.
  - Whether the worker has been suffering any musculoskeletal discomforts in the last 7 months, and if so, specify the location: cervical spine, shoulders, elbows, hands, dorsal spine, lumbar spine, hips, knees, ankles or feet.
  - Whether the worker has been temporarily incapacitated for work in the last 12 months prior to the health check-up due to suffering musculoskeletal discomforts in their cervical spine, shoulders, elbows, hands, dorsal spine, lumbar spine, hips, knees, ankles or feet.
  - Subjective questionnaire about the work activities that may develop MD in the employee. MD may derive from forced postures, manual handling of loads, repetitive motion, awkward postures and computer use.
3. **Objective Health Questionnaire**. In this section we find a record of all the musculoskeletal and neurological disorders traced in the spine and the lower and upper- extremities.

In the spine:

- Deviation of both, the antero-posterior axis, and the lateral axis.
- Cervical spine: existence of pain or limited mobility.
- Dorsal spine: existence of pain or limited mobility.
- Lumbar spine: existence of pain or limited mobility.

In the upper- extremities:

- Shoulders: existence of pain or limited mobility.
- Elbows: existence of pain or limited mobility.
- Wrists and hands: existence of pain or limited mobility.

In the lower- extremities:

- Hips: existence of pain or limited mobility.
- Knees: existence of pain or limited mobility.
- Ankles and feet: existence of pain or limited mobility.

Neurological examination:

- Lasègue's Sign.
- Bragard's Sign.
- Shöber's Test.
- Valsalva manoeuvre.
- Phalen's manoeuvre.
- Tinel's Sign.
- Finkelstein's manoeuvre.

4. **Further Objective Health Questionnaire**. This questionnaire aims at drawing further information about musculoskeletal and neurological disorders found located in the spine and the lower and upper- extremities.
  - Neri I
  - Neri II
  - Lasègue's Sign in lateral decubitus position.
  - Lasègue's Sign in upside-down decubitus position.
  - Lasègue's Sign in load.
  - McBride's Test.
  - Spurling's Test.
  - Lumbago.

- Inconsistencies or discrepancies.

The results of questionnaires 1 and 2 will serve to classify the information as ‘subjective’ since it comes from the worker. This categorisation will appear both in the epidemiological report – a summary of the collective health surveillance activities of each company – and on the ASHIMD. The results in questionnaires 3 and 4 collect information related to the targeted pathology.

Training for the medical personnel

There are three types of specific training:

- Training for the medical personnel: this is given during three 4-hour meetings which take place in each of the 6 territorial addresses. At these meetings we can find the following:
  - Instructions to the medical personnel, which are made up of 60 Basic Healthcare Units or teams containing one nurse and one Occupational physician each.
  - Teaching and unification of criteria in the application of protocols and the data collection.
  - Training to the technical and the medical personnel. Members in charge of the ergonomic section are appointed as overseers to provide solutions in case the Alert System sounds the alarm; they also assist in the employment of new techniques such as the MAPO method.
- Continuous training: all members of personnel are to be informed of the meaning of the items mentioned above, the scope of the project, the preliminary results by means of an internal mail service, newsletters and downloadable information from and internal mail server.

## Alert System for High Incidences on Musculoskeletal Disorders (ASHIMD)

An alert signal is generated and sent to the technician for Work Hazard Prevention and to the specialised Occupational physician in charge of the company’s healthcare surveillance. Then, the details of the musculoskeletal pathology found during the health examination are exported. There is no distinction regarded the time the examination has been made, either getting back to work, periodically or after a shift of tasks.

The database from which these alerts are generated is founded on records stored before the study and implementation of a process where some kind of MD is found in the 7% of workers surveyed.

One study has been made on the 24,388 healthcare examinations (54,103 in 2012) carried out on 108,577 workers (91,823 in 2012) employed in 1,197 different companies (1,477 in 2012). These examinations have aimed at detecting or not MD in 22,849 cases (49,824 in 2012). There is an incidence of pathology in 1,404 cases (2,776 in 2012).

TARGET POPULATION OF OUR ACTIONS			
Year	Nº Companies with symptomatic >7%	Nº Companies with symptomatic >10%	Nº Companies with symptomatic >15%
2012	361	274	274
2013	118	91	58

  

TARGET POPULATION OF OUR ACTIONS			
	Nº Companies with symptomatic >7%	Nº Companies with symptomatic >10%	Nº Companies with symptomatic >15%
Nº Symptomatic	772	589	<b>478</b>
Nº examination	5252	3151	<b>2203</b>
Target	7661	4638	<b>3311</b>

Figure 1: Approximated results in the beginning of the study

From these statistics and the studies on the companies where healthcare surveillance takes place, we then establish three different premises to activate the ASHIMD.

- The company's workforce must be made up of 20 workers minimum.
- The number of healthcare examinations must be carried out to 35% of theoretical employees of the company.
- A minimum of 15% of the examined employees must suffer from some sort of pathology.

An alert signal can be sent via internal mail services or via text- messages to the Smart-phones of the information receptors when all these three requirements are met.

The purpose of this alert signal is to report on the high incidence of MD to enable the intervention of the company's Occupational Medicine Department or the Ergonomics Department in case there was need. The information sent is only preliminary, and it may vary from the final epidemiologic report generated by the collective healthcare surveillance of the company examined. Nonetheless, the alert does mean that the situation is sufficiently significant to take measures.

The contents of the Alert for High Incidences of MD are the following:

1. Sample data:
  - Workers who make up the company's workforce.
  - Number and percentage of healthcare examinations that have been carried out.
  - Number and percentage of healthcare examinations that are aimed at detecting MD.
2. Information REFERRED by the workers:
  - Number and percentage of workers who complain about musculoskeletal pathology.
  - Workers who claim to have been temporarily incapacitated for work in the last 12 months because of musculoskeletal pathologies derived from or worsened at work.
  - Workers who complain about musculoskeletal discomforts in the last year and the last week prior to their health examination.
3. Information DETECTED in the workers:
  - Workers who have been found with neither musculoskeletal nor neurological pathologies.
  - Workers whose healthcare examination shows musculoskeletal pathology.
  - Workers whose healthcare examination shows neurological pathology.
  - Workers whose healthcare examination shows either musculoskeletal or neurological pathologies.
  - Chart of the anatomic location of the detected pathology.
  - Jobs and tasks where there is a high prevalence of pathology.
  - Identification of medical histories: this information is only available to the medical personnel to assess the different cases. All this is carried out preserving the confidentiality of personal data collected and the physician-patient relation.

The alert signal is generated and sent to the technician for Work Hazard Prevention and to the specialised Occupational physician in charge of the company's healthcare surveillance. When they receive this alarm, the medical personnel analyse the data, and along with the company's technician for Work Hazard Prevention, they assess the specific circumstances of each company. The technician in charge must also make sure the ergonomic assessments of the affected jobs are made.

The ASHIMD allows the Zone Ergonomics Manager to assess the situation, to implement improvement, to give specific training, and to undertake further ergonomic studies.

## Results

We selected 1616 companies that met the requirements mentioned earlier on in this report; namely, having a workforce made up of 20 workers, applying one of the specific healthcare surveillance protocols that assess MD in the workers' health examinations.

The initial population that, in theory, met these criteria, numbered 100,869 workers. The study was carried out implementing the ASHIMD based on only 83,961 healthcare examinations that met the protocol criteria, out of the total 86,084 examinations made. These are the results:

- 1,432 (1.7%) workers claimed to have been temporarily incapacitated for work last year because of discomforts related to the detected pathology.
- 17,912 (21.3%) cases claim to have suffered from musculoskeletal pains this last year.
- In 5,675 cases, musculoskeletal pathologies have been found.
- In 585 cases, neurological pathologies have been found –this means that the questionnaire of neurological examinations has been positive.
- Globally, we can number 5,909 (7.03%) cases; that is, workers whom we count as cases for the generation of Alert Signals. These 5,909 workers were employed in 1069 different companies.
- We identify 243 businesses which accumulate 2,807 employees with symptoms (3.3% of the workers in the study). We were able to detect this by applying the three criteria that have been discussed above: having a 20-worker-minimum-workforce, having 35% of their population examined, and finding disorders in, at least, 15% of their employees.
- 21.3% of employees who underwent healthcare examinations complained about musculoskeletal discomforts against 7.03% of workers whom were found pathologies.
- 15% of the companies that underwent the study accumulate 47.5% of injured workers.

## Discussion of results

In terms of incidence, during the year 2011 in Spain, 88.4 in 100,000 workers were reported on to have MD considered an occupational disease. The highest incidences of occupational diseases were in the form of tendon sheaths fatigue (62.3 in 100,000), and nerve paralysis because of stress (22.4 in 100,000) reports sent to CEPROSS in 2011. Those who suffered MD but did not ask for incapacity leave in 2011 added up to 45.6% of the MD notified (3)(7).

The percentage of workers who felt discomforts attributable to postures or excesses derived from their job was 77.5%. This figure meant an increase of 3.8% in 2011 over the 2007. Among the most frequent discomforts we found the ones in the lower and upper-back and the nape of the neck (5).

The number of accidents at work due to the overstraining of muscles added up to 38.5% of occupational accidents in Spain (2)(4)(6).

The fact that the system spotted 15% of companies which accumulated 47.5% of injured workers allowed for an efficient intervention and an impartial preventive action plan towards business whose employees may develop occupational diseases.

The results gave evidence of 1.7% of workers who had been declared with an occupational illness. They also evidenced another group (7%) with much more likelihood of developing serious pathologies; whereas there were 21.3% of hypothetical cases where employees claimed to suffer from MD, but nothing could be proved.

Thus, the ASHIMD does not make only available the identification of jobs in various companies, but also the information about occupations, economic activities and other fields. There are yet some aspects that have not been taken into that much consideration from the epidemiological perspective, these are the differences between gender and age.

## Conclusion

The Alert System for High Incidences on Musculoskeletal Disorders (ASHIMD) that has been developed accomplishes a multitude of tasks that improve the Occupational Medicine and Preventive Work Measures. It identifies and locates pathologies; the circumstances related to jobs which require corrective and preventive measures, training, further ergonomic studies and campaigns promoting healthcare.

One of the innovations of this system is that it helps identify situations and candidates likely to develop occupational diseases and to suffer from overstraining of their muscles before the injured is made.

It also helps spread epidemiological data to establish differences between jobs, businesses, companies, production sections, regions, and even countries. This system can be used as a very valuable tool to target the work that derives from healthcare surveillance activities; furthermore, to unify criteria and quality standards in the field of Prevention Services.

Moreover, it enhances the value of knowledge in the field of Occupational Medicine and also the improvement of productivity and of competitiveness.

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