DISCRETE-EVENT SIMULATION MODEL TO ANALYZE DEMAND AND WAITING TIME FOR CATARACT SURGERY. ASSESSMENT OF A PRIORITIZATION SYSTEM FOR WAITING LISTS

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BACKGROUND

Despite an increase in elective surgery rates, related to the ageing of population and the widening of indication criteria, waiting lists and unmet need of cataract surgery have increased. A prioritization system was defined for cataract surgery, as benefits from surgery are not the same for all patients and priority is related to need of surgery. The objective of this study was to define and implement a simulation model to analyze demand and waiting time for cataract surgery and to compare a waiting list prioritization system with the usual first-in, first-out system.

METHODS

A conceptual model was built to reproduce the process of cataract (figure 1), from incidence, defined as need of surgery, through demand, inclusion in a waiting list and surgery. In order to estimate each parameter of the model, a specific method was used, using administrative data and studies of our research team or others (table 1). SIMUL8 was the software used to implement the discrete-event simulation model. Sensitivity analysis was performed in order to assess the impact of introducing a prioritization system in the waiting list, compared to the usual FIFO (first-in, first-out) system. The prioritization system used included clinical, functional and social criteria. An increase of the priority score through time was taken into account. Each execution consisted in 20 replications of a 5-year simulation horizon. Outcomes were assessed through waiting time weighted by priority score, for all cases who entered the waiting list (operated cases, those still waiting, those who switched to private and those who died while waiting). The benefit of applying the prioritization system was calculated as the difference in waiting time weighted by priority score betweeen disciplines. Different scenarios of mean waiting time were used to compare the two alternatives. Comparisons were paired by stream of random numbers.

Figure 1: Conceptual model.

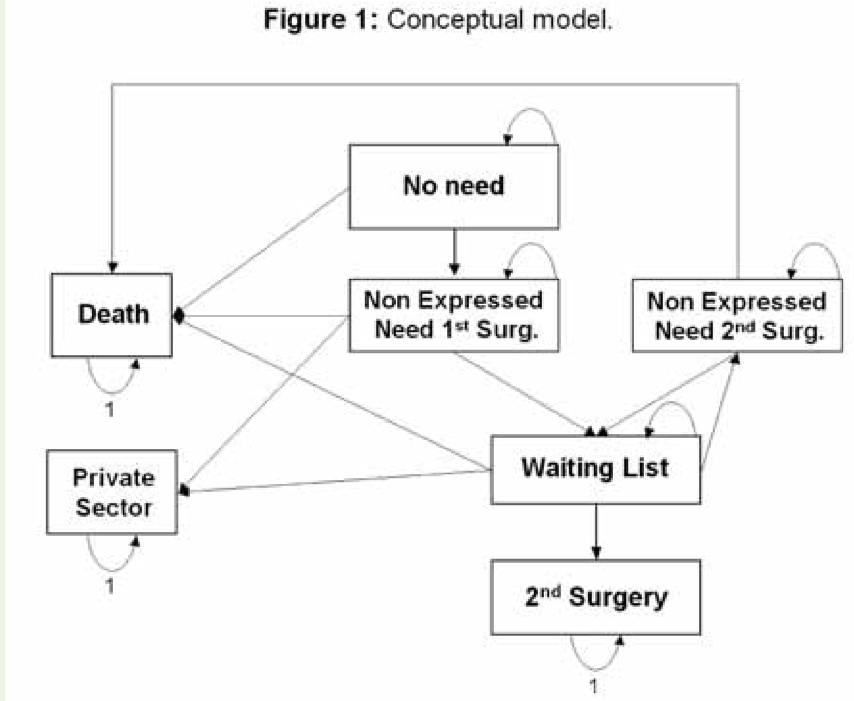

Table 1: Model parameters and their distributions.

Model parameter	Distribution	Distribution parameter
Incidence	Exponential	Monthly number of incident cases
Operations public sector	Exponential	Monthly number of operations in public sector*
Operations private sector	Exponential	Monthly number of operations in private sector
Inclusion in a waiting list	Exponential	Monthly number of entries in waiting list*
Sex	Bernouilli	Proportion of women in prevalent population
Age	Empirical distribution	Conditioned to sex
Type of patient	Bernouilli	Proportion of patients with one eye operated
Time of death	Empirical distribution	Conditioned to age and sex
Probability of having second eye surgery	Bernouilli	Monthly proportion of patients operated of second eye surgery in public sector*
Priority Score	Empirical distribution	Conditioned to type of patient
Increase in priority score through time	Points gained by time waited	
Self-regulation of the waiting list	Percent reduction	Maximum percent over initial contents of waiting list

*: dynamic parameters with a logarithmic increase through time

RESULTS

Waiting time for patients operated under the FIFO discipline was homogeneous (standard deviations between 0.5 and 0.8). When the prioritization system was applied, the waiting time distribution had a higher variability (standard deviations between 7 and 11) and was positively skewed, with 10% or less of cases with extremely high waiting times. When the waiting time was weighted by priority score for all cases who entered the waiting list, the prioritization system was more favorable than the FIFO discipline, as an average of two months was saved (table 2). This difference was significant for all scenarios (from a raw waiting time of 2 months to 21 months) and a tendency was observed showing that more time was saved in scenarios with a higher waiting time. Figure 2 shows that, for higher waiting times, patients with higher priority score were favored by the prioritization system, while patients who were penalized were those with lower priority scores.

Figure 2: Time saved or lost with respect to current system according to priority score and waiting time (operated cases).

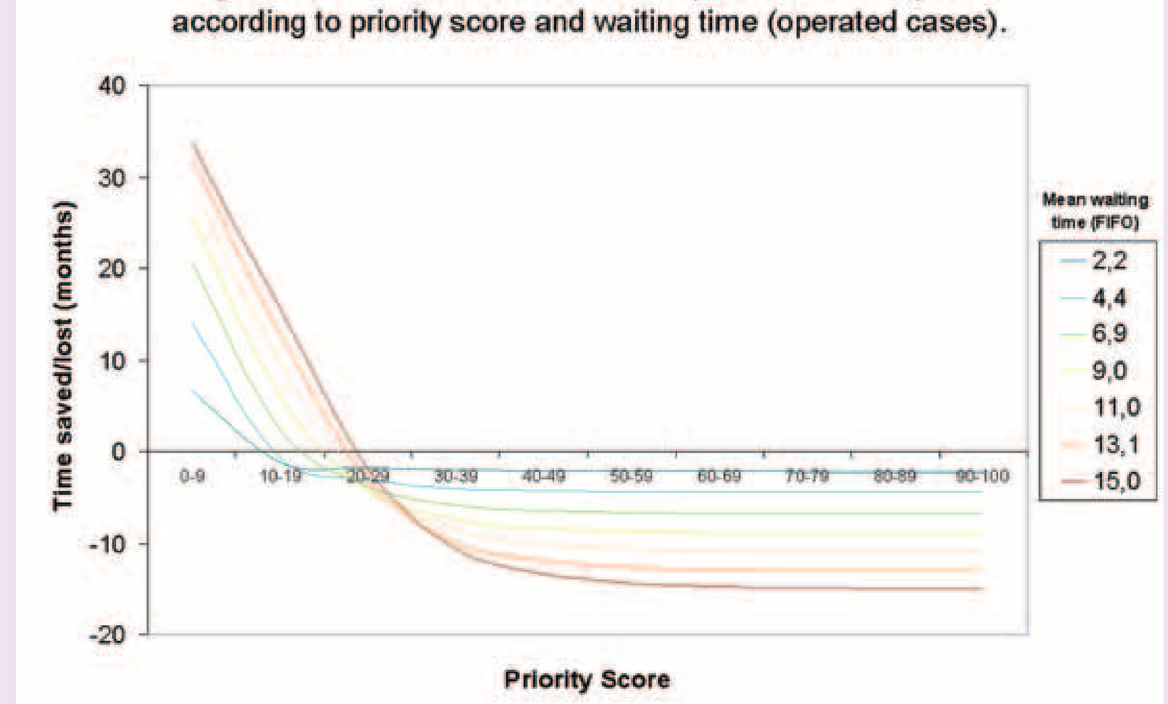

Table 2: Comparison of waiting times weighted by priority score between waiting list disciplines, by different scenarios of raw waiting time.

	Weighted waiting time		Paired differences of weighted waiting time		
Raw waiting time operated cases (FIFO)	FIFO	Prioritization System	Mean	Standard Deviation	95% Confidence Interval
2,18	2,12	0,64	1,48	0,22	[1.36; 1.60]
4,44	4,23	1,95	2,28	0,18	[2.18; 2.38]
6,86	5,32	3,46	1,85	0,50	[1.58; 2.12]
8,97	6,30	4,64	1,66	0,31	[1.49; 1.83]
10,98	7,91	5,64	2,27	0,28	[2.12; 2.42]
13,12	9,10	6,50	2,60	0,26	[2.46; 2.74]
14,96	9,39	7,18	2,21	0,21	[2.09; 2.32]
17,08	10,66	7,10	3,56	0,48	[3.30; 3.82]
19,17	12,03	8,37	3,66	0,36	[3.46; 3.86]
21,16	12,39	8,89	3,50	0,19	[3.39; 3.60]

CONCLUSIONS

The simulation model allowed to analyze the benefit of introducing a prioritization system in a waiting list for cataract surgery, in different scenarios of mean waiting time. It allowed to quantify the time saved according to priority score and to identify the cases penalized by the prioritization system. This tool will allow to test different scenarios such as changes in practice patterns (e.g., increasing the probability of second eye surgery) or assessment of needs for surgery (prevalence).

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