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 multifactor 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 ontological effect on each other. System dynamic (SD) techniques consider important the temporal information reflecting the evolution with the time of the system’s variables behavior, and this allows to deepen into the problems knowledge more than statical analysis do. Up to now, SD techniques have not been applied to study disability produced by musculoskeletal diseases (MSD).

Objectives
To develop a dynamic model to:
1) Simulate the evolution of temporary work disability (TWD) episodes due to MSD.
2) Analyse the usual evolution of MSD-TWD episodes and the effect of a specific medical intervention in their evolution towards permanent disability (PD) or recovery.

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

This study compared the effect of standard medical care versus a specific return to work intervention on the duration of TWD episodes and their evolution to PD, and was conducted on an urban population of Madrid with 500,000 active workers. All patients were retrospectively treated and were studied on the day of the diagnosis for the last two years and randomised into two groups: 1) Control (CG): following standard care management, and 2) Intervention (IG): enrolled in a specific return-to-work program. Patients were followed for another complete year and successive TWD episodes were studied avoiding overlap of patients between the groups. The minimum follow-up period of each given patient was one year.

All the MSD-TWD episodes in both groups have been analyzed using SD techniques in order to explain how medical intervention can reduce the duration of episodes and the number of patients going to PD.

Results (I)
A total of 1325 patients (786 in CG and 532 in IG) suffered 1628 MSD-TWD episodes (831 in CG and 797 in IG) during the study which have been recorded in retrospective survival curves in Figure 1. Each survival curve shows the evolution of TWD episodes 1% episodes still untreated during one-year period since the starting of each one. Most patients (88% in CG and 90% in IG) returned to work within first two months, but those returning in work after six months (23% in CG and 17% in IG) were very slow, with many of them being off work for the complete 18 months period allowed by the administration.

The average duration of TWD episode was 43.3 days in CG and 26.6 days in IG (p < 0.001). The intervention obtained a relative efficacy of 33% (percentage of days saved by the intervention (IG) with respect to CG). The intervention also produced a decrease in the number of patients requiring PD assessment process and involving any form of long-term disability compensation or early retirement (Table 1).

Results (II): Elemental Model
The mathematical function that better fit the survival curves is the exponential function because it takes the value 1.0 at t = 0, becomes zero when t becomes infinite and it is monotonous decreasing. This model has a very simple interpretation: (1-1) in the initial level of risk that falls 100% of water and finally empty the tank.

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The good approximation of the survival curves in control and intervention groups have allowed validating the dynamic model. This model and its parameters have been considered to study the disability due to MSD, to evaluate the cost and the effectiveness of their decisions, and to explore the best scenarios.

Conclusions
The model can be used to explain 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.