



## Evaluating and re-demarcating the Hospital Service Areas in Florida



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### ABSTRACT

The Hospital Service Areas (HSAs) better portray underlying local patterns of hospitalization than administrative units, and offer a promising analysis unit for studies of healthcare market. The widely used Dartmouth HSAs in the U.S. were solely based on Medicare inpatient records about two decades ago. Our analysis used all discharge records from Florida hospitals in the 2011 Healthcare Cost and Utilization Project (HCUP) dataset from the Agency for Healthcare Research and Quality (AHRQ). We first matched Medicare-paid hospitalization records in 2011 to the Dartmouth HSAs for demonstrating the temporal variation of the Medicare-derived HSAs. We then compared the HSA configurations based on the overall hospitalization records to Medicare-derived HSAs in the same year (2011) for assessing the representativeness of the Medicare-derived HSAs. Results indicate the boundaries of the Medicare-derived HSAs have significantly shifted over two decades and are inadequate in representing the overall population. The Huff model was used to generate more solid HSAs than traditional approaches.

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### Introduction

The U.S. hosts the most expensive healthcare system worldwide with healthcare expenditures at \$8508 per capita (United Press International, 2013). Many countries, including the U.S., New Zealand, Hungary, Canada, Australia, Ireland and the United Kingdom, have actively responded to the call of the World Health Organization (WHO) on creating local environments for the provision of and residents' access to healthcare resources (Goodman, Fisher, Stukel, & Chang, 1997; Shortt & Moore, 2006). Analysis of local hospital use and resource allocation may shed light on approaches for reducing costs related to long travel distance for hospitalization (Basu & Friedman, 2007). In addition to revenue retention (Basu & Cooper, 2000), local hospital atmosphere can help build and maintain a favorable patient–doctor relationship (Wilbush, 1974).

Common spatial units for reporting local hospital use or hospitalization rates are administrative units such as state and county. However, hospitals vary considerably in terms of type, specialty, size, and location, and patients often cross state or county boundaries for hospital service. State and county may not be the best units for bounding the main trends of patient-to-hospital flows and

representing underlying local patterns of hospital visits (Lembcke, 1952). Created by the Dartmouth Institute for Health Policy and Clinical Practice (2014), Hospital Service Areas (HSAs) and Hospital Referral Regions (HRRs) have been increasingly used as analysis units in policy studies including the recent IOM (2013) report on healthcare spending. The HSAs are an area where most of local hospitalization occurs (Klauss, Staub, Widmer, & Busato, 2005). The HRRs are an aggregated level based on the HSAs, wherein patients are referred for major cardiovascular surgical procedures and for neurosurgery (Center for Evaluative Clinical Sciences, 1999). The HRRs and HSAs are functional units allowing analysis of healthcare market at a fine scale (Klauss et al., 2005).

The HSAs offer promise for small area analyses (Gittelsohn & Powe, 1995; Wennberg & Gittelsohn, 1973) such as comparison of hospitalization practices and surgical procedure rates among different hospitals in various regions (Ashton et al., 1999; Fisher, Wennberg, Stukel, & Sharp, 1994). The HRRs have not yet been suggested to be as useful for revealing substantial variation at local levels (Ashton et al., 1999; Zhang, Baik, Fendrick, & Baicker, 2012). However, the widely used HSAs in the U.S. were based on the 1992–93 data two decades ago (Center for Evaluative Clinical Sciences, 1999). As the infrastructural changes, political regulations and altered insurance policies all influence the patterns of people seeking healthcare (Klauss et al., 2005), the boundaries of the HSAs may have shifted over time. In addition, the HSAs were solely based on Medicare hospitalization records that specifically

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target legal residents aged 65 and older, younger people with disabilities, and the people with end-stage renal disease (CMS, 2014). It is necessary to assess the appropriateness of the Medicare-derived HSAs before applying them to other demographic groups (Guagliardo, Jablonski, Joseph, & Goodman, 2004) and people with other insurances. Moreover, the theoretical foundation for HSA delineation, particularly from a geographic perspective, needs to be strengthened.

This study utilizes the *Huff model* (Huff, 1964) that has been widely successful in delineating trade areas of various business entities (Dramowicz, 2005). The Huff model has a built-in distance decay function to capture the spatial behavior of hospital visits, and thus provides a solid theoretical foundation for producing HSAs. The goal of this paper is three-fold:

- 1) evaluating the temporal variation of the Medicare-derived HSAs over the last two decades,
- 2) examining the representativeness of the Medicare-derived HSAs versus all insurance types, and
- 3) applying the Huff model in re-demarcating the HSAs.

### Study area and data

Florida is an ideal state for study of local hospital service. The state has three facets bordered by the Gulf of Mexico to the west, the Florida Straits between the U.S. and Cuba to the south, and the North Atlantic Ocean to the east. Most patients seek hospital care within the state. Individual discharge records from all the hospitals in Florida during the year 2011 were extracted from the State Inpatient Database (SID). The *Agency for Healthcare Research and Quality (AHRQ) 2011* has assembled, edited, and standardized the data as part of the Healthcare Cost and Utilization Project (HCUP). Developed through a Federal–State–Industry partnership, AHRQ disseminates the HCUP data in order to provide a large-scale source for national, state, and all-payer healthcare data, and enhance nationwide comparability among independent health outcomes in different states.

The 2011 SID dataset consists of 2,656,249 records from 281 hospitals in Florida. We excluded 12,745 (0.5%) records from the 13 unidentified hospitals, 123,035 (4.6%) records from 47 psychiatric, rehabilitation, children's, women's and other specialty hospitals, 23,046 (0.9%) records with missing residence zip codes, and 21,598 (0.8%) records of the inpatients living out of the contiguous U.S. continent. The remaining data included 2,475,825 records (i.e., 93.2% of the total records) for 221 hospitals (i.e., 22 acute long-term care hospitals and 199 general medical and surgical hospitals) in Florida. The 221 hospitals were geocoded to points by their addresses. Out of the 2,475,825 inpatient records, 2,376,743 (96%) were geocoded to 983 postal zones in Florida (the rest with out-of-state zip codes), of which 1,069,369 (45%) discharges were paid by Medicare. These hospitals were linked to the 2013 American Hospital Association's (AHA) survey files for information on hospitals, such as hospital type and number of beds.

### Methods

#### *Evaluating the Dartmouth Hospital Service Areas*

The aforementioned *Dartmouth method* is applied most in the U.S., and implemented through a three-step process:

- 1) all acute care hospitals are assigned to a town or city in which they are located;

- 2) each postal zone is assigned to the town or city containing the hospitals visited by most residents in that postal zone;
- 3) a visual examination is undertaken to ensure the geographic contiguity of all zip codes in one HSA, with the disconnected re-assigned to an adjacent HSA on a locational basis.

Very similar to the Dartmouth method, the *Swiss method* (Klauss et al., 2005) is adopted to define the HSAs in Switzerland, where the hospital discharge records are available at the census region level that is aggregated from postal zones. The Swiss HSAs are defined by a similar three-step algorithm:

- 1) each hospital is included in a census region by location, referred to as hospital region, and then each census region is assigned to the hospital region where the highest number of discharges in that census region occurred;
- 2) a visual examination is undertaken to ensure the geographic contiguity of all census regions in one HSA, with the disconnected re-assigned to an adjacent HSA on a locational basis;
- 3) each HSA with more residents visiting the hospital(s) within another HSA is merged into that HSA, referred to as plurality rule.

When replicating the Dartmouth method, we assigned hospitals to postal zones instead of town/city to define the HSAs at a finer scale based on the Medicare patient-to-hospital flows in 2011. Our implementation also used the plurality rule in the Swiss method, and thus may be considered a *Dartmouth-Swiss hybrid method*. The localization index (LI) refers to the fraction of discharges of HSA residents that occurred within their own has, and is an important index used in the method for measuring the degree of localization of hospital care (Guagliardo et al., 2004; Klauss et al., 2005). When all hospital care for residents is provided within their HSA,  $LI = 1$ . An LI value above 0.5 indicates that more admissions occur within the HSAs, and is thus a desirable threshold for the definition of HSAs.

All individual discharge records paid by Medicare in 2011 were geocoded to 2011 zip codes where inpatients lived at the time of admission. The sum of discharges within each postal zone was aggregated. To demonstrate the temporal variation of the Medicare-derived HSAs, the boundaries of 1992–1993 Medicare-derived HSAs were downloaded from the website of *Dartmouth Institute for Health Policy and Clinical Practice* (2014). Due to the changes of postal zone boundaries between 1992 and 1993 and 2011, we used postal zone centroids to represent all Medicare discharges within the 2011 postal zones, and then reassigned them to the 1992–1993 Medicare-derived HSAs by location.

The constructed HSAs based on the 2011 Medicare patient-to-hospital flow data are referred to as the *2011 Medicare-derived HSAs*. The percentage of Medicare discharges from each hospital within each postal zone was computed, and each postal zone was assigned to the hospital discharging the highest percentage of inpatient records within that postal zone. Each contiguous collection of postal zones assigned to the same hospital, with that hospital located within the cluster, formed an initial HSA. Geographic contiguity and the plurality rule (as cited in the Swiss method) were enforced to revise the divisions of the 2011 Medicare-derived HSAs. Each HSA with an  $LI < 0.5$  was merged into an adjacent HSA that either geographically encircled that HSA or discharged the highest percentage of inpatient records from that HSA. These steps were repeated until the LI of all HSAs was  $\geq 0.5$ , and the LI in the final 2011 Medicare-derived HSAs was recorded. Similarly, the LI was also calculated within the 1992–1993 Medicare-derived HSAs, and the two sets of LIs were compared for difference by a *t*-test for statistical significance.

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