A Model to Estimate Human Resource Needs for the Treatment of Outpatients With Cancer

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Abstract

Purpose: Although personnel costs significantly affect cancer health care expenditures, little is known about the relationship between workload, human resource requirements, and associated costs. An empirical model to forecast staffing demand is described according to the yearly caseload of outpatients with cancer beginning active treatment and the number of personnel working hours.

Methods: The oncology department at the University Hospital of Udine (Udine, Italy) is a computerized unit taking care of approximately 1,300 patients per year. Each clinical episode is centrally recorded. We queried the database for the total number of consultations per patient beginning treatment during 2006. With predefined bonds (ie, time limit set for each visit type and annual working hours per employee), we sought to estimate

yearly per-patient hours of care and the number of personnel needed.

Results: In 2006, each outpatient with cancer beginning active treatment generated an average of 16 clinical evaluations, which in turn translated into 8 and 16 hours of physician and nurse working time, respectively. Assuming an average of 1,672 annual working hours, a need for one physician and three nurses for every 600 patients could be estimated for every 200 novel patients. In the next year, the same caseload induced 4.5 consultations on average; using a similar approach, the demand for additional time and resources was calculated.

Conclusion: By means of a simple model combining predefined conditions with a centralized record of clinical episodes, we were able to provide a reasonable estimate of human resource requirements and a tool to forecast the staff expenditures of a cancer unit.

Introduction

Costs of cancer treatment account for an increasing proportion of health care spending in the entire Western world, with a yearly estimated growth of 15%.¹ Most existing studies on the economic burden of cancer lack sufficient detail to provide an accurate understanding of all the different factors associated with cancer treatment. National expenditure data show that in most health care systems, staffing costs largely exceed those of drug purchasing in the inpatient setting^{2,3}; conversely, drug expenditures represent the most important contributing factor to the cost of outpatient care. One published review suggests that costs other than those for cancer drugs, such as administration procedures, evaluation and management, and laboratory and radiology services account for 30% of total spending; a study on lung cancer reports them to be approximately 41%.^{4,5}

Although increasing drug expenditures are a matter of active debate among oncologists, scientific societies, and decision makers, staff utilization is an often neglected cost in cancer care; to our knowledge, no comprehensive effort has been made so far to design a management model describing the relationship between patient workload and human resource needs. Using data from our oncology department to build a simple model, the primary aim of our study was to describe how to determine personnel requirements and estimate associated expenditures.

Methods

The oncology department at the University Hospital of Udine (Udine, Italy) is a fully computerized, research-oriented clinical unit. The information system in use allows physicians to manage, store, and retrieve all clinically relevant patient informa-

tion; schedule treatment or follow-up visits; prescribe therapies; and draw up medical reports and discharge summaries.

Each clinical episode is recorded and coded in a centralized database. Different types of patient visits are categorized as follows: first consultations, treatment sessions, re-evaluations, follow-up visits, unscheduled visits, telephone contacts, intervening assessments, and hospitalizations. According to a fixed work plan, physician visit time is standardized at 90 minutes for a first consultation, which entails an all-inclusive patient evaluation (ie, patient medical history and physical examination, explanation of diagnosis and treatment options, treatment planning, and signing of informed consent); 60 minutes for a hospitalization; 20 minutes for a pretreatment assessment; and 30 minutes for all other visit types (average values).

The electronic database was queried for a list of all outpatients with cancer who began treatment throughout 2006. First consultations that did not lead to any medication order were excluded. The average numbers of treatment sessions, hospitalizations, and other visit types (which were considered all together) were determined for each tumor type and all first examinations. The yearly physician time (PT) per patient beginning treatment was estimated by multiplying the average number of each visit type by its set duration and then summing the products. These first steps allowed us to derive the physician resource need for a given number of first examinations and an average annual amount of physician working hours.

The resulting need for physical spaces (namely, outpatient rooms) was determined by multiplying the yearly per-patient PT by the number of first visits and then dividing the result by the amount of working days per year. These calculations provided us with the number of daily working hours and consequent need

for a variable number of outpatient rooms depending on work shift duration (8 v 12 hours [for structures with two 8-hour shifts that partially overlap], respectively).

Essentially, starting from a given number of patients who enter active treatment after their first examination, all computations are based on two key data elements: the mean number of visits generated by each first consultation, and the set duration of each visit type. At its simplest, the model may be expressed as follows:

$$x = \frac{[(V1 \times h1) + (V2 \times h2) + (V3 \times h3) + (V4 \times h4) \dots] \times n}{z}$$

where x is the number of required physicians, V is the mean number of each visit type generated by each new patient beginning anticancer treatment, h is the set duration of different visits, n is the yearly number of patients entering into treatment, and z the number of physician working hours according to national regulations.

A slightly different methodology was applied to calculate the need for nurses. Each nursing activity was divided in five steps: reception, ambulatory care, blood sampling, patient handling, and administrative tasks. Only outpatient activities were considered. The head nurse and an experienced colleague supervised nurses' duties, recorded the mean time allocated to each step, and calculated the duration of nursing care for each visit type. Then, the needed number of nursing positions could be determined in the same way as previously described.

In the second part of our work, an effort was made to determine how much additional work would be generated by the same patients from the 13th to 24th month and, as a consequence, if or how many additional workers and spaces would be required. Two strategies were pursued: on one hand, the central database was queried for the real number of visits that each patient beginning treatment the year before had undergone the next year; on the other hand, on the basis of observational data, it was devised that half of the patients cared for during 2006 would induce half the workload of the previous year. Computations were then performed as described, and the two result sets were compared.

Finally, our model was applied to determine staffing costs by multiplying the total personnel number (physicians and nurses, 2006 plus 2007) by their average gross salary per year. Spending for laboratory technicians, administrative personnel, and health care assistants—as well as the cost of high-technology radiologic procedures and associated diagnostics—was excluded from computations.

Results

The central database returned a number of approximately 1,288 first visits throughout 2006. As previously described, only outpatients who began treatment ($n = 600$) were included in our computations. The average numbers of treatment sessions, hospitalizations, and other visit types were 9.4, 0.2, and 6.5, respectively, for a total average number of 16 per-patient examinations (Table 1).

Table 1. 2006 Average No. of Different Types of Physician-Patient Contact for Each Patient Beginning Treatment After First Consultation

Type of Visit	Average No. of Visits
Treatment sessions ^a	9.4
Re-evaluations ^b	2
Follow-up visits ^c	2
Urgencies ^d	2
Intervening assessments, ^e telephone contacts ^f	0.45
Hospitalizations ^g	0.2

^a Scheduled visits performed during each type of active treatment on regular basis; physicians explain treatment characteristics, inquire about toxicities, and compile and sign chemotherapy orders.

^b Scheduled visits during treatment to evaluate disease response and treatment safety, aimed at confirming initial therapeutic program or choosing different strategy in case of poor efficacy/patient tolerance; may occur after off-therapy period and disease restaging, or in disease-free patients in whom recurrence is suspected.

^c Scheduled visits to regularly monitor radically treated patients and diagnose possible recurrence early.

^d Unscheduled visits during which patients with acute complications, toxicities, or any type of difficulty are admitted to dedicated office room and receive specific recommendations, treatment, or general care.

^e Medical record notations that do not imply patient-physician contact; used by staff to note interim changes to diagnostic/treatment program, results of examinations, contacts with other specialists, and decisions reached during department/multidisciplinary meetings.

^f Indirect physician-patient contacts used for communications that do not require formal, face-to-face visit; staff physicians keep note of all telephone contacts, except for brief contacts to schedule appointments or give simple instructions.

^g Ward admissions for unexpected and severe treatment complications/toxicities or to deliver complex treatment regimens or treat fragile patients.

Considering the set duration of each visit type, each patient beginning treatment during 2006 generated a per-patient yearly PT of approximately 8 hours (Table 2). Under Italian labor law, physicians work approximately 1,672 hours per year (38 weekly working hours $\times$ 44 working weeks); thus, one oncologist was found to be required for every 200 outpatients beginning treatment. For the same caseload, a need of one versus 0.5 outpatient rooms was determined according to the existing work shift schedule (8 v 12 hours, respectively).

As for nursing requirements, each outpatient beginning treatment during 2006 required 16 hours of nursing activi-

Takeaway Points

Costs of cancer treatment account for an increasing proportion of health care spending. Although personnel costs comprise a significant share of total health care expenditures, staff utilization is an often-neglected cost in cancer care, and scarce literature exists addressing this issue. It has been said that cost containment in oncology is a moral issue; in this perspective, oncologists should be increasingly called on to acquire a general knowledge of management issues. We describe a model that, on the basis of predefined bonds, enables the estimation of the human resource needs of a cancer unit.

Table 2. Yearly Physician Time Per Patient Beginning Active Treatment During 2006

Type of Visit	No.	Visit	Per Patient Yearly Physician Time	
		Duration (minutes)	Minutes	Hours
First visits	1	90	90	1.5
Treatment sessions	9.4	20	188	3
Re-evaluations, follow-up visits, urgencies, intervening assessments, telephone contacts	6.45	30	193.5	3
Hospitalizations	0.2	60	12	0.2
Total			483	8

ties (Table 3). Given a set of 38 working hours per week and an annual leave entitlement of 5 weeks, the need for day-hospital nurse staffing turned out to be two nurses for every 200 outpatients.

Because it is assumed that some additional activity will be generated in the next year for each patient receiving care, the central database was queried for the average number of different visit types that each patient beginning treatment during 2006 had induced from the 13th to 24th month since first consultation. Data were as follows: for the physician component, 2.3 additional treatment sessions, 0.05 hospitalizations, and 1.6 other examinations, with a consequent additional per-patient PT of 1.5 hours per year; for the nursing segment, 2.3 pretreatment evaluations, 0.5 urgencies, 0.5 re-evaluations, and 0.5 follow-up visits, corresponding to an additional per-patient nursing time of 4 yearly hours. These numbers translate into the need for 0.2 more physicians and 0.5 more nurses for every 200 treated outpatients.

Having assumed that 50% of patients beginning treatment during 2006 would have produced 50% of the activity of the previous year, we could compare our hypothesis with the data obtained from the electronic system. We found a high level of concordance (2.3 *v* 2.6 treatment sessions; 0.05 *v* 0.07 hospitalizations; 1.6 *v* three other examinations, respectively; Appendix Table A1, online only).

In conclusion, 600 outpatients beginning treatment during 2006 resulted, in the subsequent 24 months, in the need for 3.5 physicians, 7.5 nurses, and two outpatient rooms, considering

full-time 12-hour shifts and 251 of 365 working days. These figures were finally used to determine staffing costs by multiplying the total personnel number—3.5 physicians plus 7.5 nurses—by their gross salary, which amounts to an average of 80 and 26 thousand euros per year, respectively, with an overall staff cost of approximately 500 thousand euros.

Discussion

In recent years, spending on cancer treatment has risen faster than that in many other areas of health care,⁶ as a consequence of the introduction of both new technologies and novel therapeutic drugs. These factors have been the controversial subjects of intense debate, whereas poor attention has been paid so far to other possible contributors, such as spending for physician and nursing resources. The identification of alternative leading determinants of health care expenditures may be important in setting priorities for resource allocation⁷ and revealing significant opportunities for cost saving.

Human resources not only account for a substantial proportion of health care expenditures but also represent the most important input into the provision of health care.⁸ Demand for oncology services is expected to rise rapidly as a result of population aging and improvements in cancer survival rates, with an anticipated shortage in the United States of up to 4,000 oncologists in 2020 and a 48% increase in the overall demand for oncology visits.⁹ This evidence highlights the fact that high priority should be given to workforce planning and human capital management.

Health workforce planning aims at estimating the workforce needed to meet future health requirements and developing strategies to meet those requirements.⁸ An even more comprehensive definition is that of a discipline ensuring that “the right number of people, with the right skills, is at the right place at the right time to deliver health services for the population needs, at an affordable cost.”^{10(p267)}

Despite the lack of a significant body of scientific knowledge on the topic, accepting that cost containment in oncology is a moral issue,¹¹ and the expected undersupply in the health workforce partly reflects the inadequate estimation of future staff requirements,¹² we believe that oncologists are increasingly called on to acquire a general knowledge of organization and management issues. In this perspective, our study may serve as a springboard for discussion, providing a feasible tool to esti-

Table 3. Yearly Nursing Time Per Patient Beginning Treatment During 2006

Type of Visit	No. of Visits	Duration of Each Management Step (minutes)					Total Time (hours)
		Reception	Ambulatory Care	Blood Sampling	Nursing Management	Administrative Tasks	
First visits	1	5	0	0	15	20	0.7
Treatment sessions	9.4	5	0	10	45	10	11
Urgencies	2	15	30	10	15	10	2.7
Re-evaluations	2	5	0	10	10	10	1.2
Follow-up visits	2	5	0	0	0	10	0.5
							16

mate staff workload during the 24 months after patients' first visits, to forecast future human resource needs and costs, and to plan the physical space required to support health activities.

In fact, our study applies a work-study technique for demand forecasting to the world of cancer care services. Such techniques are applicable when the length of operations and amount of labor required may be calculated.¹³ The starting point consists of the output volumes for the individual department (in our case, number of first and subsequent per-patient visits). The budget of productive hours is compiled using standard time consumption for direct labor (ie, set duration of each visit type). The standard hours per unit of output (ie, time needed for all visits generated by each first consultation) are multiplied by the planned volume of production (ie, number of yearly first visits) to give the total number of planned working hours (annual PT for all new patients). The number is then divided by that of employee working hours to obtain the number of operators required.¹³

Thus, starting from a given number of patients who begin active treatment after their first examination, all computations are based on two key data elements: the mean number of visits generated by each first consultation, and the set duration of each visit type. Detailed information is provided for each phase of the model, and any organizational variable may be entered into the model without spoiling its performance.

However, a few limitations should be considered. First, Italian health care delivery is mainly a public-sector responsibility. Although the private sector may take advantage of superior management efficiency, the National Health Systems, taken as a whole, do perform well in a global cost/benefit analysis.^{14,15}

Second, our department is part of a publicly financed system with specific principles and laws, such as those applying to labor contracts, employees' leave entitlements, shift duration, and contract salaries. Also, as an academic center, teaching and research activities may affect some organizational features (eg, per-patient length and/or number of consultations).

Third, among 1,288 patients cared for by our department throughout 2006, we included in our estimates exclusively those 600 patients who began active treatment; indeed, even though individuals who are simply followed up on after their first examination do consume some amount of resources, patients receiving active treatment intuitively represent the most expensive setting. It could also be argued that different treatment regimens have variable levels of complexity and may require different efforts to be administered; however, our study includes a large cohort of consecutive patients with cancer, reflecting the mixed population that is usually referred to a department of oncology in a hub university hospital.

Fourth, as previously stated, the data set needed for resource forecasting may be easier to retrieve in units employing an elec-

tronic medical record (EMR) system, but paper-based hospitals are generally able to store and retrieve all necessary statistics as well. Besides, even if a low use of information technology has been observed in both US and European hospitals,^{16,17} several economic reports foresee that EMR market value will more than quadruple by 2013.^{18,19} Thus, an increase in the prevalence of EMRs might happen faster than expected, enhancing the reproducibility of our approach.

Finally, some allowance should be made for idle time, sick leave,¹³ or possible nonadherence to predefined time limits. A more refined model should incorporate the stochastic nature of patient flow and arrivals and of service times, which is typical of all health care systems.²⁰ Indeed, our methodology is based on the premise of an accurate organization of services and activities, which largely relies on staff sharing and compliance. On the other hand, we assume that all these features will be increasingly needed for ensuring service efficiency, facing the challenge of recent cancer trends, and improving the communication process with health decision makers, which may often contain conflicting elements.

In conclusion, our model may provide a powerful support tool to hospital medical directors and medical managers for the development of a well-functioning mix based on a given availability of human, physical, and financial resources. It also provides an example of how medical oncologists may be well-informed participants in health policy decisions; the diffusion of such expert knowledge at all levels of health organizations could work as a powerful negotiating tool when dealing with health care executives and as a crucial step forward in the achievement of a rationalizing—as opposed to rationing—health care system.²¹

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