



Original Article

# Physician and patient characteristics affecting repeat use of abdominal ultrasound: A nationwide population-based study

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## Abstract

**Background:** Ultrasound is a useful and popular imaging modality. Our aim was to assess the association between the use and repeat use of abdominal ultrasound and diagnosis, physicians, and hospital characteristics according to a Taiwanese national database.

**Methods:** The Taiwan National Health Insurance database contains data for approximately 22,134,270 insured individuals during 2004–2005 (>98% of the population in Taiwan). Patients who were scanned with abdominal ultrasound once or more during that period were identified. Associations between physicians, hospital characteristics, diagnoses, and repeat use of abdominal ultrasound were analyzed. Logistic regression with generalized estimating equations was used.

**Results:** A total of 2,319,164 abdominal ultrasound scans were performed (approximately 6.42% of the population in Taiwan). Among these, 38.34% received repeat examinations. Multiple logistic regression analysis showed that gastroenterologists [odds ratio (OR) = 1.07], male physicians, physicians younger than 40 years of age, and physicians in medical centers were more likely to use repeat abdominal ultrasound. The analysis also showed that male patients, older patients, patients with liver and biliary disease (OR = 1.17), and patients with other abdominal disease (OR = 1.37) were more likely to receive repeat abdominal ultrasound.

**Conclusion:** Our study shows that the use and repeat use of abdominal ultrasound is very high and is related to diagnosis and physician and hospital characteristics.

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**Keywords:** abdominal ultrasound; diagnosis; healthcare; hospital; physician

## 1. Introduction

Ultrasound is a relatively inexpensive and safe diagnostic imaging technique. Recent advances and novel applications make ultrasound an even better initial imaging tool for a wide range of diseases. Ultrasound scans are performed in various

specialties, and are usually categorized as general, abdominal, vascular, breast, echocardiography, obstetric, gynecological, or pediatric.<sup>1</sup> Abdominal ultrasound, like all ultrasound, is inexpensive and widely used, and is most commonly performed by radiologists, gastroenterologists, and a few other specialist physicians.

The overall utilization rate for all noninvasive diagnostic imaging increased by 3.8% from 1993 to 1999. Ultrasound use increased by 24.2% during this 6-year period.<sup>2</sup> Among the different types of medical imaging, conventional radiology accounts for the greatest proportion, with ultrasound in second place, followed by computed tomography (CT), nuclear

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imaging, magnetic resonance (MR) imaging, and bone densitometry.<sup>2,3</sup> For abdominal imaging, combined imaging use increased by 25% from 1996 to 2005. The greatest growth was for abdominal CT, followed by abdominal ultrasound (increased 12%).<sup>4</sup> This rapid growth in medical imaging and its associated costs are becoming major concerns for policy-makers and insurance companies.

Previous research has found that repeat scans account for nearly one-third of the enormous costs associated with radiological examinations.<sup>5</sup> Previous reports have also discussed possible factors affecting the repeat use of costly imaging modalities, including disease pattern, physician behavior (including self-referral), and hospital characteristics, with conflicting results.<sup>5–8</sup> Most of these studies were based on regional samples or samples from selected hospitals. In Taiwan, the healthcare of nearly the entire population (>98%) has been covered by the National Health Insurance (NHI) system since 1995.<sup>9</sup> This provides a relatively unique opportunity to study the factors affecting the use of abdominal ultrasound. In view of increasing healthcare cost for over-imaging, our study focused on the number and repeat use of abdominal ultrasound examinations.

In Taiwan, healthcare has mostly been provided by the NHI since 1995. Over the 17 years since its establishment, the NHI has provided quality medical service without exorbitant cost.<sup>5</sup> Total expenditure on health was 6.6% of GDP in 2009. Current life expectancy is 82 years for females and 76 years for males. The infant mortality rate is 4.3%.<sup>10</sup> The purpose of this study was to determine the associations between diagnoses, physicians, and hospital characteristics and the use of abdominal ultrasound examinations according to a nationwide database. The results may help to establish a reference for monitoring appropriate use of abdominal ultrasound.

## 2. Methods

### 2.1. Database and data acquisition

The 2004–2005 NHI data were obtained from the National Health Research Institute (NHRI). The NHRI database contains benefit claims for all medical care services for almost every Taiwanese individual (approximately 22,134,270), and includes registries of contracted medical facilities and board-certified physicians, and details of patient care orders. For this study, the NHRI provided de-identified data (for both patients and physicians) extracted from its 2004–2005 data set. The study was approved by the NHRI, and therefore informed consent and Institutional Review Board approval were waived.

### 2.2. Study population

All abdominal ultrasound examinations (inpatient, outpatient, and emergency services) were identified from the database. A total of 1,426,698 patients who received abdominal ultrasound during 2004 and had data available for analysis for the following year were identified from the data set. Among these, 545,452 had abdominal ultrasound performed more than

once during that time and were categorized as the repeat group. The remaining 881,246 patients who received only one abdominal ultrasound during the year were categorized as the non-repeat group. After excluding patients with missing data, a total of 1,421,307 patients (545,007 repeat and 876,300 non-repeat groups) with complete data were used for further statistical analysis. The NHI reimbursed 750 NTD (approximately US\$25) for each abdominal ultrasound during 2004–2005.<sup>9</sup>

For the repeat group, the last claims for abdominal ultrasound were subjected to further evaluation. Four time intervals were classified as follows to further evaluate the repeat group: (i) acute disease phase, 0–2 weeks; (ii) acute disease follow-up, 2 weeks–2 months; (iii) chronic disease follow-up, 2–7 months; and long-term follow-up of chronic disease, >7 months, in accordance with a study by Lee et al.<sup>5</sup>

Disease conditions were categorized into six different groups using the International Classification of Disease, 9th Revision, Clinical Modification (ICD-9-CM) diagnosis codes. The six disease groups were as follows: (1) liver and biliary disease (ICD-9: 155, 156, 570–579); (2) gastrointestinal disease (GI, ICD-9: 150–154, 530–566, 569, 578, 579); (3) other abdominal disease (other than liver and biliary disease, ICD-9: 157–159, 567, 568, 577); (4) genitourinary disease (GU, ICD-9: 580–629); (5) ill-defined disorder (ICD-9: 780–799); and (6) others (all other codes). The hepatobiliary group was further subdivided into hepatocellular carcinoma (HCC, ICD-9: 155), liver cirrhosis (ICD-9: 571), hepatitis (ICD-9: 070), other liver and biliary disease (ICD-9: 156, 570, 572–579), and others (all other codes) for further evaluation of hepatobiliary diseases. Contracted medical hospitals and clinics that performed the sonograms were classified according to their ownership and accreditation level (hospital characteristics). There were 215 public hospitals, 1572 private hospitals and clinics, and 79 not-for-profit hospitals in Taiwan. In terms of accreditation, 18 were certified medical centers ( $\geq 500$  beds), 75 regional hospitals ( $\geq 250$  beds), 391 district (community) hospitals ( $> 250$  beds), and 1382 clinics. Physician characteristics included specialty, age, and sex. Physician specialties were categorized into eight groups: gastroenterologist, internal medicine (other than gastroenterologist), surgeon, family physician, obstetrics and gynecology (OB/GYN), pediatrics, emergency physician, and others.

### 2.3. Statistical analysis

The key independent variables of interest were physician characteristics, varieties of disease, and hospital characteristics. The key dependent variable was repeat use of abdominal ultrasound for all inpatient, outpatient, and emergency services in all the hospitals and clinics in Taiwan. Univariate analysis was performed using a  $\chi^2$  test or Fisher exact test. Logistic regression with generalized estimating equations (GEE) was used for multivariate analysis to explore relationships between physician characteristics, patient disease, hospital characteristics, and repeat use of abdominal ultrasound. A two-sided *p* value of 0.001 or less was considered statistically significant.

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