Evaluation of the Performance of an Innovative Model for the Organisation of Specialised Hospital Activities throughout Italy: The "Diffuse Hospital"

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AIM: The objective of the study is to evaluate the performance of an innovative model of hospital activity known "Diffuse Hospital" (DH) that involved 3 hospital wards/departments (A, B and C) located throughout Italy and the Reference Hospital (RH) that organised the construction of this model.

METHODS: An organisational retrospective observational study was conducted on the orthopaedic ward of each hospital from March 2022 to March 2023. Hospitals A, B and C had organisational differences in relation to the working relationship of healthcare professionals, the care pathways implemented, the presence or absence of an emergency department and the management of operating theatres. The primary indicator was the number of Diagnosis-Related Groups (DRGs) provided by the individual facilities. Additionally, a series of indicators were collected, and to enable comparison, these indicators were calculated in relation to the available resources.

RESULTS: The total number of DRGs provided by the DH was 3904, broken down into 1187 at Hospital A, 1851 at Hospital B and 866 at Hospital C. The RH comparison standard recorded 1603 DRGs. Hospital B showed higher DRG indicators of 39.7, 2.5 and 30.9 percentage points, respectively, than the RH. In relation to theatre activities and healthcare staff, Hospitals A and C revealed lower scores than the standard.

CONCLUSIONS: The DH model may become a useful tool in healthcare policy strategies to enable national RHs to deliver treatments with high standards of care at a territorial level. The facilities involved in the DH organisational model produced different outcomes in terms of both efficiency and clinical outcomes. Where there is no direct management by the RH of healthcare staff, care pathways and operating theatres, replication of the standard is more difficult and outcomes are poorer. In the hospital where there is no need for emergency surgical activity and scheduling is concentrated within the week, better efficiency levels can be achieved.

Keywords: hospital administration; organizational efficiency; health services research; quality indicators; health care; hospitals standards

Introduction

Within healthcare systems, hospitals play a central role in the care of people by representing complex organisational structures. To improve the quality of care offered [1,2] over the years, different models of organising hospital systems have been implemented such as integration networks between hospitals [3,4], satellite hospital experiences [5] and hierarchical organisation in hub and spoke structures [6]. Over the last 10 years in the Emilia-Romagna region, the idea of a new organisational model known as "Ospedale Diffuso" (translates as "Diffuse Hospital" or DH) was conceived with the aim of facilitating people's access to highly specialised care by guaranteeing high standards of treatment in a more widespread manner throughout Italy. The model was implemented by a single-speciality orthopedic hospital that is a national and international reference centre for the treatment of highly complex musculoskeletal disorders. To this end, memoranda of understanding were signed between the Reference Hospital (RH) and three orthopaedic wards/departments of different hospitals in Italy. On the basis of the agreements and the specific characteristics of each context, the individual wards/departments had implemented specific organisational models in relation to the presence or absence of an emergency department, staff management, operating theatres and the care pathway.

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The DH model aims to replicate the performance of the RH in the field of orthopaedic care within hospitals present throughout Italy without creating a hierarchical relationship between the various structures.

Evaluating the performance of an organisational model is a key aspect for understanding its strengths and weaknesses and consequently for guiding health policy choices [7]. In the literature, this evaluation of performance and quality of care provided to date does not ascertain an unambiguous method [7–9] making it necessary to monitor several multidimensional aspects such as productivity in terms of services provided, clinical outcomes achieved for patients, the degree of satisfaction of healthcare staff [10,11] and patients [12]. All these elements must be read in the light of the resources made available both from the point of view of facilities and staff, taking care to evaluate not just one single indicator but a set of indicators [13].

The objective of this study is therefore to evaluate the performance of a DH. Hospital wards/departments located throughout Italy were compared with the surgical activity of one ward of the RH, defined as standard, using a series of indicators.

Materials and Methods

Study Design

Organisational retrospective observational study was conducted.

Population

There was a total of four hospitals involved in the construction of the DH, three of which were in the north of Italy and one in the south. In this article, the Reference Hospital (RH) that organised the construction of this model is referred to as the RH and was a single-specialty hospital in the orthopaedic field, while the other hospitals involved have been named as Hospital A, B and C and were basic and top-level hospitals. In all the hospitals involved, the team of orthopaedic medical directors came from the RH with a direct working relationship and overlapping orthopaedic training. Hospitals A, B and C had organisational differences in relation to the working relationship of healthcare professionals, the care pathways implemented, the presence or absence of an emergency department and the management of operating theatres. For the definition of the reference standard, one ward of the RH was selected with overlapping surgical activity in terms of patient types and also related to the activities of the emergency department.

DH performance data were collected for the period from March 2022 to March 2023. The data were available to the Directorate General of the RH for regular hospital management. The data were provided consecutively for all patients admitted to one of the facilities involved in the study in aggregate form so that individual patient data could not be traced. The study was approved by the Ethics Committee of Central Emilia (Area Vasta Emilia Centro) under protocol no. CE-AVEC 506/2023/Oss/IOR and was conducted in accordance with the Declaration of Helsinki. Given the nature of the study and the use of data in aggregate form, informed consent for the study was not necessary.

Primary Indicator

The primary outcome was defined as the number of Diagnosis-Related Groups (DRGs) provided by the individual facilities [14]. DRGs are a tool for classifying all patients discharged from a hospital on the basis of the resources used for their care. It is a tool used commonly on a national basis to identify the services provided by a healthcare facility and has been introduced in multiple countries [15–17]. Lang *et al.* [18] highlighted how the use of such a tool may facilitate improvements in the quality and efficiency of healthcare services provided by reducing waste.

For each DRG, a number of descriptors were collected, such as the age and sex of the patient, the number of DRGs belonging to the DRG-544 classification (major joint replacement or reattachment of lower extremity) and the average DRG weight, which represents the ratio of the sum of DRG weight (DRG points) produced in the specific discipline of the evaluated hospital facility to the number of people discharged from the same facility.

Secondary Indicators

A series of indicators were collected that can be divided into four categories [19]:

- Indicators related to the management of beds and admissions such as the average number of surgical beds available, the bed occupancy index, the preoperative length of stay for all operations and the length of stay for DRG-544 cases known as major joint replacement or revision of lower extremity.
- Indicators related to the management of operating theatres such as theatre available hours, operating theatre occupancy (defined as the number of operations per 6-hour), the ratio of operating theatre hours used to available hours, and the Under-Utilisation (UU) indicator. Surgical activity is the central aspect of orthopaedic hospital treatment thereby making the management of operating theatre activity a central aspect of the organisational model.
- Indicators related to human resource management such as the number of healthcare staff (nurses and healthcare support workers) assigned and the number of total days of absence in relation to the number of workers assigned as proxy indicators of staff satisfaction. The DH model was also introduced with a view to qualifying healthcare personnel who were involved in the construction of the new care pathways.
- Clinical outcome indicators such as the number of readmissions at 30 days for patients undergoing hip replacement surgery, the mortality rate at 30 days for all in-patients, the number of elderly (over 65 years) fractures operated on within 48 hours of attending the emergency department,

Table 1. Organization of the facilities involved in the "Diffuse Hospital".

Hospital	Setting	Management of the healthcare professionals	Care pathways implemented	Emergency department	Management of operating theatres
A	General Hospital (100–300 beds)	Partially by RH	Reply RH	Present 20% of the surgery	Directly by RH
B	Specialty Hospital (<100 beds)	Directly by RH	Reply RH	Absent	Directly by RH
C	General Hospital (100–300 beds)	With other organization	Reply other organization	Present 40% of the surgery	By other organization

RH, Reference Hospital.

Table 2. DRGs and secondary outcome descripted for different hospitals.

	RH	A	B	C
DRGs, (n)	1603	1187	1851	866
Age, mean (SD) year	53.1 (21.1)	56.4 (19.6)	52.6 (22.9)	60.4 (22.6)
Female, n (%)	797 (49.7)	574 (48.4)	852 (46)	386 (44.6)
DRG weight index, (points/n)	1.43	1.48	1.62	1.42
DRG 544-major joint replacement or revision, n (%)	433 (27)	395 (33.3)	621 (33.5)	191 (22.1)
Management of beds				
Average n of beds, (n)	32	23	30	16
Bed occupancy index, (%)	72.8	59.1	55.7	97.5
Preoperative length of stay, mean (SD) day	1.2 (1.9)	0.7 (1.1)	1.0 (1.3)	2.0 (3.9)
Length of stay for joint replacement, mean (SD) day	7.9 (3.5)	8.0 (2.4)	5.5 (2.8)	12.2 (5.5)
Management of operating theatres				
Theatre available, hours (h)	2880	2646	3672	1974
Operating theatre occupancy, (n/h)	2.71	2.19	2.3	2.42
Operating theatre hours used, (%)	79	67	75	84
Under utilization index, (%)	6	9	4	10
Management of human resource (healthcare professionals)				
N healthcare worker, (n)	30	28	30	29
Absence per worker, (day)	20.4	11.7	13.7	22.1

DRGs, Diagnosis-Related Groups; RH, Reference Hospital; SD, Standard Deviation.

the percentage of correct antibiotic prophylaxis administration, the number of complaints and the number of falls and their incidence during the hospital stay out of all admissions. The functional recovery of hip and knee replacement patients five days after surgery was measured with the Iowa Level Of Assistance (ILOA) scale [20], which takes into account five functional items such as reaching a sitting position, standing vertically, walking, ascending and descending stairs and walking speed. Levels of assistance were assessed on the basis of the patient's autonomy and the aid used. The scale ranges from 0 to 50 where lower scores indicate a higher level of autonomy.

Sample Size and Statistical Analysis

Given the descriptive observational nature and the organisational type of study, no sample calculation was performed, but all DRGs performed consecutively during the study period for which a hospitalisation was planned were taken into account. Descriptive analysis of the indicators was performed. Data of a continuous nature were reported as mean and while dichotomous data were reported as absolute frequency and/or a percentage. To enable a comparison between the different facilities involved in relation to the available resources, some DRG indicators were calculated in accordance with [21] and using the value of the DRG points as a numerator:

- DRGs weighted by beds: DRG points/average number of beds.
- DRGs weighted by theatre hours: DRG points/operating theatre hours.
- DRGs weighted by healthcare staff: DRG points/number of staff.

Results

The total number of DRGs provided by the DH was 3904, broken down into 1187 at Hospital A, 1851 at Hospital B and 866 at Hospital C. The average age of the patients was 55.5 years and 46.4% were female. The RH comparison standard recorded 1603 DRGs with an average age of 53.1 years and 49.7% female.

Table 1 summarises the main differences between the facilities involved. Hospital B was the facility with the most

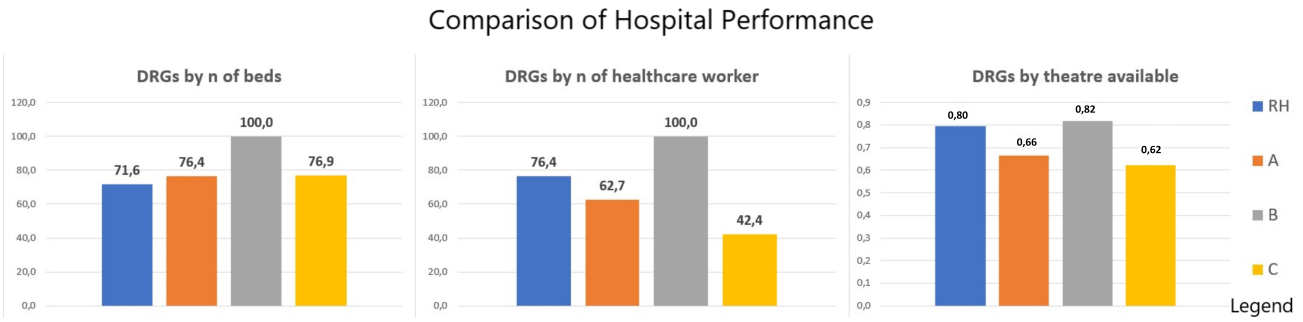

Fig. 1. Comparison of hospital performance. DRG reported by n of beds, n of healthcare workers and by theatre available.

Table 3. Comparison between the Reference Hospital and the hospitals involved in the "Diffuse Hospital" model.

DRGs indicators	RH	A		B		C	
	Standard		% Change		% Change		% Change
By n of beds	71.6	76.4	+6.7%	100.0	+39.7%	76.9	+7.4%
By theatre available	0.80	0.66	–17.5%	0.82	+2.5%	0.62	–22.5%
By n of healthcare worker	76.4	62.7	–17.9%	100.0	+30.9%	42.4	–44.5%

RH, Reference Hospital.

closely linked organisation and was dependent on the RH, which had the possibility of directly managing the healthcare personnel and operating theatres. Conversely, Hospital C independently managed care pathways that were different from those of the RH. Finally, Hospital A had an intermediate management between the aforementioned ones with partial control by the RH but with replication of the care pathways (Table 1).

Table 2 describes the indicators taken into account in relation to the management of beds, operating theatres and healthcare staff.

DRGs Indicators

Comparing the efficiency of individual centres through the calculation of DRGs indicators and considering the RH centre indicators as the standard showed some differences between the hospitals (Table 3). For the DRG weighted by beds, theatre activity and healthcare staff, Hospital B showed higher scores of 39.7, 2.5 and 30.9 percentage points, respectively, than the RH. The DRG weighted by the number of surgical beds showed similar values between Hospitals A and C and both were above the standard by 6.7 and 7.4 percentage points. Conversely, in relation to theatre activities and healthcare staff, Hospitals A and C revealed lower scores than the standard respectively by 17.5 and 17.9 percentage points for Hospital A and 22.5 and 44.5 for Hospital C (Fig. 1).

Clinical Outcomes

Evaluation of the clinical outcomes showed that different data were not available at Hospital B and C, making comparison more difficult (Table 4). Hospital C showed a percentage of femur fracture patients operated on within 48 hours of 44%, 32 percentage points below the standard. Antibiotic prophylaxis was performed correctly with rates above 90% in all hospitals (Except for Hospital C) with a maximum value of 98% in the RH. The number of falls ranged from 0.8 to 1 per cent in Hospital A and B, both scores were below the RH. The clinical outcome of joint replacement patients was better at Hospital A with a lower ILOA score than the reference score of 4.6 and 4.7 points for hip and knee replacements, respectively.

Discussion

The DH created a new organisational model which, to the authors' knowledge, was studied for the first time in this study. The distance between an individual's home and the hospital in which they are to be treated is one of the main criteria guiding the choice of patients [22,23]. At the same time, in orthopaedic surgery, having high surgical volumes is a factor that is associated with better patient outcomes [24]. The aim of the "Ospedale Diffuso" was precisely to facilitate patient access to highly specialised care by spreading facilities capable of replicating high standards of treatment throughout Italy. Data from the analysis of this model show that the replication of treatment standards must be carefully monitored.

The facilities involved in the DH model implemented different management models for beds, operating theatres and staff, resulting in different efficiency performances. In absolute terms, Hospital B had a higher production than the standard while Hospital A and C had a lower production, and this was most clearly seen when considering the value of DRGs produced in relation to their average weight. Hospital B in fact not only had a higher production of admissions, in absolute terms, but also a higher average weight of

Table 4. Clinical outcome descripted for different hospitals.

	RH	A	B	C
N of death within 30 days of admission, (n)	1	0	1	5
N of readmissions at 30 days for joint replacement, n (%)	0	2 (2)	NA	1 (1.9)
N of elderly fractures operated on within 48 hours, n (%)	39 (76)	7 (88)	NA	28 (44)
Correct antibiotic prophylaxis, (%)	98	90	94	NA
N of fall, (%)	1.3	0.8	1.0	NA
Percentage of falls in hospital, (%)	1.3	0.8	1.0	NA
Complaints, n (%)	14 (0.9)	2 (0.2)	11 (0.6)	1 (0.1)
ILOA score hip replacement, mean (SD)	21.4 (9.1)	16.8 (7)	20.3 (5.8)	NA
ILOA score knee replacement, mean (SD)	23.5 (10.7)	18.8 (8.3)	22.0 (5.9)	NA

RH, Reference Hospital; ILOA, Iowa Level Of Assistance; SD, Standard Deviation; NA, Not Available.

DRGs than the other hospitals.

The varied efficiency of the hospitals was seen in relation to the calculation of discharges weighted by beds, operating theatre activity and healthcare staff. In relation to beds, it can be observed that all the hospitals involved have values in line with or above the standard. The situation is different in relation to theatre hours and available healthcare staff where, for Hospital A and C, the two indicators proved to be below the standard. It could be hypothesised that these two hospitals could improve their performance through better management of available beds while keeping staffing and operating theatre hours unchanged. With regard to bed management for Hospital C, the longer average length of stay and a higher occupancy rate should be taken into account. These aspects could be the result of a greater difficulty in organising appropriate care pathways after hospital discharge for users of an older average age. An improvement in patient turnover at Hospital C may have a beneficial effect in recovering useful beds to increase the number of discharges. In general, at Hospital C, where the healthcare staff did not have a direct relationship with the RH and the care pathways did not replicate the reference model, the greatest differences to the standard were evident. A prolonged observation period over time may provide a clearer and more consolidated picture of the aspects that emerged in this first analysis. In addition, aspects related to the level of competence of the healthcare personnel or the financial resources used in each facility are elements that could provide a further key to understanding the different performances recorded. These elements should be taken into account in the planning of future studies. From the point of view of discharge performance, Hospital B was seen as the model with the best indicators. A reduced average hospital stay and a good operating theatre occupancy with an Under-Utilisation Index of 4% reflect the high patient turnover capacity. The absence of emergency surgical activity, the organisation of the theatre managed directly by the RH, and surgical activity concentrated during the week with a planned reduction at weekends, are elements that can explain the better performance of this facility.

Although the weighted efficiency for the RH healthcare staff is high, this figure should be considered in the light of the days of absence per staff member being the highest among the facilities analysed. Absence from work due to illness is recognised by several authors as a factor that is associated with reduced job satisfaction, increased workload and risk of burnout [25–27]. Rauhala *et al*. [28] reported absence values per staff member per year of 27.9 days for the group of nurses where the workload was 30% higher than the optimal load. In two hospitals, RH and Hospital C, the values of absence days were higher than 20, while in Hospitals A and B, the value was lower with values of 11.7 and 13.7. Hospital B had an organisation with a planned reduction in weekend activities which may, in part, explain this result, while in Hospital A, the number of healthcare staff in relation to available beds may have facilitated a more adequate workload. In Hospital C, the non-direct management of staff by the RH makes it difficult to analyse this result.

Analysing the clinical outcomes, the National Outcomes Plan of 2023 [29] reported a readmission rate of 3.6% for individuals undergoing hip replacement in the year 2022 and a rate of femur fractures operated within 48 hours of 50.6%. Lundine *et al*. [30] reported a 93% rate of antibiotic prophylaxis performed correctly according to dose and timing in a trauma centre. The data reported by all the facilities involved in the DH were in line with these clinical outcomes. The lack of the percentage of surgery within 48 hours and readmission after hip replacement for Hospital B and the lack of the percentage of antibiotic prophylaxis for Hospital C does not allow a full comparison with these facilities.

Within the facilities involved in the DH, however, differences in outcomes were seen. The hospital mortality, the number of readmissions and the percentages of patients with femur fracture operated within 48 hours were poorer for Hospital C. The lack of direct management of care pathways and operating theatre activity offer food for thought on the difficulties in replicating the standard set by the reference facility.

The functional recovery recorded for hip and knee replacement patients measured using the ILOA scale was optimal in Hospital A, which had a score more than 4 points below the standard and the values of which were in line with the data presented in the literature [20].
The results of this study may also be a useful starting point for other clinical contexts. The DH model may become a useful organisational model to spread high standards of specialist treatment throughout Italy, not only in the orthopaedic field but potentially in other disciplines as well. The necessary requisite to obtain good results is the possibility for the hospitals involved to replicate as closely as possible the care pathway of the RH.

Study Limitations

Firstly, the evaluation of indicators needs a prolonged observation period, the indicators need a longer observation time in order to verify their stability. In addition, the evaluation of clinical outcomes has some deficiencies. In particular, Hospital B and C did not have some indicators available, which were relevant for the comparison between the different facilities both within the DH and on a national basis. Finally, no patient satisfaction indicators were taken into account in the study. For the planning of future studies in this field and the comparison of hospital performance, it is therefore essential to have extended observation times and the standardisation of the indicators also in the way they are collected and used.

Conclusions

The DH model may become a useful tool in healthcare policy strategies to enable national RHs to deliver treatments with high standards of care through existing hospitals reaching a wider audience. Future studies must precisely be aimed at understanding the impact of this organisational model throughout Italy in terms of improving the care provided and citizen satisfaction.
The facilities involved in the DH organisational model produced different outcomes in terms of both efficiency and clinical outcomes. Where there is no direct management by the RH of healthcare staff, care pathways and operating theatres, replication of the standard is more difficult and outcomes are poorer. The more freedom the RH has to manage the available resources and organise them independently, the better the indicators. Furthermore, in the hospital where there is no need for emergency surgical activity and scheduling is concentrated within the week, better efficiency levels can be achieved. The improvement of performance indicators must however take into account the satisfaction and workload of the healthcare staff involved, which must be carefully monitored.

Availability of Data and Materials

The data that support the findings of this study are available from the corresponding author upon reasonable request.

Author Contributions

CF, AM, VD, EB, AC designed the research study; GC, EB, MDC, EC, MB, MT, GP collected the data; MM, CF, GC analyzed the data; AM, VD, AC supervised the project; AM, VD, EB, GC, MDC, EC, MB, MT, GP contributed to the interpretation of the results and MM and CF wrote the manuscript. All authors contributed to important editorial changes in the manuscript. All authors read and approved the final manuscript. All authors have participated sufficiently in the work and agreed to be accountable for all aspects of the work.

Ethics Approval and Consent to Participate

The study was approved by the Ethics Committee of Central Emilia (Area Vasta Emilia Centro) under protocol no. CE-AVEC 506/2023/Oss/IOR and was conducted in accordance with the Declaration of Helsinki. Given the nature of the of the study and the use of data in aggregate form, informed consent was exempted by Ethics Committe.

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Conflict of Interest

The authors declare no conflict of interest.

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