Original Investigation

The Ongoing Gap in Availability of Imaging Services at Teaching Versus Nonteaching Hospitals

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Rationale and Objectives: This study aimed to characterize associations between availability of imaging services and intensity of teaching among US hospitals.

Materials and Methods: Using the American Hospital Association Annual Survey Database, we studied information regarding the availability of imaging services at general hospitals nationwide in 2007 (4102 hospitals) and in 2012 (3876). Teaching intensity was categorized as Council of Teaching Hospitals (COTH) member, non-COTH teaching hospital (non-COTH member with affiliated medical school and/or residency), and nonteaching hospital. Availability in hospitals of reported basic and advanced imaging modalities, as well as beds, number of employed physicians, and case mix index, was analyzed. Univariable and multivariable trends were assessed.

Results: All 15 assessed modalities showed significant increases in availability with increasing hospital teaching intensity ($P < 0.001$). Modalities showing the largest differences between COTH and nonteaching hospitals in 2012 were image-guided radiation therapy (78% vs. 14%), positron emission tomography/computed tomography (74% vs. 17%), and single-photon emission computed tomography (88% vs. 35%). The gap between COTH and nonteaching hospitals increased from 43% in 2007 to 57% in 2012 for positron emission tomography/computed tomography, and from 34% to 48% for virtual colonoscopy. COTH status was a significant predictor, independent of beds and employed physicians, for 10 modalities ($P < 0.001$–0.038). Greater case mix index was significantly associated with availability of advanced, although not basic, modalities.

Conclusions: Availability of imaging services increased with greater hospital teaching intensity. Differences were most pronounced and sustained over time for advanced modalities. Our findings reflect the greater advanced imaging resources necessary to support the complexity of care rendered at teaching hospitals. This differential must be considered when exploring adjustments to teaching hospitals' funding levels.

Key Words: Imaging modalities; graduate medical education; academic medical centers.

INTRODUCTION

Robust graduate medical education (GME) is vital in ensuring a future supply of well-trained physicians. However, GME is a costly process. Training programs entail considerable direct costs, such as the salaries and benefits of residents and their supervising faculty, as well as the administrative and overhead costs of operating an accredited training program. In addition, teaching hospitals face greater costs relating to offering more advanced and specialized services, as well as caring for a greater fraction of sicker, more complex, and uninsured patients (1–3).

Acad Radiol 2016; ■:■■–■■

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http://dx.doi.org/10.1016/j.acra.2015.11.017

GME is largely funded by the Medicare program (3,4), which provides teaching hospitals with both a direct GME payment to cover teaching costs as well as an indirect medical education (IME) payment to cover teaching hospitals' greater overall cost of patient care (2). Concerns regarding the solvency of the Medicare program have driven continual efforts to curtail Medicare's GME funding (1,2,5). For instance, the Balanced Budget Act in 1997 capped the number of nationally funded GME positions and substantially reduced the IME add-on percentage (2,3). MedPAC, the National Commission on Fiscal Responsibility and Reform, the Congressional Budget Office, as well as several recent annual White House budgets have all called for further large reductions in Medicare's GME funding, typically targeting IME payments (4,5). Some policymakers have even suggested that Medicare cease funding GME altogether (6).

Such measures would have a profound impact on teaching hospitals (7), which generally have lower operating margins than nonteaching hospitals (8). Academic medical centers are facing increasing financial pressures from various sources (9,10), including decreasing reimbursements for clinical care, expansion of managed care programs, growing competition with

nonacademic providers, and reduced federal funding for biomedical research (9,11). Thus, sustained GME funding is increasingly vital to support the mission of teaching hospitals in promoting biomedical research, educating the physicians of tomorrow, and providing uninsured and other underserved populations with critical safety net clinical services (12).

The controversy about funding teaching hospitals illustrates the need for greater and broader insight into the extent of the complex care rendered at teaching institutions. For example, academic medical centers are recognized to provide a disproportionate share of various patient services, including neonatal and pediatric intensive care units, surgical transplant services, level 1 trauma centers, and burn care units (13). Nonetheless, additional credible data describing actual differences in practice between teaching and nonteaching hospitals would help further inform discussions regarding teaching hospitals' greater resource needs. Advanced medical imaging is commonly performed in the management of complex patients and serves as a category of healthcare expenditures that has been the focus of federal policy efforts (14). Use of medical imaging has previously been applied as a marker of the intensity of provided clinical care for various medical conditions (15–17).

Although it may seem intuitive that teaching institutions would have greater access to advanced, and possibly even basic, medical imaging services, there is a paucity of data formally investigating such relationships. Such information is necessary to permit appropriate GME funding policy-making. Therefore, we conducted this study to characterize the nature of associations between the availability of imaging services and the intensity of teaching services at hospitals in the United States.

METHODS

This study did not constitute human subjects research and therefore did not require review by our institutional review board.

We acquired the American Hospital Association (AHA) Annual Survey Database (18) from the AHA for years 2007 and 2012. Health services researchers have frequently used this data source to investigate various characteristics (19–22) for hospitals across the United States as reported by hospitals participating in the survey. The survey is available in the public domain (23) and contains more than 1000 data elements regarding a comprehensive array of facility characteristics. The survey contained data for 6312 hospitals in 2007 and for 6307 hospitals in 2012. Of these, 4904 hospitals in 2007 and 4789 hospitals in 2012 that were identified as "general medical and surgical hospitals" were selected for further evaluation. Examples of excluded hospital types include prison hospitals, psychiatric hospitals, and rehabilitation centers.

We assigned each included hospital to one of three categories reflecting its intensity of teaching activity based on self-reported database fields: (1) hospitals that are members of the Council of Teaching Hospitals and Health Systems ("COTH teaching hospital") of the Association of American Medical Colleges; (2) hospitals that are not members of COTH but have residency training approval by the Accreditation Council for Graduate Medical Education and/or a medical school affiliation reported to the American Medical Association ("non-COTH teaching hospital"); or (3) all other hospitals ("nonteaching hospitals"). This three-tiered classification is similar to that used in numerous prior studies comparing teaching to nonteaching hospitals (19,24–26). Nationwide, fewer than 500 hospitals are COTH members and are commonly denoted as major teaching hospitals or academic medical centers (27). Designation as a non-COTH teaching hospital did not specifically require presence of a radiology residency, as this information is not reported within the AHA database.

We then identified whether each hospital participating in the survey offered each of the following AHA-defined diagnostic imaging or imaging guidance service parameters for each year: computed tomography (CT), multi-slice spiral CT, 64-slice spiral CT, electron-beam CT, ultrasound (US), magnetic resonance imaging (MRI), intra-operative MRI, positron emission tomography (PET), PET/CT, single-photon emission computed tomography, a diagnostic radioisotope facility, mammography, full-field digital mammography, image-guided radiation therapy, and virtual colonoscopy. These service parameters represent long-standing predetermined fields established by the AHA. This information was available for 4071 to 4102 (83%–84%) of hospitals in 2007 (some responding hospitals did not provide data for all of imaging modalities that year) and for 3876 (81%) of hospitals in 2012 (all responding hospitals provided data for all of imaging modalities that year). For both 2007 and 2012, we recorded whether the modality was offered at the hospital itself (requiring that all patient revenues, expenses, and use related to the service occur at the hospital level, rather than only at an affiliated facility [23]). For 2012, we also recorded whether the modality was available elsewhere through the hospitals' health systems, networks, or joint ventures.

Additional hospital characteristics captured as measures of the hospitals' overall level of patient care activity were the total number of setup and staffed facility beds ("total beds") and the total number of employed full-time equivalent physicians and dentists ("FTE physicians"). This latter metric is a predetermined field historically included in the AHA database, considers only individuals on the hospital payroll, excluding those paid on a fee basis or who hold an administrative or externally-funded research position (23), and was defined for 100% of responding hospitals in 2012. For this analysis, we refer to these as "employed physicians" to distinguish them from all privileged physicians (employed and private) for which AHA survey data are incomplete (missing for 34.9% of responding hospitals in 2012).

Using hospitals' transfer-adjusted case mix index (CMI) scores based on Medicare Severity Diagnosis Related Group Grouper Version 33, as published in the Medicare FY 2016 Inpatient Prospective Payment System (IPPS) Final Rule (28), we identified a CMI for each hospital participating in the AHA survey whenever such scores existed. The CMI has been used in prior