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Death on the waiting list for cardiac surgery

Gerry B. Hill

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Long waiting lists for cardiac surgery are a problem for national health care systems,[1] and deaths among those waiting to be treated are a special cause for concern.[2,3] Priority is usually given to patients who are at above-average risk of dying.[4] The impact of such a policy can be illustrated by a simple compartment model (Fig. 1).

Suppose that N patients per year are added to the waiting list and S patients (some number less than N) are treated each year. If N and S are constant, and patients remain on the waiting list until they are treated or die, then a waiting list of size Q will result. Among patients on the waiting list, there will be $D = mQ$ deaths per year, where m is the death rate per patient-year. In this steady state (where inflow = outflow) $N = S + D$, $D = mQ$, and $Q = (N - S)/m$. T, the average waiting time before death or surgery, is Q/N.

For example, if $N = 1000$ patients per year, $S = 960$ patients per year, and $m = 0.1$ deaths per patient-year, then $Q = (1000 - 960)/0.1 = 400$ patients, $D = 0.1 \times 400 = 40$ deaths, and $T = 400/1000 = 0.4$ years or 146 days. From these calculations we can see that even a small difference between the number accepted for treatment and the number treated with available resources will result in a sizeable waiting list, since in calculating the size of the waiting list, the difference between N and S is multiplied by the reciprocal of m, a small number.

This model can be applied to any waiting list scenario that is in a steady state. Such steady states would occur in any large health care system in which the value for $N - S$ is constant.

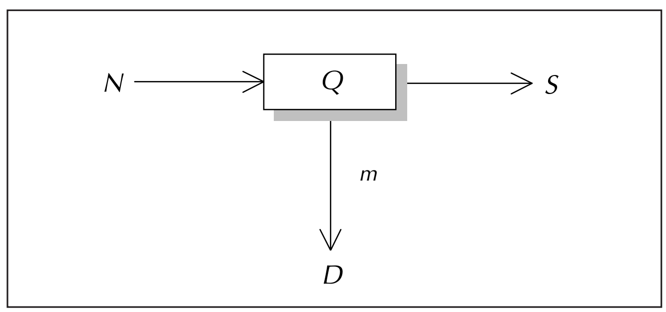

Fig. 1: A compartment model of a waiting list. *N* = the number of patients accepted for surgery each year, *Q* = the number waiting for surgery at any given time, *S* = the number who undergo surgery each year, *m* = the death rate per person-year among those waiting for surgery, *D* = the number of deaths each year among those awaiting surgery.

Suppose now that the 1000 patients accepted each year for surgery comprise 2 groups: $N_1 = 300$ per year with mortality rate $m_1 = 0.24$, and $N_2 = 700$ per year with mortality rate $m_2 = 0.04$. The degree of priority given to one or the other of these 2 groups is determined by the allocation of the total available treatments, S per year, to each group, say S_1 and S_2 (such that $S_1 + S_2 = S$). If complete priority is given to the high-risk group, then all 300 high-risk patients will

Table 1: Effect of priority allocation on deaths, size of waiting list and waiting time*

	Priority; no. (and %) of patients†		
	To high-risk patients	To neither group	To low-risk patients
Patients treated/year			
High-risk group	300 (100)	288 (96)	260 (87)
Low-risk group	660 (94)	672 (96)	700 (100)
Deaths/year			
High-risk group	0	12 (4)	40 (13)
Low-risk group	40 (6)	28 (4)	0
All patients	40 (4)	40 (4)	40 (4)
No. of patients on waiting list			
High-risk group	0	50	167
Low-risk group	1000	700	0
All patients	1000	750	167
Mean waiting time, days			
High-risk group	0	61	203
Low-risk group	521	365	0
All patients	365	274	61

*The total number of patients accepted for surgery each year is 1000: 700 in the low-risk group (with mortality rate 0.04 per patient-year) and 300 in the high-risk group (with mortality rate 0.24 per patient-year).
†Except where indicated otherwise.

be treated, leaving 960 – 300 = 660 treatments for the low-risk group. Conversely, if complete priority is given to the low-risk group, then all 700 low-risk patients will be treated, leaving 960 – 700 = 260 treatments for the high-risk group. If no priority is given to either group (i.e., $S_1/S_2 = N_1/N_2$), then $S_1 = 288$ and $S_2 = 672$.

Table 1 shows the effect of these 3 scenarios on the number of deaths per year, the size of the eventual waiting list and the mean waiting time for each risk group and for the patient group as a whole. Giving priority to the high-risk group yields a larger overall waiting list and a longer mean waiting time, although the total number of deaths per year is the same as under the other scenarios. The latter must be so, since $N_1 - S_1 + N_2 - S_2 = N_1 + N_2 - (S_1 + S_2) = N - S$, which is constant.

Thus, the natural clinical tendency to give priority to the group with a higher mortality rate does not yield fewer deaths among patients on the waiting list and leads to a larger overall waiting list. To reduce the size of the waiting list by giving priority to the group with lower mortality rate (see Table 1) would probably be considered cynical and unethical, but it should be noted that such a policy would not increase the overall number of deaths per year.

It can also be shown that these results hold where there are more than 2 risk groups.

This analysis is not intended to be normative or to constitute a recommendation that priorities for surgery be changed. However, there is anecdotal evidence that in Ontario "some access to specialized cardiovascular services occurs preferentially on the basis of facts other than clinical needs."[5] Although rightly considered deplorable, such behaviour would not, according to the model, increase the number of deaths on the waiting list.

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