Public Health in Practice 2 (2021) 100174

Contents lists available at ScienceDirect

Public Health in Practice

journal homepage: www.sciencedirect.com/journal/public-health-in-practice

The impact of hospital support function centralization on patient outcomes: A before-after study

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ARTICLE INFO

Keywords:
Health policy
Organization of health services
Quality in health care

ABSTRACT

Objectives: This study aimed to evaluate the impact of centralizing hospital support functions such as administration, quality monitoring, procurement, and insurance on patient outcomes in a French regional hospital group.
Study design: A before-after study was conducted within a medium-sized hospital in a rural region of France including 87,373 hospital stays between 2013 and 2017.
Methods: The intervention tested was the centralization of support functions: administration, quality monitoring, procurement, and insurance. The outcomes analyzed were patient mortality, 30 day readmissions and average length of stay.
Results: The odds ratio (OR) for patient mortality after centralization was 0.99 (95%CI, 0.92 to 1.06), and 0.94 (95%CI, 0.90 to 0.96) for readmissions. The multiplicative factor for average length of stay was 0.93 (95%CI 0.92–0.94).
Conclusions: There was an increase in measured quality of care after the intervention. This study highlights the complexity of assessing the impact of hospital-level centralization on quality-of-care indicators.

1. Introduction

The costs associated with healthcare are growing in most developed countries. Hospitals are striving to reduce these costs whilst maintaining safety and the quality of care. Multiple approaches have been proposed to make healthcare more efficient [1,2]. In 2016, France chose to introduce a form of centralization in its healthcare system by requiring all public health institutions to be part of a Regional Hospital Group (RHG) by July 2017. A RHG is a consortium of hospitals in the same geographical area that join forces in a contract-based program in order to coordinate their actions, centralize support services (administration, quality control, and procurement) and form a common strategy to care for all the patients in their region. One hospital in the group is named the leader and this leader hospital, which is usually a university teaching hospital or the largest hospital in the group, provides centralized support functions. One of the primary aims of this policy was to centralize these functions with the leader providing services for the whole group. The other hospitals in the group which are called "peripherals" are often smaller and must coordinate their delivery of healthcare with the support services provided by the leader. The goals of this organizational change were to provide proportional and egalitarian healthcare delivery in a specific geographical area, to meet healthcare demands whilst considering local specificities, and to reduce the cost of care by optimizing resource use. Similar centralization efforts were undertaken in the United States during the first decade of 2000 [1] and in other European countries such as Denmark around 2007 [2,3] when centralization was mandated nationwide.

These organizational changes are causing important shifts in priorities as well as management, and the impact on the patients is difficult to predict. Centralization generally leads to staffing changes in the clinical departments that deliver care and usually results in a reduction in personnel. Unfortunately, the staff often perceives these policies as being unilaterally imposed on them by management, which could lead to decline in performance and quality of care [4].

Despite human resource management having a central impact on patient outcomes, it is often overlooked during policy evaluations when significant structural changes are being implemented [5,6]. A recent review of the literature raised a question about the role of governance on patient outcomes [7]. Resource management and procurement activity centralization may have a noticeable impact on quality of care.

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https://doi.org/10.1016/j.puhip.2021.100174
Received 21 April 2021; Received in revised form 14 July 2021; Accepted 26 July 2021
Available online 6 August 2021

Moreover, quality control and medical information departments perform tasks such as the verification of patient identities, oversee adverse event reporting and accreditation procedures. Therefore, centralization leads to shared activities in domains that were previously specific within each individual hospital. Quality of care can be assessed by analyzing healthcare structures, processes or outcomes [8]. Mortality has traditionally been an outcome of prime interest, due to its reliability and widespread use in clinical trials [9]. Length of stay and readmissions have been used to assess the efficiency of healthcare because of their direct impact on healthcare costs [10] and patient satisfaction. The 30-day threshold for readmissions is used in Denmark, England and the United States [11].

This study sought to assess the impact of the centralization of support functions in a French regional hospital group on three common indicators of patient outcome, namely patient mortality, 30-day readmissions and Average Length of Stay (ALOS).

2. Methods

2.1. Study design

This retrospective study assessed patient outcomes in the leader hospital of a RHG situated in the eastern region of France that transitioned to the mandatory centralization of its support functions in June 2015. The hospital conducting the study (Troyes Hospital) was the delegated "leader" hospital of the group and had a management team common to all the hospitals in the group. It had responsibility for the centralization of quality of care, hygiene, management of adverse events, medical information management, purchasing, human resources, and overall governance. The hospitals in the group also implemented a medical on-call system whereas a physician on call in the leader hospital provided support for the other hospitals in the group.

This study used a before and after design to compare the differences of patient outcomes before and after the organizational change. Data was collected from 2013 to 2017.

Data from another hospital in the same RHG was considered to perform a difference-in-differences model to account for temporal trends however the parallel trend assumption was not possible using the data gathered from the control hospital (Supplementary Material) which precluded the use of this approach. Therefore, two 2-year periods for the before and after analyses (in the years 2013 and 2014 being the before period, and years 2016 and 2017 being the after period) were considered. The year 2015 was elected as a transition period. The sample size was determined by the number of patients who visited the hospital during the study period.

The hospital that provided the data for this analysis was the leader hospital of the RHG for the Aube and Sézannais in the eastern region of France. It is worth noting that it is one out of 136 currently constituted RHGs in France. All adults aged 18 years or older who were admitted to an acute department for at least one night between January 2013 and December 2017 were identified. To preserve the homogeneity of the sample, patients admitted for iterative care, such as chemotherapy, radiotherapy or hemodialysis were not included.

2.2. Patients and public involvement

The patients and public were not involved in the design, conducting, reporting, or dissemination of the research plans.

2.3. Data sources

Hospital level information regarding staffing and human resources was obtained from the French national hospital statistics database which is an open database of aggregated information pertaining to healthcare facilities. Patient level data was obtained from the hospital's medical information database. Although usually compiled for billing purposes, medical information data contains standardized discharge reports for each hospitalization as well as unique patient identifiers.

2.4. Outcomes and covariates

This study aimed to evaluate the impact of a change in organizational structure (namely the move towards centralization of support services) on patient outcomes to obtain insight into quality of care and overall performance. Therefore, a focus on in-hospital patient mortality from all causes [12,13], average lengths of stay (ALOS) [13–16] and 30-day readmission for any reason was chosen [13–15,17,18]. Patient mortality and ALOS data were available in the standardized discharge reports and 30-day readmission information was identified using the patient identification number combined with entry and discharge dates.

Several additional variables were also studied for explanatory purposes or to account for confounding. The number of Full-Time Equivalent employees (FTE) per year was recorded using the data provided in the national statistics database. This indicator is comprised of three parts: non-medical caregiving personnel (nurses, nurses' aides), medical personnel (qualified physicians) and residents (the study hospital is a teaching hospital). The number of available beds per year was also extracted from this data. From the anonymous patient discharge reports, the following variables were analyzed: age and sex of the patient, primary and secondary diagnoses (coded according to the International Classification of Diseases, 10th revision (ICD-10)) and the Charlson Comorbidity Index from ICD-10 diagnoses [19] was calculated. Finally, the Diagnosis-Related Group (DRG) for each stay was recorded. DRG's regroup hospital stays into homogenous groups for billing purposes by associating a standardized fixed cost with each type of stay from admission to discharge, instead of reimbursing actual itemized costs. From the DRG's, the Main Diagnostic Category (a 26-class categorisation of the types of hospital stays), the DRG definition of the severity of the stay and whether surgery was or was not performed during the stay were extracted.

2.5. Statistical analysis

Population and hospital characteristics for each period were summarized using means and standard deviations for quantitative variables, or percentages for categorical variables. Yearly trends in outcomes were assessed and then plotted against year-on-year changes in FTE's, the number of stays and the number of beds. All the plotted variables were centered and scaled in order to yield graphical presentations that are intuitively interpretable representing how each variable changed with respect to the others.

To assess whether the centralization of support functions had an impact on outcomes in the second period compared to the first, patient mortality and 30-day readmissions using a logistic regression model were conceptualized. Additionally, a Gamma regression with a log link for ALOS to account for any rightwards skewing in this type of data was applied [20]. Gamma regression is a generalized linear model (GLM) useful for the analysis of right-skewed positive random variables. It has been shown to have adequate performance in modelling length of stay [21]. The candidate covariates for adjustment were patient characteristics (sex, age, Charlson Comorbidity Index, surgery/no surgery, severity as derived from DRG's and the Main Diagnostic Category) and human resources (yearly number of FTE's for hospital resident doctors, medical and non-medical caregiving personnel). For continuous covariates (age, Charlson Comorbidity Index and DRG-derived severity), polynomials up to the third degree (squared and cubed covariates) were used to account for non-linear relationships. A bidirectional stepwise procedure using the Bayesian Information Criterion [22] for the main analyses was employed to select the most parsimonious models. The bidirectional stepwise selection procedure consists of removing and adding covariates until the model with minimal BIC is found.

2.6. Sensitivity analysis

To assess the robustness of the results, several sensitivity analyses were performed. Models using all the candidate covariates without the stepwise procedure were tailored and a model that adjusted for human resources only was constructed followed by another model that only adjusted for patient characteristics.

3. Software

Analyses were performed using R version 3.5 (www.r-project.org).

4. Results

4.1. Population and hospital characteristics

A total of 101,987 stays matching the inclusion criteria from 2013 to 2017 were extracted. Among these, 87,373 were used for this before-after analysis (Fig. 1).

4.2. Descriptive analysis

Trends in the outcomes of interest and in hospital characteristics are presented in Fig. 2. The vertical line represents the year when the centralization of support functions occurred in the hospital under study. This figure uses data from the "All Year Set" (before exclusion of the year 2015) totaling 101,987 stays. After 2015, there was a reduction in the number of available beds and an increase in the number of stays concomitant with a reduction in the ALOS. However, this trend saw a reversal after 2016 with a reduction in the number of stays and an increase in the ALOS. No obvious visual relationships between human resource variables and outcomes can be identified on this graph.

4.3. Before-after models

The stepwise procedure performed for the before and after models at the leader hospital did not retain human resource variables such as covariates in the final models for all three outcomes. The sex variable and the third polynomial degree on the Charlson Comorbidity Index variable were also dropped in the mortality model.

The odds ratio (OR) for patient mortality (before centralization being the reference period) was 0.99 (95 % CI 0.92–1.06) and 0.94 (95 % CI 0.90–0.96) for readmissions. The multiplicative factor for ALOS was 0.93 (95 % CI 0.92–0.94).

In sensitivity analyses, the sex covariate and the third-degree polynomial for the Charlson Comorbidity Index variable in the mortality model were maintained which led the OR to decrease to 0.88 (95 % CI 0.82–0.94). When fitted, the models with adjustment on human resource covariates showed only that the confidence interval widened substantially. For example, the width of the 95 % CI increased to 0.5 for patient mortality versus 0.14 in the main analysis. Readmissions increased to 0.4 versus 0.07 in the main analysis and for ALOS, and an increase to 0.2 was seen compared to 0.02 in the main analysis. This widening of the 95%CIs occurred irrespective of an adjustment for patient characteristics. These results are presented in Table 3.

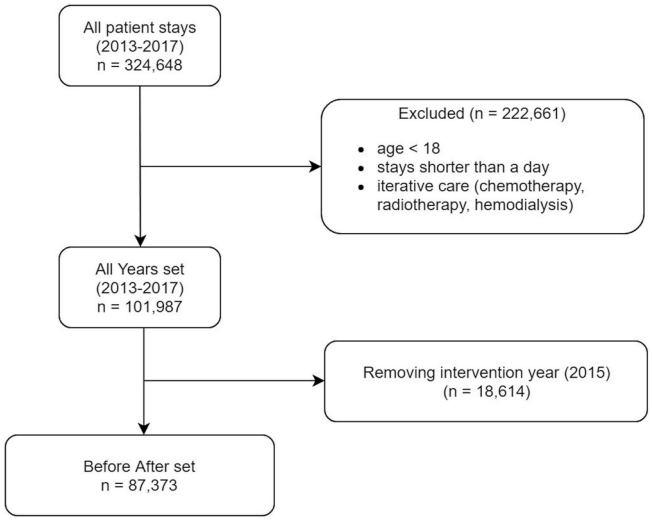

Fig. 1. Flow chart.
The patient and hospital level characteristics of the population are presented in Table 1.

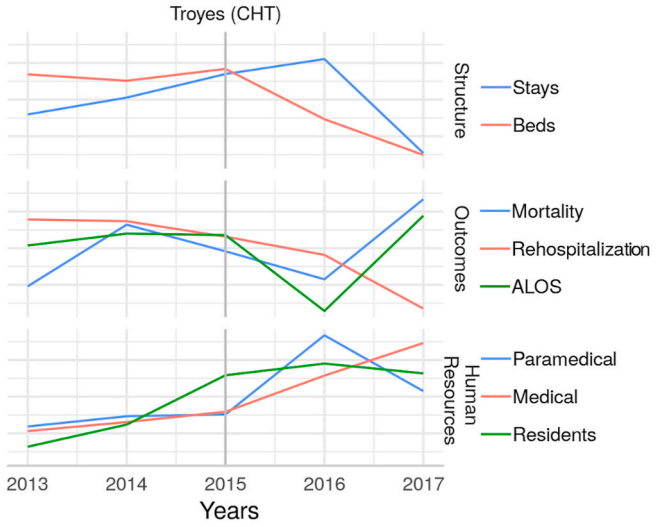

Fig. 2. Trends in patient outcomes and structural characteristics of a hospital
Table 2 displays the outcomes for each two-year period and the unadjusted before-after estimation.

5. Discussion

This study aimed to assess the impact of organizational

Table 1
Patient and hospital characteristics for the before-after study on the impact of hospital support function centralization.

	Before	After	Total
	N = 43,687	N = 43,686	N = 87,373
Patient characteristics			
DRG severity: mean (SD)	1.60 (0.89)	1.67 (0.93)	1.64 (0.91)
Age: mean (SD)	59.53 (21.82)	60.71 (21.56)	60.12 (21.70)
Charlson Comorbidity Index: mean (SD)	1.23 (1.79)	1.18 (1.77)	1.21 (1.78)
Surgery (%)	8598 (19.7)	9069 (20.8)	17,667 (20.2)
Male (%)	19,959 (45.7)	19,833 (45.4)	39,792 (45.5)
Universal health coverage plan patients (%)	2752 (6.3)	2770 (6.3)	5522 (6.3)
Hospital characteristics			
Beds	568.5	503.5	535
Residents (per bed)	81.5 (0.143)	83 (0.165)	82.2 (0.154)
Medical average full-time equivalents per bed	183.7 (0.323)	196.2 (0.390)	189.9 (0.355)
Paramedical average full-time equivalents per bed	1295.5 (2.28)	1239.5 (2.46)	1267.2 (2.37)

SD: Standard Deviation.

Table 2
Analysis of the outcomes during the before-after periods.

	Before	After	Difference
ALOS: mean (SD)	6.74 (8.76)	6.66 (8.45)	−0.08a
Mortality (%)	1966 (4.5)	1992 (4.6)	1.02 b
Readmission (%)	6062 (13.9)	5387 (12.3)	0.88 b

SD: Standard Deviation.

Table 3
Before-after model results.

Final models		
Models	Parameters	95 % CI
Mortality	0.988	(0.921–1.06)
Readmissions	0.935	(0.897–0.975)
ALOS	0.932	(0.921–0.943)
Adjusted for patient characteristics only		
Models	Parameters[a]	95 % CI
Mortality	0.879	(0.819–0.944)
Readmissions	0.935	(0.897–0.975)
ALOS	0.932	(0.921–0.943)
Adjusted for human resources centralization only		
Models	Parameters[a]	95 % CI
Mortality	0.765	(0.546–1.074)
Readmissions	0.953	(0.773–1.175)
ALOS	0.921	(0.841–1.008)
Adjusted for patient characteristics and human resource centralization		
Models	Parameters[a]	95 % CI
Mortality	0.822	(0.568–1.192)
Readmissions	0.974	(0.782–1.214)
ALOS	0.990	(0.931–1.054)

Multiplicative factor for ALOS.
ALOS: Average Length of Stay - CI: Confidence Interval.
[a] Odds Ratio for mortality and readmissions.

centralization whereby support functions for several hospitals, especially human resource management, are grouped together in a leader hospital. A reduction of 30-day readmissions in the leader hospital after centralization was observed with an OR of 0.94 (95 % CI 0.90–0.96) as well as a reduction in the ALOS (0.93, (95 % CI 0.92–0.94)). The change in mortality was not significant. These analyses were not adjusted for human resource variables since they diminished the quality of the models as evaluated by the BIC [22].

A Canadian study found a decrease in mortality rates from 12.6 % in 2006 to 9.9 % in 2010 following the reorganization of 9 health regions in Alberta into 1 province-wide provider organization consisting of 5 geographic zones. This reorganization, however, was accompanied by an increase in the number of stroke centers from 5 to 16 [23]. A large study based on Medicare claims did not show any significant change in 30-day readmission rates (−0.10 %; 95 % CI −0.53 to 0.34; p = 0.72) or in 30-day mortality (−0.03 %; 95 % CI, −0.20 to 0.14; p = 0.72) between hospitals merging in a health system and control hospitals [24].

Organizational changes are sometimes accompanied by increased referral to high-volume hospitals, which in turn has been linked to a decreased risk of long stays after surgery (risk estimates of 0.454 ± 0.151 vs 0.506 ± 0.139 for hospitals in the highest and lowest volume quartiles of lung cancer surgery volume respectively) [25].

Evaluating the effect of centralization is a recurrent topic in quality of care literature [2,4,26,27]. However, studies have mostly focused on the centralization of a single department or in the gathering of resources for a specific process of care. In this study, the hospital-wide impact of a centralization policy on common patient outcomes was evaluated.

There are, notwithstanding, some limitations to this study. First, data on hospital stays is produced with the primary purpose of billing the national health care system. As a result, the data coding process is influenced by financial concerns and not epidemiological accuracy. An adjustment for the major diagnostic categories aimed to balance the two periods based on the assumption that similar patients would be coded in a similar way during both periods, yet some coding disparity cannot be completely ruled out [28]. Information created mainly for billing purposes is often used for epidemiological studies and even though it can provide useful insights with the right methodology, it is believed that for transversal policies such as centralization of support services, data created specifically for the purpose of quality evaluation is preferable. The analysis was limited to a single center (before and after study). Furthermore, despite the widespread use of patient mortality rates, ALOS and readmission data as outcomes [29], there is a substantial body of literature highlighting their inadequacy in assessing quality of care [30–33]. Unfortunately, there is no perfect indicator that can adequately capture all the dimensions of quality of care. Finally, although a large number of stays were contained in the dataset, detailed information on human resource allocation was not available especially in departments in which staff numbers declined or increased. Similarly, a more detailed temporal breakdown was also unavailable since the national hospital statistics only provide aggregated yearly data. This precluded any inference of a direct effect of human resource management on patient outcomes in the leader hospital. In terms of human resource variables, even if they were not retained in the final models, a connection between staffing parameters and outcomes is expected. Previous studies have shown that human resources are a key component in the success of policy changes [5,6]. In addition, Troyes Hospital is situated in a geographical area where recruitment can be challenging. As previously described, low turnover and a high staff-to-patient ratio are important factors in attracting and retaining potential employees [34]. Unfortunately, efforts to contain healthcare costs frequently involve cutbacks in staff, and a substantial fluctuation in personnel over the study period was observed. Nevertheless, it is probable that more detailed information regarding where and/or how human resources were allocated would help inform hospital management and policymakers in their quest to attain cost-effectiveness goals.

6. Conclusions

An impact of the centralization of hospital support functions on both readmissions and ALOS was observed in this before-after study conducted in a rural setting. An improvement in patient outcomes of this magnitude could occur in other hospitals since RHGs are destined to be omnipresent in France in the coming years. Nonetheless, the specific conditions in which comparable increases in quality of care are likely to occur need to be ascertained in further studies.

Funding

This research received no specific grant from any funding agency in the public, commercial or not-for-profit sectors.

Author contributions

Data management and statistical analysis were realized by ALG. SS and ALG designed the study. JC revised the manuscript for critical intellectual content. All authors have approved the final manuscript and agree to be accountable for all aspects of the work.

Competing interests statement

The authors declare that they have no competing interests.

Funding

This research did not receive any specific grant from funding agencies in the public, commercial or not-for-profit sectors.

Acknowledgements

The authors would like to thank Sarina Yaghobian (AcaciaTools) and Marie-Anne Le Guillou for proofreading this article.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.puhip.2021.100174.

Ethics approval and consent to participate

All legal conditions for epidemiological surveys were respected and the French national commission governing the application of data privacy laws ("Commission Nationale Informatique et Libertés") approved the project. Since the study was strictly observational and used anonymous data in accordance with French legislation relating to non-interventional clinical research namely articles L.1121–1 and R.1121–2 of the Public Health Code, written informed consent from the participants was not required, nor was authorisation from any other ethics committee for this survey.

Consent for publication

Not Applicable.

Data availability statement

The data for human resources can be found through the SAE website (in French): https://www.sae-diffusion.sante.gouv.fr/sae-diffusion. Patient-level information, even though anonymous, cannot be published.

Competing interests statement

The authors declare that they have no competing interests.

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