Acute Pancreatitis: Computed Tomography Utilization and Radiation Exposure Are Related to Severity but Not Patient Age

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This article has an accompanying continuing medical education activity on page e33. Learning Objectives—At the end of this activity, the learner should appreciate the frequent and potential overuse of computed tomography scanning in acute pancreatitis and understand the potential link between radiation exposure and the subsequent risk for cancer.

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BACKGROUND & AIMS: A goal of radiologists is to use computed tomography (CT) imaging less frequently in younger patients because of radiation exposure. We evaluated abdominal CT use among patients hospitalized for acute pancreatitis at a tertiary care hospital and compared estimated radiation doses with disease severity and patient age. **METHODS:** We performed a retrospective analysis of numbers and types of CTs performed on patients with acute pancreatitis (1036 admissions, 869 patients; mean age, 50.8 y); 566 had 1081 abdominopelvic CTs performed from October 1, 2001, to September 30, 2006. Effective dose estimates for abdominopelvic CTs were used to estimate exposure. Disease severities were stratified using Balthazar CT grades and severity indexes. **RESULTS:** The mean number of abdominopelvic CTs per patient, per hospitalization, was 1.9 (range, 1–12); the mean number was 3.0 over the 5-year period (range, 1–19). During hospitalization, each patient was exposed to a mean estimated radiation dose of 31.03 ± 26.4 mSv (range, 14.7–176.9 mSv). Patients with pancreatitis grades D or E (n = 233) compared with grades A through C (n = 333) had longer periods of hospitalization (mean, 23.3 vs 10.8 d; $P < .001$), more days as an inpatient (mean, 2.54 vs 1.45 d; $P < .001$), more total CT scans (mean, 4.02 vs 2.37; $P < .001$), and higher total effective radiation doses (mean, 53.5 vs 35 mSv; $P < .0001$). Linear regression revealed a relationship between dose and disease grade, but not patient age. **CONCLUSIONS: Regardless of age, patients with severe acute pancreatitis undergo more abdominopelvic CTs as inpatients and outpatients and are exposed to higher doses of radiation compared with patients with less severe disease. Awareness of CT ordering patterns for patients with acute pancreatitis may aid in the development of alternate imaging strategies to reduce radiation exposure in this population, especially for younger patients.**

Keywords: Pancreatic Inflammation; Imaging Utilization; Tertiary Care.

The clinical diagnosis of acute pancreatitis often is straightforward and confirmed easily with laboratory findings. Acute pancreatitis patients may present clinically with either severe disease, defined by the presence of organ system failure, or mild disease. Contrast-enhanced computed tomography (CECT) is the mainstay of imaging patients with acute pancreatitis, especially those with severe disease and systemic manifestations. Its widespread utility in this clinical entity has been recognized by experts of the Acute Pancreatitis Working Group, who in their revision of the findings of the 1992 International Symposium on Acute Pancreatitis (Atlanta Classification) have proposed that typical findings on CECT define the presence of the disease (M. Sarr, personal communication, November 2008). However, this recommendation may lead to even more liberal use of CT.

There is concern that increased use of CT for clinical imaging in Western countries is contributing to population risk of carcinogenesis.[1–5] More important to the individual patient is the lifetime risk of developing cancer,[6–8] potentially attributable to cumulative radiation exposure from CT. This factor has a greater bearing on younger patients than older patients,[4,5,9] and some clinical areas of concern include imaging of the pediatric population or repeated imaging in adult patients with renal stone disease,[10] Crohn's disease,[11] and other chronic illnesses. Patients with severe acute pancreatitis are likely to undergo CT not only at the time of initial diagnosis, but also as a means of monitoring morphologic changes of peripancreatic inflammation and fluid collections in the retroperitoneum throughout hospitalization. In addition, outpatient follow-up imaging might be necessary to assess longer-term complications arising from severe acute pancreatitis, such as disconnected duct syndrome or pancreaticocutaneous fistula formation. Because the age spectrum of patients presenting with acute pancreatitis is wide, we sought to determine the estimated per-patient radiation dose from abdominopelvic CT in our tertiary referral medical center setting, correlated with acute pancreatitis disease severity and relationship to age at presentation. We propose that knowing this information is a prerequisite to develop alternate imaging strategies for these patients.

Abbreviations used in this paper: CECT, contrast-enhanced computed tomography; CTSI, computed tomography severity index; IV, intravenous; MRI, magnetic resonance imaging.

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Subjects and Methods

We received expedited approval from our Institutional Review Board for this retrospective study, with waiver for informed consent; Health Insurance Portability and Accountability Act compliance was strictly observed. The medical records database was searched electronically for patients with a discharge diagnosis of acute pancreatitis cross-referenced to the procedure codes for abdominopelvic CT over a 5-year interval from October 2001 to September 2006. The departmental Radiology Information System then was searched for the numbers and types of abdominopelvic CT, including noncontrast single-phase; intravenous (IV) contrast-enhanced single (portal venous)-phase; and IV contrast-enhanced multiphasic (precontrast, arterial phase, and portal venous phase). The CTs were categorized as inpatient or outpatient during the study interval and follow-up evaluation was stratified by year. For those patients with at least 3 years of follow-up evaluation the total cumulative individual exposure estimates were tabulated. CTs of other body regions were not included in the tabulation.

Standard abdominopelvic CT protocol for the evaluation of patients with suspected pancreatitis at our institution includes a single-portal, venous-phase acquisition using IV (42 mg iodine/kg) and 720 mL positive oral contrast. However, patients in this population might have undergone single-phase noncontrast abdominopelvic CT, or multiphasic pancreatic CT including noncontrast and arterial phase upper-abdominal images followed by portal venous-phase images through the abdomen and pelvis if ordered as such by the clinical services. Over the 5 years of the study, a variety of scanners with detector configurations ranging from 1 to 40 rows was used. Although dose information based on the CT dose index (a phantom-based estimate of exposure per CT slice) and the dose-length product (an indicator of the integrated radiation dose of an entire CT examination) was available for individual patient CT examination(s) in the latter part of the 5-year study interval, it was not routine to capture this information in the earlier years. Thus, effective dose estimates for each CT recorded for each patient were based on published standards[12] as follows: single-phase CT, 14.7 mSv; and 3-phase CT, 29.9 mSv.

Review of each patient's admission abdominopelvic CT was performed by a single abdominal imager (D.D.) with 15 years of experience for calculation of the Balthazar et al[13] CT grade for all patients regardless of CT technique and for CT severity index (CTSI)[14] if intravenous contrast was administered during the CT scan. The Balthazar CT grade describes the amount of pancreatic inflammation present (eg, grade A, normal; grade B, pancreatic enlargement; grade C, peripancreatic inflammatory stranding; grade D, single peripancreatic fluid collection; grade E, ≥2 peripancreatic/retroperitoneal fluid collections), and the CTSI is a prognosticator of clinical disease severity based on morphologic abnormalities of pancreatic inflammation combined with pancreatic parenchymal necrosis as depicted on contrast-enhanced CT. In general, a greater degree of inflammation and amount of pancreatic glandular necrosis is associated with a higher CTSI number, and more severe pancreatitis. The severity of pancreatitis was stratified into groups using 3 methods for the purpose of statistical comparison. First, all patients in the population were dichotomized into grades A through C versus D and E pancreatitis; second, those patients receiving IV contrast enhancement were dichotomized into CTSI less than or equal to 3 versus greater than 3 to mimic the potentially clinically relevant threshold for admission to a general gastrointestinal medicine or surgery ward versus ICU admission; and third, the same IV contrast-enhanced population was split into CTSI less than 7 versus greater than or equal to 7 to separate out the highest acuity patients.[15] Clinical variables evaluated included number of hospitalizations, number of hospital days, total number of abdominopelvic CT scans, number of inpatient versus outpatient follow-up abdominopelvic CT scans, total quantitative effective radiation dose estimate, and effective dose estimates received as inpatient and outpatient. Cumulative effective dose estimates were calculated for those patients with at least 3 years of follow-up evaluation. Finally, the patients who completed 3 years of follow-up evaluation were substratified by age (in decades), and the relationship between age and grade to the number of scans or total dose was assessed with linear regression.

All statistics were performed by a biostatistician using SPSS 12.0 software (SPSS Inc, Chicago, IL). Comparison of the mean total hospital days, number of scans, and radiation dose estimates for patient groups below and above the designated threshold values for pancreatitis severity was performed using the Student *t* test. Linear regression was used to assess the effects of age and grade on total dose estimate and number of scans. Pancreatitis grade (A–E) was coded as 1 to 5 and patient age was examined both continuously and as a 6-category variable (≤30, 31–40, 41–50, 51–60, 61–70, >70). A *P* value of less than .05 was considered statistically significant.

Results

A total of 869 patients had 1036 admissions for acute pancreatitis over the 5-year period (34.6% men, 65.4% women; mean age, 50.8 y; range, 16–93 y). Etiologies of acute pancreatitis included gallstones (32%), ethanol abuse (23%), recurrent acute pancreatitis (14%), endoscopic retrograde cholangiopancreatography–induced (6%), pancreatic cancer (5%), posttransplant and hypertriglyceridemia (4% each), and other not specified (9%). A total of 746 patients had a single hospitalization for acute pancreatitis with a mean stay of 9.4 days (range, 2–113 d). A total of 123 patients had multiple admissions over the study period, with a mean of 2.5 (range, 2–8 admissions) and mean total hospital days of 15.9 (range, 2–229 d). Ten patients died and 7 patients were transferred with no follow-up evaluation at our institution.

Not all patients treated for acute pancreatitis underwent abdominopelvic CT. A total of 303 (35%) of 869 patients hospitalized over the 5-year period had no CT. A total of 566 (65%) of the 869 patients had at least one abdominal pelvic CT. A total of 1081 abdominopelvic CTs were performed in these 566 patients. The types of abdominopelvic CTs included 697 portal venous phase, 106 multiphasic pancreatic multidetector CTs, and 278 noncontrast single-phase CTs. The number of CTs per patient included 220 patients who underwent one abdominal pelvic CT, 135 patients who had 2 abdominal pelvic CTs, and 211 patients who received 3 or more abdominal pelvic CTs. The mean number of abdominopelvic CTs per patient per hospitalization was 1.9, with a range of 1 to 12, and per patient over the 5-year interval was 3.0 with a range of 1 to 19. By using the published dose estimates for single and multiphasic CT, the mean radiation dose estimate during hospitalization per patient was 31.0 ± 26.4 mSv (range, 14.7–176.9 mSv). The total mean dose estimate per patient (including inpatient and out-