Dynamic Model of Temporary Work Disability due to Musculoskeletal Diseases


Introduction

Mathematical models and computer simulations have become important experimental tools in many fields to analyze and resolve multifactored problems and to explain the behavior of complex systems. Disability is a dynamic state that can be represented as a system of several interrelated factors changing in time and having an eventual effect on each other. System dynamics (SD) techniques constitute important temporal information reflecting the evolution with the time of the system’s variables behavior, and they allow to deepen into the problem knowledge more than statistical analysis do. Up to now, SD techniques have not been applied to study disability produced by musculoskeletal diseases (MSD).

Objectives

1. To develop a dynamic model (II) of temporary work disability due to musculoskeletal diseases (TWD).

Material and Methods

The results of a two years prospective controlled cohort study—described in detail in paper “Work disability related to Musculoskeletal disorders: An intervention from public health perspective” by J.A. Jover et al. N—have been the basis to develop and assess a dynamic model of musculoskeletal disability.

Results (I): Elemental Model

A total of 13,077 patients (7,805 in CG and 5,272 in IG) were included in the study (4,875 in CG and 6,464 in IG) during the study which have been registered in episodes of temporary work disability (TWD) episodes (% episodes still unfinished) during one-year period since the starting of each one. Most patients (89% in CG and 86% in IG) returned to work within the first two months, but those returning to work after six months (12% in CG and 17% in IG) were very similar, with many of them being off work for the complete 18 months period allowed by the administration. The average duration of TWD episode was 41.3 days in CG and 25.6 days in IG (p < 0.001). The intervention obtained a relative efficiency of 30% (percentage of days saved by the intervention) with respect to CG. The intervention also produced a diminution in the number of patients initiating PD evaluation process and involving any form of long-term disability compensation or early retirement (% of patients initiating PD evaluation process and involving any forms of long-term disability compensation or early retirement) (Table 1).

Results (II): The dynamic model

In order to develop a dynamic model of TWD processes due to MSD, an intervention program of patients initiating the PD evaluation process and involving any form of long-term disability compensation or early retirement was applied to patients in IG. To develop a dynamic model to:

1. Analyse the usual evolution of MSD-TWD episodes and the effect of a specific medical intervention on their evolution towards permanent disability (PD) or recovery.

2. The mathematical function that better fits the survival curves is the exponential because it takes the value 100 at t=0, becomes zero when t becomes infinite and it is monotonous decreasing. This model has a very simple to read and understand application (Figure 4), with the value 0 (0%) because the tank has a valve and the outflow rate of water through the valve has been proportional to the level of the tank. Operating time or in a way it is possible to accelerate or to brake the emptying of the tank. Using this study for the TWD process, the medical intervention can be simulated as the manipulation of the value. The only parameter of this function, the time constant, would have the average duration of the TWD processes.

Conclusions

The SD approach to TWD allows explaining how the medical team affects the TWD episode evolution and can improve its dynamic characteristics.

- Specific medical intervention acts decreasing the average duration of short- and long-term work disability episodes, decreasing the percentage of patients that get the PD and increasing the percentage of patients that return to work.

- The good approximation of the survival curves in control and intervention groups have allowed validating the dynamic model. This model and its parameters may be used by the medical team to study the disability due to MSD, to evaluate the cost and the effectiveness of their decisions, and to explore the best scenarios.