ORIGINAL ARTICLE

A Toolkit for Pediatric CT Dose Reduction in Community Hospitals

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Abstract

"Eighty percent of success is just showing up."

—Woody Allen

Pediatric CT radiation dose optimization is a challenging process for pediatric-focused facilities and community hospitals alike. Ongoing experience and trial-and-error approaches to dose reduction in the large academic hospital setting may position these centers to help community hospitals that strive for CT quality improvement. We describe our hands-on approach in a pilot project to create a partnership between an academic medical center and a community hospital to develop a toolkit for implementing CT dose reduction. Our aims were to (1) assess the acceptability of an interactive educational program and electronic toolkit booklet, (2) conduct a limited test of the efficacy of the toolkit in promoting knowledge and readiness to change, and (3) assess the acceptability and practicality of a collaborative approach to implementing dose reduction protocols in community hospitals. In partnering with the community hospital, we found that they had size-specific radiation doses two to three times higher than those at our center. Survey results after a site visit with interactive educational presentations revealed an increase in knowledge, stronger opinions about the health risks of radiation from CT scans, and willingness and perceived ability to reduce pediatric CT doses.

Key Words: Pediatric CT, community hospital, radiation dose optimization, patient safety

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INTRODUCTION

US population doses from medical radiation sources are at a historic high, having increased by 600% since the 1980s [1,2]. The greatest contributor to the striking increase in population exposure is the CT scan [3]. In recent years, CT scans have drawn considerable scrutiny because of the health risks of ionizing radiation [3-7]. Children are especially vulnerable to the harmful effects of radiation [7-12]. Two epidemiologic analyses in the United Kingdom and Australia on large populations over many years have shown similar results: a 24% increase in cancer in children and adolescents exposed to ionizing radiation from CT scans [8,13,14]. These lifetime risk estimates based on direct analyses and epidemiologic data gleaned from national health registries are compatible with various lifetime risk estimates derived from atomic bomb survivor data [4,7].

For the 6.8 million CT studies performed outside the auspices of a dedicated pediatric facility, there are critical questions about whether diagnostic reference levels are followed for radiation doses on pediatric CTs [15-18]. For example, a recent study at Children's Hospital Boston and Harvard Medical School evaluated abdominal-pelvic CT performed in children during trauma evaluations at community hospitals (CHs) prior

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to transfer of care [19]. The study revealed that fully one-half of children received radiation doses that were greater than the 75th percentile norm, ranging overall from 0.17 to 5.07 times the norm [19]. As initially described in 2001 by Paterson et al [20] in pediatric patients undergoing abdominal CT, multiphase scanning is still common in the CH setting, despite the fact that, rather than increasing the diagnostic yield, radiation dose is substantially increased (up to tripled) [4,18,21].

The purpose of this study was to develop a partnership between a large academic medical center (AMC) and a CH to develop a toolkit for implementing CT dose reduction, which eventually could be disseminated to CHs statewide. Our aims were to (1) assess the acceptability of an interactive educational program and electronic toolkit booklet, (2) conduct a limited test of the efficacy of the toolkit in promoting knowledge and readiness to change, and (3) assess the acceptability and practicality of a collaborative approach to implementing dose-reduction protocols in CHs.

METHODS

Preliminary Data

We conducted our research at a public tertiary care academic level I adult and pediatric trauma center. For the purpose of this study, a CH was defined as a general non–university hospital that does not specifically focus on the care of pediatric patients [22]. The biomedical institutional review board at our institution determined this study to be a category 4 exemption under 45 CFR 46.101(b).

To establish baseline data, our study team conducted a preliminary retrospective analysis using CT dose length product contained in head CT imaging dose reports from 20 CHs and radiology practices sent to our center for second opinions or transfer of care during a 6-month period in 2012. This survey identified 12 sites with a variety of CT scanners and pediatric exposures (based on CT dose length product) higher than our usual adult doses, with many sites using *two to ten times higher dose* than our corresponding age-based protocols (see Data Supplement S1, available online, for graphical representation of data).

Field Test

After identifying the variations in doses, the research team employed survey and semi-structured interview methods to develop, assess, and refine a pediatric CT dose reduction toolkit in one CH that could be generalized over different manufacturers and platforms. Our research team made site visits to the CH and met with selected stakeholders, including the CH imaging administrative director, CT technologists, and private practice radiologists. In these meetings, we presented a brief, interactive educational program, discussed the project, and assessed knowledge of radiation exposure and radiation-related cancer risk through pretest and posttest surveys (see Data Supplement S2, available online, for survey/questionnaire). Pre- and posttest surveys were designed to explore attitudes, including opinions about CT risk, before and after the educational intervention on a 5-point Likert scale. These responses were totaled and compared across respondents in a pre/posttest fashion. The survey assessed staff familiarity with best practice guidelines in pediatric CT dose reduction, comfort level with the ALARA ("As Low As Reasonably Achievable") principle and preservation of diagnostic image quality, knowledge of automatic dose reduction applications in existing CT systems, and familiarity with dose reduction techniques on the Image Gently website.

We then distributed a pediatric dose reduction electronic toolkit booklet, *The ABCs of Childcare in CT: Awareness, Belief, Change*, to CH participants. The electronic toolkit booklet included selected examples of pediatric protocols; selected medical literature regarding practical strategies for dose optimization with links to online articles; examples of head and abdominal CT with ALARA doses (Data Supplement S3, available online); glossary of definitions and terms, selected educational links (eg, Image Gently® [23], Image Wisely® [24], the ACR National Radiology Data Registry [25]); tips, contacts, links provided by the ACR Imaging 3.0 [26]; and a list of contact information for help from the AMC team.

We conducted semi-structured interviews with the radiology team to gather feedback about the current content of the educational intervention and toolkit, as well as to identify issues related to dose optimization that may not be addressed by the educational session and toolkit. The interviews were transcribed and then reviewed for insights that supplement our survey data (see Data Supplement S4, available online, for semi-structured interview format and semi-structured interviewees' direct quotations table).

To establish baseline data for a future dose reduction intervention, we collected and quantified recent prior dose data from CH pediatric CT scans for comparison to benchmarks. Shared CH data included CT scanner vendor and scanning parameters obtained from data in