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An economic evaluation of the optimal workload in treating surgical patients in a breast unit

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Abstract

A breast unit is a cancer centre specialised in the diagnosis and treatment of patients with breast cancer. The high level of specialised skills involved in running a breast unit makes it an expensive pattern of care. The European Society of Mastology (EUSOMA) recommends a minimum caseload of 150 cases sufficient to maintain expertise for each team member and to ensure cost-effective working of the breast unit. Specific economic analysis evaluating main diagnostic services (radiology and pathology) and treatment are needed. The present study assesses the activity level at which the breast unit represents good value for money in surgically-treated patients. Cost assessment is realised by defining a cost function according to the following assumptions: cost function input is personnel costs and technical equipment and output is the number of newly diagnosed cases of primary breast cancer admitted to the breast care unit each year. The increase from 50 new cancer cases per year to 100 will reduce average costs by almost 50%. Cost reduction is important up to a volume of 200 new cases per year. For economic investment to be justified, it is desirable that intake rises to at least 200 new cases per year. Our result is in-line with the EUSOMA recommendation.

Keywords: Breast neoplasm; Cancer care units; Cost analysis; Workload

1. Introduction

Site-specific cancer services are a major challenge to improve outcomes in cancer patient care. They should be based on teams of co-ordinated experts linked to a comprehensive network. This policy seeks to ensure that benefits of specialised care are promptly available to all patients. A specialist cancer unit is expected to be in charge of a large volume of cases. In the case of breast cancer, as hospital volume of surgical cases seems to have a strong positive effect on mortality and the 5-year survival of patients [1–3], the specialist unit should improve outcomes and provide more effective care.

The complexity and multidisciplinary nature of breast cancer diagnosis and treatment requires the involvement of skilled specialists, working together in a co-ordinated team [4–7]. Many papers exploring the impact of specialisation on care for breast cancer conclude that being cared for by specialists or multidisciplinary teams improves patients' quality of life [8,9] and therefore warrants more updated and evidence-based treatment [10].

Many studies suggest that benefits associated with care provided by specialists are not only due to surgery, but also to the use of other therapeutic tools, such as adjuvant therapies [2,11–13]. Specialised surgeons can provide better results including cosmetic ones by use of techniques such as sentinel node biopsy and conservative treatment. Well-performed surgery could affect cancer treatment policies by providing accurate information on prognostic factors [14,15].

Even if caveats have been proposed because of the observational nature of the studies evaluating site-specific cancer units [10,16], several among the best known international guidelines, such as the Scottish Intercollegiate Guidelines, National Health and Medical Research Council (NHMRC) National Breast Cancer Centre Guidelines and National Health Service Breast Cancer Guidelines, agree with the idea of a specialised multidisciplinary team [17–19].

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The European Society of Mastology (EUSOMA) has recently structured a proposal on the standards required for performing high quality breast cancer care in Europe [20]. Standards are established with the intention of assuring high quality specialist breast care and a means of accreditation easily recognisable by patients and providers.

The implementation of the guidelines provided in the EUSOMA document implies profound innovation in the healthcare delivery process.

Because of economic constraints any new strategy (scientific, technological or organisational) should be considered also with regard to its impact on resource consumption.

One mandatory requirement agreed by the EUSOMA working group identifies a minimum workload per unit of 150 newly diagnosed cases per year of primary breast cancer. The following statement motivates this requirement:

> The reason for recommending a minimum number is to ensure a caseload sufficient to maintain expertise for each team member and to ensure cost-effective working of the Breast Unit: the establishment of a clinic staffed by experts is expensive and must have a high throughput of patients.

The link between workload and cost-effectiveness is an area of debate. By concentrating hospital activity into large units, efficiency can be improved with the generation of economies of scale, in which long-run average total cost declines as the output increases. Nevertheless, there is no evidence from the international literature that cost savings can be secured merely by increasing hospital activity volume and it is likely that large hospitals may suffer from inefficiencies due to diseconomies of scale [21].

We are not aware of any cost analysis on breast cancer units evaluating the EUSOMA recommended caseload of 150 cases from an economic perspective.

In a previous document on breast cancer care by the UK National Health Service Executive [18], the justification for the caseload of 100 new breast cancer patients per year is based, among others, on the cost-effectiveness goal. A lower level could not justify the costly organisation of a highly specialised team. Nevertheless, it is acknowledged that the figure of 100 is arbitrary as no evidence for its choice is given.

In looking for the workload threshold, accessibility also has to be addressed. To determine an activity level that allows economy of scale patient access should also be considered, so that the economic reasons are counterbalanced by assessment of population distribution and travelling opportunities.

In Italy, cancer units are still far from being a standard service. Since in Piedmont the Regional Health Plan and recent regional breast cancer management guidelines [22] propose to implement a network of centres specialised in diagnosing and treating patients with cancer—including breast cancers—economic assessment becomes mandatory.

2. Methods

2.1. Objectives

The main objective of the present study was the assessment of the surgical activity level at which the breast unit represents good value for money, on the basic assumption that specialised personnel and equipment guarantee high quality care. Our aim was to study the relationship between the volume of surgical cases and cost, in order to offer to policymakers an additional tool in cancer services organisation.

The cost of standard practice has not been analysed, as this study is not a cost evaluation based on the comparison of two alternatives.

Analysis is run assuming that a breast unit is a production process innovation—that is, the transformation of available resources into services—with an impact on quality of care and clinical outcomes, but not on the amount of services (diagnostic procedures, surgical treatments, inpatient care, outpatient care) supplied to patients. This assumption is reductive because the process innovation is likely to determine a different consumption of healthcare resources due to changes in the attitude to prescription of the medical doctors working in a team. The net effect of the breast unit on resource consumption could be both an increase because of the major updating and higher technological level of staff and equipment, or a decrease due to improved rationalisation of patterns of care.

A breast unit covers many different aspects of care: screening, diagnosis, surgical and medical therapies, follow-up, etc., each one with its own organisation, production process and target population. The demand for diagnostic services is much broader than the demand for surgical care. Caseload and cost patterns related to diagnostic services (i.e. radiology and pathology) are not analysed here. In this study, we focused on the activity related to surgical treatment; the assessment of an optimal annual caseload refers to surgical patients only.

2.2. Methods

In the cost function adopted here, input is personnel costs, technical equipment and overhead costs.

Output is the number of newly diagnosed cases of primary breast cancer (at all ages and stages) admitted to surgical care in the breast unit each year. Activity includes management of patients who turn out to be cancer-free (hereafter referred to as 'benign cases', whereas patients with cancer requiring treatment are called 'malignant cases'). In the base scenario, the assumption is 1 operated upon benign lesion out of 5 cancer cases, while in a second scenario the assumption is 1 out of 2 [23,24].

We refer to the definition and requirements of breast units as reported by the EUSOMA document [20]. The activities of the unit related to patient treatment (except diagnosis) embodied in the cost function are:

a. outpatient care immediately before and after surgery (consultation and dressing);
b. surgery;
c. case management meetings;
d. periodic scientific briefings and continuous updating;
e. research and training.

A breast unit is also supposed to have an important teaching role. This aspect is not included in the cost analysis because it is not strictly linked to the healthcare supply.

Italian public healthcare providers' knowledge of analytical economic data is usually fairly scant, both because of the only recent adoption of analytical cost accounting systems and the lack of actual payment or billed charges. Thus, cost function is based on some assumptions in order to reduce complexity and to minimise errors due to incorrect data. Only personnel costs and equipment used in the breast cancer treatment are taken into account; overhead costs (including administrative costs) are attributed as a proportion of the previous.

Resources necessary for the new organisational model are related to the activity level, under the hypothesis of implementing the unit within an already functioning hospital setting. The personnel time and equipment usage not absorbed by the breast unit are assumed to be utilised by other existing hospital units, so that they are costs attributable to the rest of the hospital and not to the breast unit.

Lastly, as we are studying the organisational model, costs directly related to patient treatment (such as adjuvant therapies and follow-up) are not included in the cost function: they are not a direct consequence of the multidisciplinary and specialist organisation.

The cost function determined by the above mentioned assumptions is the following:

$$\text{Total cost} = E(x) + A(x) + B(x) + C(x) + D$$

E = equipment; x = number of patients treated; A = outpatient care; B = surgical care; C = case management meetings; D = scientific briefing and updating.

The staff to manage the treatment activity of a breast unit requires the professions listed in Table 1, the level of commitment differing. Since surgeons, radiologists and pathologists have to devote part of their time to follow-up, screening, recurrences, research and other activities not directly related to breast cancer surgery, they are counted in the breast unit treatment activity as only part time. In case of an annual activity level between 250 and 400 new cases, two surgical teams (one highly qualified surgeon, three surgeons, two scrub nurses and two staff nurses) are necessary; for above 400 new cases a third team is added. One additional radiologist and pathologist have to be added at a level of 450 new cases per year.

Each service is divided into specific activities and the related personnel workload is estimated in terms of hour by each profession. Part of the workload is a function of the weekly activity level, but part of it is a fixed amount independent of the number of patients treated. The cost data used in the analysis are the total annual cost—inclusive of taxation and social funds—of each staff member in the Piedmont Region during the year 2000 (Table 1).

2.2.1. Outpatient

Outpatient care includes visits by specialists and dressing after surgery. Outpatient activity is not merely related to the number of patients to be treated; it is a public service, which has to remain open for a minimum number of hours per week (not less than 5 h), even if the activity level is low.

Outpatient activity is run by surgeons (1 h/week per patient, 1 h/week for dressing and postoperative visit per operated positive case, half-hour/week per operated negative case), other specialists (oncologist, radiotherapist, rehabilitation specialist, plastic surgeon and psychologist, half an hour/week per patient) and nurses (1 h/week per new patient and 1 h/week per operated

Table 1
Total annual personnel costs (Euros), Piedmont Region, year 2000

Anaesthetist	81 301.72
Highly qualified surgeon	122 428.40
Qualified surgeon	81 301.72
Plastic surgeon	81 301.72
Radiologist	81 301.72
Pathologist	81 301.72
Scrub nurse	31 889.46
Staff nurse	31 889.46
Oncologist	81 301.72
Radiotherapist	81 301.72
Rehabilitation specialist	81 301.72
Psychologist	73 657.97
Epidemiologist	81 301.72
Administrative secretary	22 209.54
Data manager	32 111.48

Source: Piedmont Region data.

positive case and in relation to outpatient medical activity, half-hour/week per operated negative case). Administration and data management are related to the number of patients and to the nursing staff activity.

2.2.2. Surgery

A breast unit ought to have a specifically equipped operating theatre and sessions devoted to surgery for breast cancer. Some technical equipment is settled in the operating theatre permanently: gamma probe detection for sentinel node biopsy, faxitron and the bench for pathologist. They are fixed costs until a high level of activity. Within the activity range considered in the study further equipment acquisition is not necessary. Purchasing prices of operating theatre technical equipment are given in Table 2.

Mammography and ultrasound equipment for preoperative localisation and specimen radiographs (or faxitron) of impalpable lesions are devoted to surgical care only when the operation theatre is used by the breast unit surgeons and their cost is estimated in relation to the number of hours of activity (on a total weekly time period of 40 h). The time of utilisation is then obtained from the average number of patients who are operated upon.

Technical equipment, according to Italian law, have a life expectancy of 8 years that is a 12.5% yearly depreciation on the purchasing price, which is identified through the producer budgets (Table 2). This duration is probably overestimated, because of technological turnover.

The operating theatre has to be devoted to breast cancer at least one morning per week, even if the average volume of activity does not need 5 h of surgery. The surgical operation is assumed to last an average of 2 h per positive and half an hour per negative case. The plastic surgeon is required for half an hour per positive case. The pathologist and radiologist are required to be present for one hour and a half per positive and half an hour per negative case, in order to guarantee the coverage of the service for the duration of the operation.

2.2.3. Other activities

Time devoted to case management meetings is mainly related to the number of patients treated by the unit (half an hour per patient). Periodic scientific briefings for audit and continuous education require a fixed number of hours per week, independently from the workload and fixed at 3 h per week.

Table 2
Purchasing prices of operating theatre technical equipment (Euros), year 2000

Gamma detection provides	25 822.84
Faxitron	25 822.84
Bench	51 645.69
Mammography	61 974.83
Ultrasound	129 114.22

Source: producer's budgets.

The epidemiologist is assumed to take part only in scientific briefings (2 h per week at any activity level).

A general rule adopted in the calculation of personnel time necessary to sustain the activity is that of using whole hours rather than fractions. As treatment costs are already routinely sustained by the hospital, herein only costs specifically related to the organisation of the unit are computed. Overhead costs are assumed to be a portion (30%) of the direct costs (both personnel and equipment) of the breast unit. The effect of this assumption on the final results has been tested for both a higher (50%) and a lower (10%) level.

3. Results

The analysis of weekly total workload of the breast unit staff is reported in Table 3 showing the hours required for running the service at each level of activity by each staff member. Figures sum up all activities (surgical, outpatient and others).

The average costs per patient (labour and equipment) are listed in Table 4(a). The increase from 50 new cases per year to 100 results in an almost 50% reduction of the average cost. The cost reduction is important until a level of 200 new cases per year. Above this level, the reduction has small downward variations (3–11% for each 50 additional patients per year, in the base scenario). The effect is shown in Fig. 1, where the average cost curve declines at the increase of activity volume, but has a flatter slope above 200 new cases.

Marginal cost is the change in total costs divided by the change in the amount of output produced, that is the cost related to the surgical treatment of a new cancer case. In Fig. 1, the marginal cost curve has an irregular pattern, with higher peaks from 250 new cases per year. This is mainly caused by the basic assumption of adding further surgical teams to provide care to $\geqslant$250 and $\geqslant$450 new patients per year and, at an activity level of 450 cases, to add one radiologist and one pathologist.

All peaks—every 100 new cases—are also due to the assumption of using whole hours rather than fractions for every activity considered. At a level of 450 and 550 patients per year, the resource increment determines a high marginal cost and an increase of average costs. Variations of the assumption related to overhead costs do not affect the pattern of results. Results in the case of a higher rate of benign operations (1 out of 2) offer a similar cost pattern and the same conclusions (Table 4(b)).

Table 3
Weekly workload of a breast unit staff as a function of the activity volume (hours per week)

	Year activity volume											
	50	100	150	200	250	300	350	400	450	500	550	600
Anaesthetist	5	5	7	9	12	14	16	18	21	23	25	27
Highly qualified surgeon	14	14	17	20	16	17	18	20	17	18	20	20
Qualified surgeon[a]	14	14	17	20	16	17	18	20	17	18	20	20
Plastic surgeon	14	14	15	15	16	16	17	17	18	18	21	21
Radiologist[b]	9	9	11	12	15	17	20	21	16	17	19	20
Pathologist[b]	9	9	11	12	15	17	20	21	16	17	19	20
Scrub nurse[a]	5	5	7	9	12	14	16	18	21	23	25	27
Staff nurse	33	36	41	45	51	56	61	65	71	76	83	90
Oncologist	9	9	10	10	11	11	12	12	13	13	15	15
Radiotherapist	9	9	10	10	11	11	12	12	13	13	15	15
Rehabilitation specialist	9	9	10	10	11	11	12	12	13	13	15	15
Psychologist	9	9	10	10	11	11	12	12	13	13	15	15
Epidemiologist	2	2	2	2	2	2	2	2	2	2	2	2
Administrative secretary	28	31	34	36	39	42	45	47	50	53	58	63
Data manager	6	7	8	9	10	11	12	13	14	15	17	18

[a] Data per person referring to one surgeon and one scrub nurse at 50–200 cases, three surgeons and two scrub nurses at 250–400 cases and five surgeons and three scrub nurses at 450–600 cases.
[b] Data per person referring to one radiologist and one pathologist at <450 cases and two radiologists and two pathologists at $\geqslant 450$ cases.

Table 4
Average and marginal cost (personnel and technical equipment) per new cancer case operated upon in a breast unit (Euros)

Cases per year	(a) Base scenario: 1 benign/5 malignant			(b) Second scenario: 1 benign/2 malignant		
	Average cost	Average cost reduction (%)	Marginal cost	Average cost	Average cost reduction (%)	Marginal cost
50	10 165	–	10 165	10 165	–	10 165
100	5146	49	127	5170	49	176
150	3921	24	1471	4002	23	1667
200	3221	18	1123	3280	18	1111
250	3120	3	2716	3213	2	2944
300	2773	11	1037	2870	11	1159
350	2615	6	1666	2688	6	1593
400	2399	8	890	2504	7	1221
450	2626	−9	4442	2680	−7	4082
500	2405	8	413	2535	5	1232
550	2422	−1	2589	2570	−1	2924
600	2331	4	1330	2427	6	853

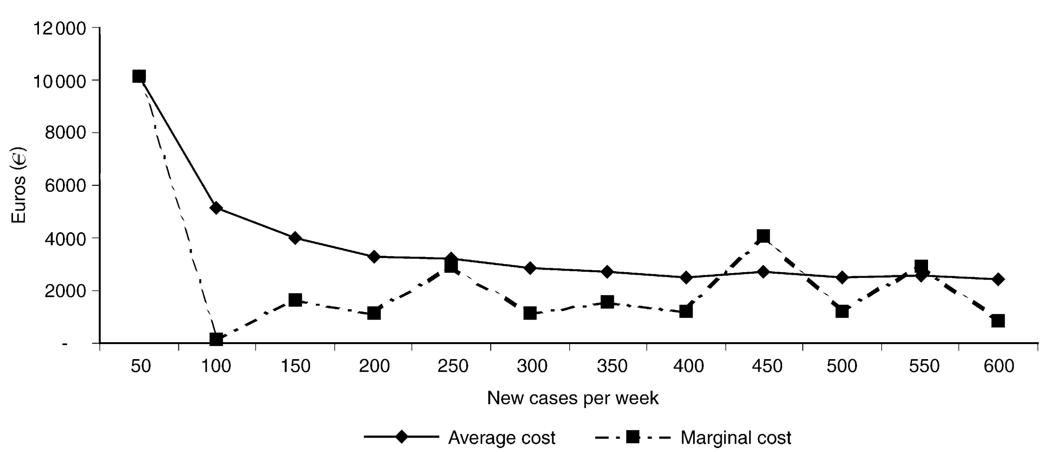

Fig. 1. Average and marginal costs curves of a breast unit (only personnel and technical equipment included). Base scenario (1 benign/5 malignant operations).

4. Discussion

The analysis of the costs related to different activity volumes shows that the organisation of a breast unit has an economic impact due to the high level of specialisation of the personnel and the equipment required for running the activity.

To justify the economic investment, it is desirable to achieve a volume of approximately 200 newly diagnosed breast cancer cases per year. Below 200 new cases per year, average costs per patients show a sharp increase. In fact, at a lower activity level, fixed costs—equipment and the staff work not related to number of patients, such as scientific meetings or updating—place a heavy burden on a small number of patients.

The minimum caseload recommended by EUSOMA was 150 new cases [20] in order to maintain expertise for each team member. This level is also compatible with the training duties of the specialist team. From the economic perspective, this level is not as worthwhile as 200: the average cost per patient is 18% higher than at a level of 200 patients/year.

Above 200 cases, within the interval 200–600, the average cost reduction compared with the activity level of 50 cases shows only a small variation (from 68 to 77%).

These results can assist in the planning of the optimal network of breast cancer units from a clinical and economic point of view.

As an example, we have provided data from our region (Piedmont) in this study. New breast cancer cases in Piedmont, estimated on the basis of the incidence data in the main city of the area (Turin), which is served by a population cancer registry, were more than 2500 per year during the period 1993–1997 [25–27]. An increase in incidence is expected due to the extension of the breast cancer screening programme in the whole Region since the year 2000. If we plan to implement breast units treating 200 new cases, around 13 units (one every 350 000 inhabitants) will be required.

An analysis of the inpatients discharge records in Piedmont [22] shows 3576 surgical operations for breast cancer (Diagnosis Related Groups 257 and 260) in the year 2000. Although this figure includes prevalent cases, the distribution of admissions by hospital is interesting: 56% (28 out of 50 hospitals) treat less than 50 patients per year, and only four hospitals have a workload $\geqslant 200$ new cases. If the Regional Health Service plans to organise a network of breast units, a big effort is needed to change the current practice in order to ensure high quality care in a smaller number of specialised hospitals.

In interpreting our results, limitations of the study should be kept in mind. Diagnostic assessment, adjuvant therapies and follow-up have not been included in the present analysis due to the specificity of each of these different activities. However, given the strict relationship they hold with surgery in a multidisciplinary specialised breast unit [20], additional useful data for planning will emerge once the picture is complete.

Specialisation and a concentration of resources result in a reduction in service accessibility for patients. The increase in patients' and their caregivers' travelling expenditures has not been assessed in this study. In planning a network of breast units, both accessibility and the organisational cost profile will have to be addressed and counterbalanced. While requirements for high quality care, based on specialisation and activity volume, can be reasonably constant across countries, accessibility can have a very different impact according to the population density, physical structure of the territory, communications and life-style.

This study provides the first cost analysis supporting the appropriateness of the minimum target of 150 newly diagnosed cases per year set by EUSOMA for breast cancer units [20] and indicates that a volume of approximately 200 cases is likely to be more favourable from an economic point of view.

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