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Development of a structural capacity index for oncological surgery in acute hospitals

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A B S T R A C T

Introduction: The study of the impact of structure on outcomes has mainly been focused on the number procedures. The aim of our study was to develop a structure capacity index for hospitals for oncological surgery.
Methods: Cross-sectional study by means of a questionnaire related to the structural characteristics of hospitals that had performed gastrointestinal oncological surgery in Catalonia during 2004. Variables were considered for the index according to their measurement and conceptual properties.
Results: A response was obtained from 37 out of 48 hospitals. Variables with good conceptual and measurement properties (Cronbach alpha 0.92 and Item-Total correlation >0.7) were included in the index. These variables were related to teaching, management and technology.
Conclusions: The index has acceptable levels of reliability and validity, and can be a useful tool to classify hospitals according to their technological characteristics and management strategies.

Desarrollo de un índice de capacidad estructural para hospitales de agudos con cirugía oncológica

Palabras clave:
Estructura
Volumen
Resultados
Cirugía
Oncología
Índice

R E S U M E N

Introducción: El estudio del impacto de la estructura sobre los resultados se ha basado principalmente en el número de intervenciones. El objetivo de este trabajo fue desarrollar un índice de capacidad estructural para hospitales de agudos con cirugía oncológica.
Métodos: Estudio transversal por encuesta, relativa a las características estructurales de los centros que habían realizado alguna intervención quirúrgica de oncología digestiva en Cataluña en 2004. Se desarrolló un índice sobre la base de la maximización de la fiabilidad, y se seleccionaron las variables por sus características métricas y también conceptuales.

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Resultados: De los 45 centros seleccionados se obtuvo respuesta válida de 37. El conjunto de variables incluidas en el índice (relacionadas con la docencia, la gestión de casos y la tecnología) presentó buenas propiedades métricas (alfa de Cronbach: 0,92 y correlación ítem-total >0,7).

Conclusiones: El índice desarrollado permite clasificar los centros hospitalarios atendiendo a sus especificidades tecnológicas, organizativas y de gestión.

Introduction

Donabedian was the first to conceptualize the evaluation of the quality of care based on 3 aspects: structure, process, and outcome. The structure represents the context in which health care is practiced. The process represents the set of services and procedures performed during the care process. In the end, the result is a measurable consequence.

The study on the impact of the structure[1] on surgical results has been centred on relating the number of interventions with the results, where a greater number of interventions should be directly related with greater experience, and, at the same time, with better results.[2] Several studies, mostly conducted in English-speaking countries, show this positive relationship between the number of interventions and outcomes.[3,4] In our context, a study carried out on oncological surgery showed a wide variability between hospitals in relation to mortality and surgical practice. The partial hepatectomy and pancreatectomy are those interventions that showed this positive relationship between the number of interventions and outcomes.[5] However, reducing the study of the impact of structure on the results to the number of contributions represents an oversimplification. Other features inherent to the hospital, such as the number of beds, presence or absence of residents, the technological conditions, the existence of an organizational culture or an incentive target policy in the centre can have an impact on the quality and efficiency of the department.[6]

No studies have been located in the Spanish medical literature that have developed an index of structural capacity of the centres where cancer surgery is performed. However, 2 systems have been identified to classify the structural capacity of a centre: the centre's variable level of the minimum basic data set on hospital discharges (MBDSHD) and the relative intensity structure index (RISI). The MBDSHD is an activity log that contains information concerning the discharges carried out in acute patient hospitals. This log includes a variable that ranks centres according to 6 categories: high technology, reference, area, isolated, local network and private. The primarily organizational character of the district, isolated, and local network categories allows these 3 to collapse into a single category, labelled as "area." The RISI[7] is a complex index that attempts to explain the structural capacity of a centre. The Catalonian Health Service (CatSalut) calculates its values using different approaches based on the Manton's grade of membership statistical method. The applicability of these indices in our context seemed difficult given the characteristics of surgical oncology, as well as tertiary level and diversity of the procedures investigated.

As a result, one could consider developing a tool which would make it possible, especially in health services research or comparative studies between centres, to measure the impact of structure on the results. The aim of this project was to develop an index capable of measuring the structural capacity of the hospital with cancer surgery in relation to their specific technological, organizational and management skills.

Material and methods

Transversal descriptive study carried out by surveys, where public and private acute centres of Catalonia participated that had carried out some type of intervention on cancer of the oesophagous, stomach, rectum, pancreas or hepatic metastasis in 2004 within the Oncorisc study.[8] A questionnaire was developed expressly for collecting information on the structural characteristics of the centres. The questionnaire included questions that were generally dichotomous, identified in a review of previous studies: a survey of GOM centres of the CatSalut and a survey of the TOP 20 hospitals of the IASIST.[9] These were related to the patrimonial dependency, teaching, the number of beds (<151, 151-300, 301-500, and >500) and discharges(<7000, 7000-15 000, 15 001-25 000, and >25 000), departments related to the onocological health care available in the centre, the availability of functional units, pathology, information services, registration of tumours, and technological equipment.

Variables collected in the questionnaire were described by the number of cases and the percentage of their categories. The development strategy of the structural capacity index was based on maximizing the reliability (Table 1), and variables were selected by their metric[10] and conceptual characteristics; first those variables were discarded with roof or floor effect (Table 1) or a level of heterogeneity in their responses below 20%. In a second stage, we calculated item-total correlation (Table 1), a measurement of correlation between each question and the rest, minus the current one. Those variables that showed a high correlation with the rest (<0.6) were discarded. The others were selected to create an index, and its internal consistency (Table 1) was verified using Cronbach's alpha (alpha >.8).

Table 1 – Glossary of terms[10,13]

Reliability	It is the degree to which an instrument is free from randomized errors, that is, that to the measurement made there is no systematic error
Ceiling effect	The proportion of centres that achieved the highest score in relation to an item or scale/index
Floor effect	The proportion of centres that achieved the lowest score, the expected value for both effects is less than 20%, higher values would jeopardize the discriminative ability of the item or scale/index
Item-total correlation	Linear correlation between an item and the score of all items (excluding the item under consideration). Values are expected to be over 0.35 in a range from 0 to 1
Internal consistency	It is the degree to which all items of a scale/index whose values added to give a total measure the same concept, normally Cronbach's alpha is used for analysis, this statistic is calculated by averaging the correlations between all items and it is summarized in a value between 0 and 1, when comparing items, expected values are above 0.9
Convergent validity	It is the study of the correlation between the score of an instrument with other instruments measuring similar concepts. Correlation values between scores >0.60 are expected

Table 2 – Structural characteristics of the centres examined for entry in the index (n=37)

	Question	No.[a]	%[b]	% Total Var[c]	Item-total correlation	Cronbach's alpha
Variables removed	Endoscopy rooms (yes/no)	36	97	11	–	–
	Access to results via information systems (yes/no)	33	89	39	–	–
	Computed Tomography (yes/no)	32	86	47	–	–
	Day hospital (yes/no)	31	84	54	–	–
	Oncology department (yes/no)	30	81	61	–	–
	Prevention of nosocomial infections unit (yes/no)	7	19	61	–	–
	Cobalt radiotherapy(yes/no)	5	14	47	–	–
	Positron emission tomography (yes/no)	4	11	39	–	–
	Brachytherapy units (yes/no)	2	5	21	–	–
	Number of discharges					–
	<7000	10	27	na	–	–
	7000-15 000	15	41	na	–	–
	15 001-25 000	6	16	na	–	–
	>25 000	6	16	na	–	–
	Upper gastrointestinal endoscopy (yes/no)	14	38	94	0.53	–
	Rectal endoscopy (yes/no)	13	35	91	0.54	–
	Semicritical unit (yes/no)	15	41	96	0.53	–
	Department of anatomical pathology (yes/no)	12	32	88	0.43	–
	Computerised medical records (yes/no)	13	35	91	0.09	–
Variables included	University centre (yes/no)	12	32	88	0.76	0.92
	Centre with university residents (yes/no)	24	65	91	0.71	0.93
	Radiotherapy department (yes/no)	8	22	68	0.78	0.92
	Critical unit (yes/no)	21	57	98	0.82	0.92
	Functional cancer units (yes/no)	11	30	83	0.75	0.93
	Tumour registry (yes/no)	18	49	100	0.87	0.92
	MRI (yes/no)	16	43	98	0.90	0.92
	Gamma cameras (yes/no)	10	27	79	0.81	0.92
	Linear accelerators (yes/no)	8	22	68	0.78	0.92
	Number of beds				0.93	0.93
	<151	13	35	na	–	–
	151-300	11	30	na	–	–
	301-500	9	24	na	–	–
	>500	4	11	na	–	–

na indicates not applicable; Var, variance.
[a]Number of affirmative answers to the question.
[b]Percentage of positive answers to the question.
[c]Percentage of total possible variance, which is 100 × (0.5) × (0.5).

The index score was calculated by adding structural capacity values assigned to different categories of response, beginning with a 0 for the response category least indicative of structural capacity. The resulting score generated a range of values from 0 to 12, where 0 indicates minimum structural capacity of the centre and 12 indicating maximum structural capacity of the centre (see example calculation in Table 3).To examine the convergent validity (Table 1), using the Spearman correlation coefficient, the index score in each centre was compared with the level variable of the centre for the MBDSHD, and the index score in each centre with the RISI index. It was expected that the correlation coefficients were moderate to high (>0.6). Furthermore, the association was examined using the Spearman correlation coefficient of the index with the number of operations of the 2 cancers with the highest number of cases within the ONCOrisc study (stomach and rectum).[8]

The level of statistical significance was set arbitrarily at .05 and the software used for statistical analysis was Intercooled Stata v. 9.2.[11]

Results

Of the 45 centres selected, responses were received by 39 centres, although responses from 2 centres were considered as invalid because the number of unanswered questions was above 25% (response rate, 82%).

Table 2 presents a description of all variables in the order that they were analysed. The variables that showed a ceiling or floor effect or a level of heterogeneity in their responses below 20%, were the first to be withdrawn: the oncology department, outpatient hospital, nosocomial infection prevention unit, access to diagnostic results via information systems, computed tomography, endoscopy rooms, positron emission tomography, cobalt radiotherapy, and brachytherapy units. On the other hand, the high number of variables and number of beds had a strong association in its continuous version (Spearman's rho = 0.97), as well as a significant concordance in its categorized version (kappa [κ] = 0.78). Conceptually, it is considered more appropriate to include the variable number of beds as it is more related to the structure of a centre than the number of discharges. With all other non-eliminated variables, the item-total correlation statistics and internal consistency were calculated. The variable computerized medical records presented an item-total correlation of 0.09, indicating a negligible relationship to the whole. Furthermore, the following variables showed an item-total correlation that was not very high (<0.6): pathology (0.43), semi-critical patient unit (0.53), upper digestive endoscopy (0.53), and rectal endoscopy (0.54), that were also withdrawn. In the end, the remaining questions were considered as optimal from a metric standpoint (Cronbach's alpha 0.92, range of item-total correlation, 0.71-0.93) to form the conceptual and structural capacity index (Table 3).

Figure 1 shows the relationship between index score and the variable MBDSHD level of the centre (Spearman's rho = 0.91). The 4 high-tech hospitals in Catalonia scored 12, the maximum value of the index, and all district centres scored between 0 and 2. On the other hand, the score range of the reference centres was much wider: between 2 and 11. Figure 2 shows the association between the developed index and the RISI (Spearman's rho = 0.89). The figure also includes the linear prediction between the developed index and the RISI index, with an adjusted coefficient of determination of 0.75, with an interpretation that 75% of the variability of the RISI index is

Table 3 – Practical implementation of developed structural capacity index

Is it a university hospital?	Yes	No
Do resident physicians work in the hospital?	Yes	No
Does the centre have a radiotherapy department?	Yes	No
Does the centre have a critical unit?	Yes	No
Does the centre have functional cancer units?	Yes	No
Does the centre have tumour registry?	Yes	No
Does the centre have magnetic resonance imaging?	Yes	No
Does the centre have gamma cameras?	Yes	No
Does the centre have a linear accelerator?	Yes	No
What is the total number of beds in the centre?		
	<151	
	151-300	
	301-500	
	>500	

Scores of the items: Yes = 1 No = 0, <151 = 0; 151-300 = 1 301-500 = 2, >500 = 3.
Example: at a university hospital, with resident physicians, with a radiotherapy department, with a critical patient unit, with magnetic resonance devices, with functional units and tumour registry, but without a gamma camera or a linear accelerator and with a total of 380 beds.
Calculation: the index score for this centre structure would be obtained by adding one point for each affirmative answer and 2 points for having between 301 and 500 beds.
Score index = 1 + 1 + 1 + 1 + 1 + 1 + 1 + 0 + 0 + 2 = 9 of the 12 possible.
Interpretation: because 12 is the maximum score, 9 representing 75% of this, and thus the hospital's example can be evaluated as a centre with a medium-high structural capacity.

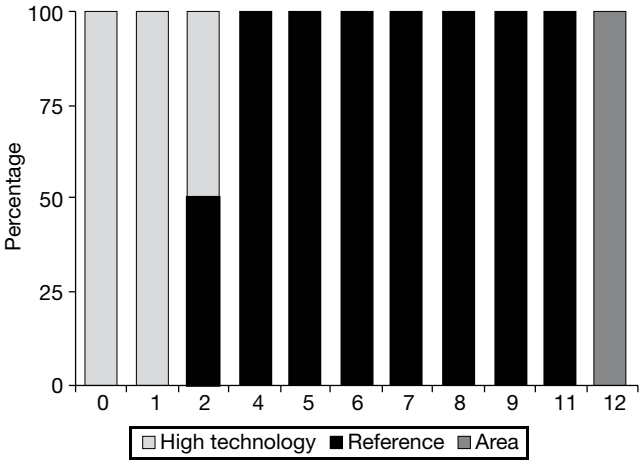

Figure 1 – Distribution of centres according to index score of structural capacity and the classification level of the minimum basic data set on hospital discharges.

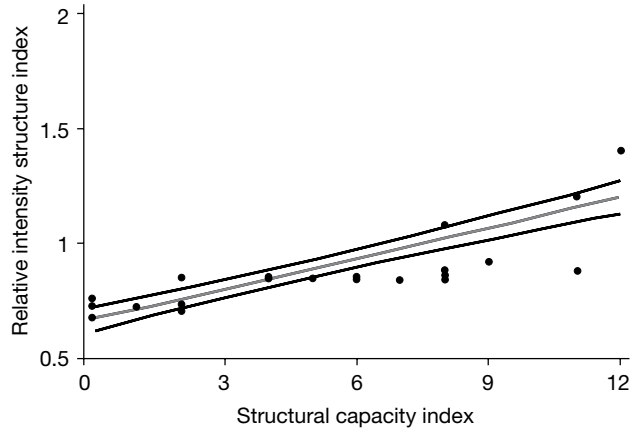

Figure 2 – Association between the structural capacity index and relative intensity structure index (Spearman's rho = 0.89).

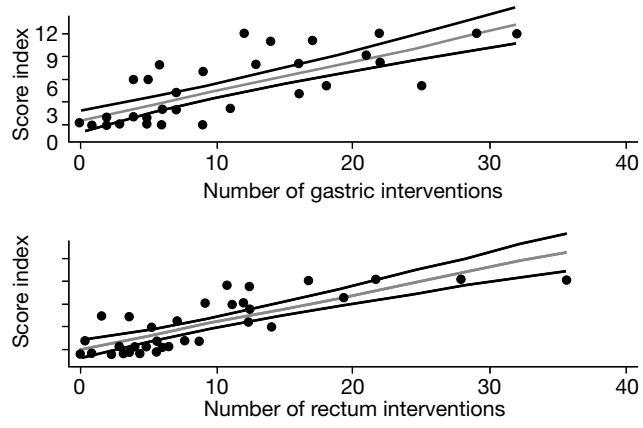

Figure 3 – Association between the structural capacity index and the number of stomach and rectum interventions in 2002 and 2004 in the centres included in the study (Spearman's rho = 0.80, both).

explained by the developed index. In the end, Figure 3 shows the association between the index score of structural capacity and the number of gastric (Spearman's rho = 0.80) and rectum (Spearman's rho = 0.80) interventions in the centres included. The linear prediction presents a coefficient of determination adjusted from 0.6 for stomach and 0.63 for rectum.

Discussion

An index has been developed to classify the acute hospitals in those that perform oncological surgery based on objective and readily accessible information relative to its structure. This index provides a novelty when compared with indexes with an identified structure: the introduction of issues related to teaching (teaching hospital with resident physicians), the organization and management of cases (tumour registry, cancer functional units), as well as a greater simplicity in their calculation.

The results show the good psychometric properties of the developed index (Table 3). Furthermore, it presents very acceptable levels of convergent validity. The high positive correlation of the score of the index with the classification of the level of MBDSHD of the centre (Figure 1), as well as the RISI index (Figure 2), show it this way. On the other hand, it appears that the developed index enables the discrimination both within the category of reference hospitals as well as district hospitals in relation to the classification offered by MBDSHD. The case of reference hospitals is particularly interesting, because there are centres that are as diverse as a teaching hospital with approximately 400 beds and positron emission tomography, or another centre with approximately 200 beds, with no functional units and a less specific technological equipment. This discriminative ability is also highlighted in Figure 2, where those centres with a score of about 0.8 in the RISI index present a score range between 3 and 10 in the structural capacity index. In Figure 3, the correlation between the number of procedures performed and the index score confirms that the number of statements describes, in part, the structural capacity of the centre. On the other hand, the determination coefficients denote that about 40% of the variability of the index cannot be explained by the number of interventions and, therefore, other factors may be key, such as the organization or the technological equipment.[12]

The limitations of the index would be given mainly by the loss of information by dichotomizing the variables or the lack of representation of the surveyed centres. However, to study the validity, the representation is not as important as the inclusion of enough centres with varied characteristics (64% of acute hospitals of Catalonia) to ensure wide ranges of the potential scoring of the instrument. On the other hand, the inclusion of certain variables focused on the cancer care process may call into question the applicability of the index in other areas. However, although it is not the objective of this index, the high correlation with the RISI index (Spearman's rho = 0.89) shows that technological and organizational capabilities of the centre in the cancer area may be extrapolated to other areas of the same centre. In the end, the variables used are somewhat insufficient to assess

related organizational aspects, for example, with the policy of centre management.

The structural capacity index will be sensitive to the technological incorporations and organizational changes of the centres. The score of a centre can be updated over time, but at a certain point, the index will lose some of its ability to discriminate between centres, due to their concentration in the highest scores, although this point related with the assessment of the ability to measure sensitivity to change of the index requires more investigation.

To conclude, the structural capacity index developed for oncological surgery centres in Catalonia makes it possible to classify centres based on their specific technological, organizational and management characteristics. Furthermore, it presents a greater capacity to discriminate and is easier to calculate the variable level of the centre of MBDSHD and the RISI. Thus, it is expected to facilitate the use of the index as a tool in different types of clinical and epidemiological studies. It may be especially useful in research in projects where the impact of structure on performance is the overriding objective. It is especially useful in health services research in health monitoring or comparative studies between centres.

Conflict of interest

The authors affirm that they have no conflicts of interest.

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