



# Congestion analysis to evaluate the efficiency and appropriateness of hospitals in Sicily



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## ARTICLE INFO

### Article history:

Received 29 November 2013

Received in revised form

10 December 2014

Accepted 14 December 2014

### Keywords:

Efficiency

Appropriateness

Data envelopment analysis

Output-congestion

Undesirable outputs

## ABSTRACT

Over the past twenty years, important changes in the Italian National Health System have been made in order to obtain significant improvements in the efficiency, appropriateness and quality of health care delivery, while reducing health expenditure. In this paper we proposed a multidimensional approach to assess the impact of organization inappropriateness on the efficiency evaluation of hospitals in Sicily for the year 2009. This study was based on cross-sectional data for 116 (out of 129) short-term, acute-care hospitals. The analysis considered beds, physicians, nurses and other personnel as inputs, ordinary discharges and day-hospital admissions as desirable outputs and inappropriate discharges and day-hospitals as undesirable outputs of the health care process. We refer to *output-congestion* to measure the loss of desirable outcome, which is related to the simultaneous occurrence of inappropriateness. The main findings of our analysis indicate that most of the measured overall inefficiency of Sicilian hospitals could be attributed to congestion and pure technical inefficiency and that congestion was statistically different among hospital trusts, local public hospitals and for-profit hospitals and along the provinces. In Sicily, significant shares of inputs are still employed to supply inappropriate care, with the effect of producing less desirable health care outcomes than expected.

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## 1. Introduction

In the last two decades, in Italy, the National Health System (NHS) has undergone a profound reform process aimed at obtaining a significant improvement in the efficiency, appropriateness and quality of health care delivery and simultaneously a reduction in health expenditure. Hospital care is responsible for most of the resources employed in the health care sector. In order to rationalize the usage of resources, the reform defining the so-called essential levels of care (LEAs) (LEA Decree, dated 29 November 2001) established that each year the NHS must define the categories of

services to be delivered at hospital level, which must be available to all citizens. The NHS entrusts more complex cases to hospital trusts (HTs), leaving low-intensity medical care to local health authorities (LHAs). Of note, HTs are highly specialized hospitals, with regional relevance, bearing full responsibility for their own budgets, management and technical functioning. LHAs are legal public bodies that have organizational, administrative, fiscal, financial, managerial and technical independence, which organize and provide healthcare services within their territorial areas through local public hospitals (LPHs) and accredited private structures (For-profits). The interested reader can see [1] for a more extensive description of the Italian NHS.

The most important criterion for the LEAs' choice is its appropriateness, together with efficiency, human dignity and effectiveness [2]. In Sicily, the regional government has

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posed itself the additional objective of guaranteeing the proper provision of LEAs and ensuring the appropriateness of all phases of hospital care delivery, from admittance, to care and discharge.

To define appropriateness, a useful starting point is the RAND Corporation definition, whereby care is appropriate when the expected health benefit exceeds the expected negative consequences by a sufficiently wide margin that the procedure is worth doing [3,4]. Effective hospital care can be defined as appropriate based on two different dimensions: *clinical* – if it is delivered to patients who may actually benefit from care for their clinical condition, and *organizational* – if it is adequately and consistently organized, taking into consideration the amount of resources used, the complexity of the intervention and the clinical characteristics of the patient [5]. The Italian NHS defines inappropriateness as providing services which are deemed to deviate from the healthcare provision (not recognized within the LEAs) and for which an alternative care setting is required from the norm.

To assess quality in health care delivery, a multidimensional approach should include appropriateness indicators as quality measures in technical efficiency evaluation. Technical efficiency describes the ability of operating units to transform their inputs into outputs, such that when an operating unit is technically efficient, it works on its production frontier [6]. Measures of technical efficiency can be obtained through the non-parametric Data Envelopment Analysis (DEA) [7,8]. In classical DEA analysis, it is generally assumed that decreases/increases in one or more inputs are associated to decreases/increases in the outputs and that decreases/increases in one output are associated to the inverse change in another output. When the first assumption is not true, there is *input-congestion*; if the second one is not true, it is the case of *output-congestion*. In particular, the concept of *output-congestion* regards the loss of desirable output, which is related to the simultaneous occurrence of undesirable outputs [9]. In Health, either indicators of organizational inappropriateness or adverse patient care outcomes are undesirable outputs, which are jointly produced together with medical and surgical discharges (desirable outputs).

The aim of this paper is to assess the impact of organization inappropriateness on the efficiency evaluation of hospitals in Sicily for the year 2009, through output-congestion analysis. After a brief literature review on the topic, we describe the data and the methodology used. We then proceed with the results and a discussion of the implications of our findings for providers and policy makers.

## 2. Literature review

There are several studies aimed at incorporating quality aspects in the statistical evaluation of hospital efficiency. Quality in health care can refer to the employed inputs, such as qualified personnel and high standard capital, to the process implemented, consisting of efficient and effective treatments, and to the outcome, measured as inpatient mortality rates adjusted for age, morbidity rates or readmissions [10].

Most of the studies on this topic used regression-type techniques and just focused on a single quality measure. Picone et al. [11] estimated a quasi-maximum-likelihood discrete factor model on data on elderly persons, finding that higher intensity of hospital care improved patient survival and functional status among those who survived, while longer inpatient length of stay did not. Deily and McKey [12] included inefficiency scores in a regression model of the in-hospital mortality rates, controlling for predicted risk-adjusted mortality, using data from Florida hospitals over the period 1999–2001. Cellini et al. [13] used the number of patients discharged alive as the desirable outcome, proxy for quality of care delivered by hospitals. They compared the efficiency scores estimated from four alternative DEA models, on data drawn from the official records of a sample of 1183 Italian hospitals, over a total of 1789, for the year 1996. Focusing on a specific diagnostic category, Francese et al. [14] exploited the significant regional variation in the share of caesarean deliveries in Italy to explore the impact on inappropriateness of three groups of policy variables.

In the last decade, the effects of output-congestion in health delivery systems have been considered to investigate the relationship between hospital technical efficiency and undesirable quality of patient outcomes. Ferrier et al. [15] performed output-congestion analysis on cross-sectional data for 170 Pennsylvania hospitals in 2002, to investigate how uncompensated care affects hospitals' ability to provide the services for which they do receive compensation. Valdmanis et al. [16] performed output-congestion and slack analyses on data of 1377 urban U.S. hospitals, using risk-adjusted patient safety indicators as undesirable outcomes of hospital care. Clement et al. [17] used output-congestion analysis on data drawn from patient-level discharge and hospital-level organizational data from 10 U.S. states in 2000. More recently, Simões and Marques [18] performed the input-congestion analysis of 68 Portuguese hospitals, in order to study the output decline which is associated with the increase of inputs. They measured the congestion effect by using three alternative methods.

Most of the Italian literature about hospital efficiency is aimed at comparing technical efficiency at a regional level, and Sicilian hospitals as a whole have been shown to be inefficient compared to other regions [19–22].

Based on our knowledge, the present study represents the first attempt to analyze hospitals' relative efficiency in Sicily and to include multiple indicators of organizational inappropriateness as undesirable outcomes of health care delivery. Other literature is limited to indicators of clinical inappropriateness and is concerned with single measures of appropriateness.

## 3. Methodology

With the aim of incorporating indicators of organizational inappropriateness as undesirable outputs, we used an output-oriented DEA model, under the assumption that hospitals are required to optimize the delivery of appropriated health care procedures, while maintaining the amount of resources consumed constant.

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