Dose Reduction Efforts for Pediatric Head CT Imaging in Washington State Trauma Centers: Follow-Up Survey Results

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Purpose: To examine variation in pediatric trauma head CT imaging protocols in Washington State trauma centers (TCs) in 2012 and compare to a previous survey conducted in 2008-2009.

Methods: A mixed-mode (online and paper) survey was sent to all adult and pediatric Washington State TCs (levels 1-5). Respondents provided information about the CT scanner used for pediatric head scans and technical information about pediatric dose reduction protocols. Mean head effective dose and organ dose for a female baby were estimated. Results were compared with previous data.

Results: Sixty-one of 76 TCs responded to the 2012 survey (response rate, 80.3%, versus 76% for 2008-2009 survey). In 2012, 91.7% reported having a dedicated pediatric protocol (87.7% in 2008-2009). Protective shielding use ranged from 80% to 100% across both survey years. In 2012, 2.5 times more TCs provided sufficient information to conduct dose calculations than in 2008-2009. Estimated mean CT dose index was 23.1 milliGray (mGy) in 2012, compared with 34.8 mGy in 2008-2009 ($P = .01$). Estimated mean dose length product was also significantly lower in 2012 than 2008-2009 (307.6 mGy $\times$ cm versus 430.1 mGy $\times$ cm, respectively; $P = .04$). Wide variation in mean effective dose was observed for level 3 and 4 TCs in 2012, similar to variation observed in 2008-2009 among level 4 TCs. Mean organ dose was significantly lower in 2012 for eye lens and brain, but higher for thyroid than in 2008-2009 ($P < .05$).

Conclusions: Although most Washington State TCs employ dose reduction protocols for pediatric head CTs, and some measures were lower in 2012, variation in protocols use and estimated dose continues to exist. More complete responses in 2012 suggest improved understanding of the importance of pediatric dose reduction efforts. Education and institutional protocols are necessary to reduce pediatric radiation dose from head CTs.

Key Words: CT imaging protocols, pediatric head CT, trauma center, radiation dose, Washington State

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INTRODUCTION

In recent years, numerous studies have reported the rising use of CT among pediatric patients [1-4]. In the emergency department, where timely diagnosis of traumatic injury is critical, there has been a 5-fold increase in the use of CTs for children from 1995 to 2008 [4]. However, given the recent work showing that clinical decision rules can accurately identify the presence or absence of a serious intracranial bleed in the more common mild traumatic brain injury [5], researchers and clinical practice guidelines have called for providers and institutions to more carefully weigh the benefit of diagnostic needs versus the risks posed by imaging [6-10]. Each year, approximately 435,000 children aged 14 years and younger seek emergency department care for a traumatic brain injury [11].

CT imaging poses a potential risk of radiation exposure, especially among children [9,12,13]. Until recently, this association was largely informed by the precautionary principle and research from nonmedical sources (eg, Chernobyl or Hiroshima) [14,15]; however, recent studies have since provided evidence for increased cancer risk associated with CT, specifically of the head region [13]. Pearce et al found significant positive associations between cumulative ionizing radiation dose from childhood CT scans and subsequent leukemia and brain cancer [13].

To avoid unnecessary risks, it is important to pursue the lowest dose of radiation possible for pediatric patients in need of medical imaging. This can be achieved through education and increased awareness, promotion of alternative nonionizing imaging modalities, utilization review or controls, decision support software, and the use of pediatric protocols when operating CT imaging equipment [16-18]. To optimize pediatric dose reduction efforts, it is important to understand how often and where appropriate pediatric CT protocols are used and explore variations in the possible radiation risks from CT imaging. Previous research in Washington State showed substantial variation in radiation dose from pediatric head CT in a statewide survey of trauma centers (TCs) conducted from July 2008 to August 2009. Within level 4 TCs, the estimated median ED for a baby ranged from 0.60 to 9.60 milliSieverts (mSv), a 10-fold variation (median 3.5 ± 0.84 mSv) [19]. Since that time, national campaigns, such as Image Gently®, have been launched to educate and encourage adoption of child-appropriate protocols when CTs are used [20,21]. Possible outcomes of education and awareness efforts include increased use of pediatric dose reduction protocols and protective shielding and lower radiation doses from pediatric CT. This study sought to investigate the changes over time by conducting a follow-up survey in Washington State, 4 years after the previous survey. The objective of this study was to examine variation in pediatric trauma head CT imaging protocols in Washington State TCs in 2012 and compare them with a previous survey conducted in 2008-2009.

METHODS

Survey Design and Contents

We based the current survey instrument on one used in the previous study in Washington State and incorporated changes based on that experience [19]. The current survey comprised questions asking about the following: (1) institutional information, (2) CT scanner information, (3) protocol scan parameters for trauma head CT scan for an infant patient, and (4) protective shielding (survey instrument available online as supplemental material).

Survey Sample and Administration

We administered the current survey to all Washington State TCs. The state recognizes 5 levels of trauma services, ranging from level 1 (most comprehensive) to level 5 (basic). All institutions, levels 1 to 5, that served children (including pediatric-only TCs) were considered eligible for this study. There were slight changes in TC designations between 2008-2009 and 2012, shown in Table 1.

The current survey was administered by e-mail and mail. First, we obtained e-mail addresses for radiology contacts (chiefs of radiology, lead CT technologists) through professional contacts, websites, and by contacting TCs directly. For TCs with e-mail addresses, an e-mail describing the study was sent, along with a link to the survey and an educational module about radiation dose reduction for pediatric patients [22]. To access the educational module, respondents were required to complete the online survey. A reminder e-mail was sent to nonrespondents 3 and 6 weeks after the initial contact. Nonrespondent institutions were then contacted by telephone and a hardcopy of the survey was sent by mail

Table 1. Washington State TCs designations

General trauma level designation	2008-2009*		2012†	
	Adult	Pediatric	Adult	Pediatric
1	1	1	1	1
2	4	0	4	1
3	23	5	25	6
4	33	0	33	0
5	15	0	16	0
Pediatric-only‡	—	2	—	1
All Levels	76	8	79	9

Values indicate number of TCs (by level of designation) in Washington State at the time when the surveys were administered. Unless otherwise indicated, pediatric TCs also serve as adult TCs. Data provided by the Washington State Department of Health, Office of Emergency Medical Services and Trauma System.
*Current as of November 31, 2008.
†Current as of August 31, 2011.
‡Level 2 pediatric-only TC.
TC = trauma center.

3 times thereafter. Incentives of $5 gift cards for a popular coffee shop were offered to the first respondent from each TC. If more than one survey was received from an institution, responses were compared and the most complete response (with the fewest missing items) was used. The survey was administered from April to December 2012.

Descriptive data about TCs were collected from multiple sources. We used existing information from the Washington State Department of Health to categorize institutions by TC designation (levels 1-5) and population served (adult and pediatric, or pediatric only) [23]. To categorize TCs by ACR accreditation for pediatric CT imaging, we cross-referenced the list of TCs with the list on the ACR's website [24]. Finally, we used data from the Washington State Department of Health Community Hospital Quarterly Files to describe TC bed size and number of emergency visits for 2011 [25]. In cases where these data were not available, the American Hospital Directory was used to ascertain bed size information (n = 4) [26].

Because survey questions inquired about institutional and not individual practices, this study was deemed to be exempt from human subjects review by the University of Washington's institutional review board.

Measures

Based on questions in the survey instrument, 3 main outcome measures were developed: use of a dedicated pediatric protocol, use of shielding, and estimated radiation dose. To compare the results of this survey with the 2008-2009 data, survey questions focused on CT scans for head trauma among pediatric patients. Other scanning modalities or body parts were not covered.

Dedicated pediatric protocol. Each institution was asked whether it had a dedicated protocol for a pediatric trauma patient receiving a head CT scan, and if so, what year this protocol was implemented. Having a dedicated protocol is indicative of institutional awareness and action to address pediatric radiation dose exposure. This question was asked in the previous version of the survey as well.

Protective shielding. Use of shielding was ascertained in the survey questionnaire for each TC in the previous and current survey. Respondents were asked if their hospital uses external shielding to protect any organs during head CT scans, and if so, which organs are shielded and the type of shielding used.

Estimated radiation dose. Respondents were asked to report the manufacturer and model for the CT scanner and protocols most often used for pediatric patients. We calculated the estimated effective dose (ED) and estimated absorbed dose for organs—brain, eye lens, and thyroid—for a hypothetical patient with a head trauma. We also calculated CT dose index ($CTDI_{vol}$) and dose length product (DLP), additional measures of estimated dose, for each TC. To compare with the previous survey, estimated dose was calculated for a female infant (length, 57 cm; anteroposterior size, 12.2 cm; weight, 4.2 kg) for all facilities that reported technical data. Rationale for selecting these hypothetical patient characteristics was explained previously [19]. In short, a female infant represents a patient with the highest potential risk for exposure and sensitivity to medical radiation. We calculated estimated doses using the CT-Expo Dosimetry Spreadsheet version 1.7 (Medizinische Hochschule, Hannover, Germany), a tool used previously for calculating patient organ and ED from CT scans [27]. ED is measured in milliSieverts, $CTDI_{vol}$, absorbed organ dose is measured in milliGray (mGy), and DLP is measured in milliGray × centimeter (mGy × cm). If information about more than 1 CT scanner was reported (eg, institutions use scanners in equal frequency), we reported the mean dose estimates for that institution.

Analysis

Data merging, cleaning, and statistical analysis were conducted using Stata/SE 11.2 statistical software (StataCorp LP, College Station, TX). We calculated descriptive statistics for respondents and nonrespondents (ie, TC level, population served, ACR accreditation, bed size, emergency visits) and compared them using χ^2 tests (substituted in pertinent situations with Fisher's exact test). We described the overall proportion of TCs that used a dedicated pediatric protocol and protective shielding. ED, $CTDI_{vol}$, DLP and organ dose estimates were summarized using means, standard deviations, medians, and interquartile ranges. We used χ^2 tests to compare the proportion of TCs that reported using a dedicated pediatric protocol and protective shielding in 2012 with the proportion reported in 2008-2009. Student t tests were used to compare dose estimates between baseline and follow-up.

RESULTS

Of the 79 designated TCs in 2012, 3 reported not having a CT scanner on site. Of the remaining 76, we received 65 replies, yielding 61 usable responses for analysis: a completion rate of 80.3% (Fig. 1). Four responses had incomplete information that prevented their inclusion in analyses. Sixty general TCs (levels 1-5) and one pediatric-only TC responded to the survey (Table 2). The distribution of respondents across TC levels in 2012 was not significantly different from 2008-2009 (Fisher's exact text, $P = .87$). The respondent group closely resembled nonrespondents in terms of ACR CT accreditation, bed size, and emergency department visits (no significant differences, Table 2).

Use of Dedicated Pediatric Protocols

Most responding TCs reported using a dedicated pediatric dose reduction protocol in 2012 (91.7%) (Table 3). Eighty-four percent (n = 46) of TCs that

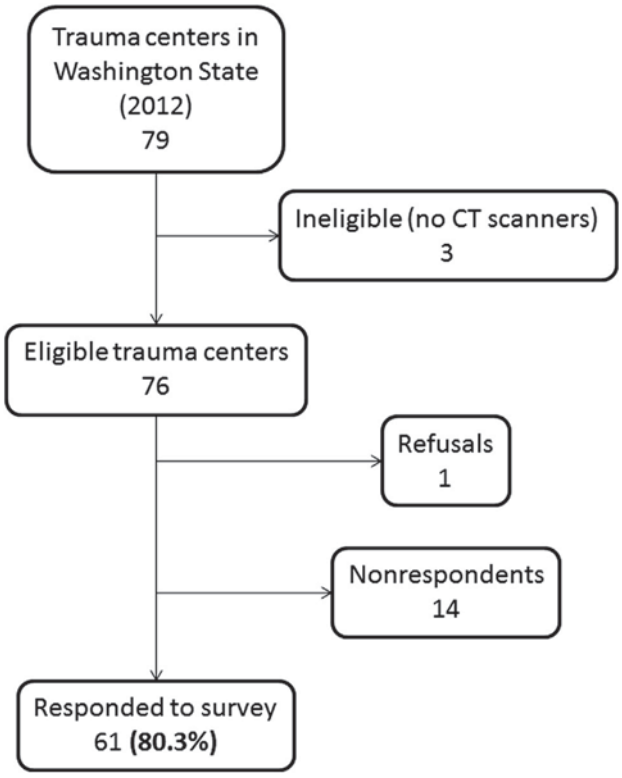

Fig 1. Response rate calculation for 2012 survey of Washington State TCs (using Council of American Survey Research Organizations formula). The response rate was the number of hospitals who completed surveys (n = 61) divided by the sum of the number who were eligible and initially consented (n = 75) plus the estimated number who were eligible among those who refused (n = 1): 61/(75 + 1) = 80.3%.

reported use of a protocol provided the year of adoption; in 39%, this occurred before 2007, 24% between 2007 and 2010, and 37% in or after 2010. There was no significant difference in year of adoption across TC level ($P = .73$).

In 2008-2009, fewer reported using a dedicated pediatric dose reduction protocol (87.8%) compared with 2012, though this difference was not statically significant ($P = .54$). The proportion of responding TCs that reported using pediatric protocols was not significantly different in 2012 than 2008-2009 ($P = .49$) (Fig. 2).

Use of Protective Shielding

In 2012, 87.9% of responding TCs reported using protective shielding when conducting head CT scans on pediatric patients, compared with 84.3% in 2008-2009 ($P = .59$) (Table 3). Most centers that reported using shielding in 2012 indicated use of bismuth shielding (53.6%, n = 30); the remainder used either lead (n = 19) or a combination of lead and bismuth shielding (n = 1) (one center did not answer this question).

Across trauma level designations, a nonsignificantly higher proportion of respondents reported using shielding in 2012 than in 2008-2009 (with the exception of one level 1 TC, which reported having a CT scanner that cannot use shielding because of its automatic tube current modulation technology; in this case, use of shielding would increase the radiation dose and is therefore not employed) (Fig. 2).

Estimated Radiation Dose

For all responding TCs in 2012, 48 (78.7%) provided sufficient information to conduct dose calculations, between 2 to 3 times as many as provided data in 2008-2009 (n = 19) [19]. (For these analyses, we were able to access 17 responses from 2008-2009 to conduct comparisons.) In 2008-2009, significantly fewer hospitals (n = 3) reported using helical mode for scanning, compared with the number in 2012 (n = 24; $p < .01$). Estimated mean $CTDI_{vol}$ was 23.1 mGy in 2012, compared to 34.8 mGy in 2008-2009 ($P = .01$). Estimated mean DLP was also significantly lower in 2012 than in 2008-2009 (307.6 mGy × cm versus 430.1 mGy × cm, respectively; $P = .04$). No significant difference was observed for estimated ED (Table 3). For eyes, the estimated mean dose in 2012 was significantly lower than the dose in 2008-2009 (30.3 mGy versus 45.2 mGy, respectively; $P = .01$). The estimated organ dose for thyroid increased significantly from 6.8 mGy in 2008-2009 to 14.7 mGy in 2012 ($P = .02$). There was not a significant change in brain organ dose between the 2 time-points.

The 2008-2009 survey results reported a 10-fold variation in estimated ED across level 4 TCs [19]. The 2012 survey shows similar variation among level 4 TCs (range, 0.9-9.2 mSv), and also 10-fold variation among level 3 TCs (range, 0.9-9.1 mSv) that was not observed in 2008-2009 (Fig. 3).

DISCUSSION

Although CT imaging is an extremely valuable tool, it brings with it risks to the patient. Adoption of appropriate dose reduction protocols helps reduce radiation risk while maintaining diagnostic imaging quality [28,29]. This study serves as a follow-up to a previous survey of Washington State TCs to understand their use of dose reduction protocols among pediatric patients receiving head CT scans.

Most Washington State TCs reported use of dedicated pediatric protocols to reduce radiation dose among children receiving head CT scans at their institution in 2012. In the 2008-2009 survey, estimated ED showed substantial variation among level 4 TCs, which persisted in 2012. Increased reporting among level 3 TCs in 2012 allowed for dose calculations among those institutions, which also showed considerable variation in estimated ED. Overall, item response rates were higher in 2012 than in 2008-2009, which allowed for a more complete analysis of results. Improved item response in 2012 may be associated with greater understanding of the importance of dose reduction among pediatric patients and increased

Table 2. Characteristics of TCs in 2012 survey, respondents and nonrespondents

Characteristic	Respondents (n = 61)		Nonrespondents (n = 18)		All Washington TCs (N = 79)	
	No.	Percent	No.	Percent	No.	Percent
General TC level						
1	1	2%	0	0%	1	1%
2	2	3%	2	11%	4	5%
3	18	30%	6	33%	24	30%
4	28	46%	5	28%	33	42%
5	11	18%	2	28%	13	20%
Pediatric only*	1	2%	0	0%	1	1%
Population served						
Pediatric only	1	2%	0	0%	1	1%
Adult only	54	88%	17	94%	71	90%
Both	6	10%	1	6%	7	9%
ACR CT accreditation†						
Yes	19	31%	7	39%	26	33%
No	42	69%	11	61%	53	67%
Bed size‡						
0-50	24	39%	7	39%	31	39%
51-150	19	31%	3	17%	22	28%
150+	18	30%	6	33%	24	30%
Emergency department visits‡						
≤5,000	17	28%	5	28%	22	28%
5,001-15,000	13	21%	2	11%	15	19%
15,001-50,000	23	38%	4	22%	27	34%
>50,001	8	13%	5	28%	13	16%

Values in table indicate the number and percentage of TCs that responded or did not respond to the 2012 survey. Percentages may not total 100% because of rounding or missing responses. No significant differences were observed between respondents and non-respondents ($\chi 2$ and Fisher's exact tests). Missing values were excluded from significance testing.

*Level 2 pediatric-only TC.

†From ACR-accredited facility search (http://www.acr.org/Quality-Safety/Accreditation). Accessed August 31, 2012.

‡From Washington State Department of Health, Community Hospital Quarterly Files, 2011. (http://www.doh.wa.gov/DataandStatisticalReports/HealthcareinWashington/HospitalandPatientData/HospitalFinancialData/QuarterlyReports.aspx). Accessed March 3, 2013. Bed size data for hospitals that did not submit data to the State Department of Health were obtained from the American Hospital Directory (www.ahd.com) profile search (n = 4).

TC = trauma center.

familiarity of dose reduction efforts, such as Image Gently®, which was implemented in 2008 and has since gained exposure [20].

Estimated radiation dose from head CT scans decreased from 2008-2009 to 2012 for some measures, whereas for others, estimated mean dose did not change (eg, ED and brain organ dose) or increased (eg, thyroid organ dose). This variation may be due to the greater use of helical scan mode reported in the current survey compared with the use of axial scan mode previously [30].

Our study showed that although use of protective shielding was widely reported among Washington State TCs in 2012, a smaller proportion of respondents indicated thyroid shielding compared with the previous survey. It is possible that respondents did not provide complete information when answering this open-ended question in the survey. Although open-ended questions may provide greater depth of information, closed-ended (fixed-response) questions generally place a lesser burden on the respondent. In the future, a closed-ended question with check boxes for organs could be considered. Shielding is a simple and effective method of dose reduction [31], but its use is not universally recommended as use of shields during scanning may introduce noise or increase beam-hardening artifacts [32]. Also, proper use of shielding depends on the design of an individual scanner; therefore, a universal approach to shielding is not appropriate for all CT scanners. In fact, inappropriately used shielding may lead to increased radiation dose [16].

Online educational modules inform radiologists and CT technologists about appropriate CT protocols and strategies to optimize image quality at the lowest dose possible [33]. In Washington State, the Department of Health supported the creation of a free, instructive web-based module that covers the following topics: CT dose monitoring, CT dosimetry, and factors that influence CT dose. Participants are also provided a list of educational resources for future reference. As part of the 2012 survey, TCs were provided with a link to access this module. (It is also accessible to the public at https://ct-dose-reduction.herokuapp.com.)

The lack of significant differences between 2008-2009 and 2012 in terms of the proportion of TCs using dose-reduction protocols or in the estimated effective dose may be due to a ceiling effect. Even in 2008-2009, most

Table 3. Survey results from general TCs in 2008-2009 and 2012

Measure	2008-2009 Survey	2012 Survey	Sig
Use of a dedicated pediatric protocol, n (%)	n = 49	n = 60	.54
Yes	43 (87.8%)	55 (91.7%)	
No	6 (12.2%)	5 (8.3%)	
Use of protective shielding, n (%)	n = 51	n = 58	.59
Yes	43 (84.3%)	51 (87.9%)	
No	8 (15.7%)	7 (12.1%)	

Estimated dose	2008-2009 Survey n = 17	2012 Survey n = 48	Sig
Effective dose, mSv			
Mean (SD)	3.1 (2.2)	3.0 (1.8)	.89
Median (IQR)	2.6 (1.7)	2.6 (2.0)	
$CTDI_{vol}$, mGy			
Mean (SD)	34.8 (25.6)	23.1 (10.9)	.01
Median (IQR)	30.9 (15.5)	20.7 (15.0)	
DLP, mGy*cm			
Mean (SD)	430.1 (315.7)	307.6 (161.4)	0.04
Median (IQR)	366.9 (233.9)	273.0 (198.5)	

Estimated organ dose	2008-2009 Survey N = 17	2012 Survey n = 48	Sig
Brain, mGy			
Mean (SD)	39.0 (28.8)	25.4 (12.0)	.08
Median (IQR)	34.7 (17.3)	22.4 (15.5)	
Eye lens, mGy			
Mean (SD)	45.2 (33.7)	30.3 (14.2)	.01
Median (IQR)	40.1 (20.0)	26.6 (18.3)	
Thyroid, mGy			
Mean (SD)	6.8 (5.7)	14.7 (12.8)	.02
Median (IQR)	4.6 (3.3)	9.4 (11.6)	

Values in table indicate responses to 2008-2009 and 2012 surveys. Values represent the number (percentage), mean (SD), or median (IQR) as indicated. Significance values represent results from χ^2 test (*P* values) comparing proportions between the 2008-2009 and 2012 surveys or unpaired Student *t* tests for dose comparisons. For comparison purposes, pediatric-only TCs are excluded from these analyses. CTDIvol = CT dose index; DLP = dose-length product; IQR = inter-quartile range; mGy = milligray; mSv = millisievert; SD = standard deviation; TC = trauma center.

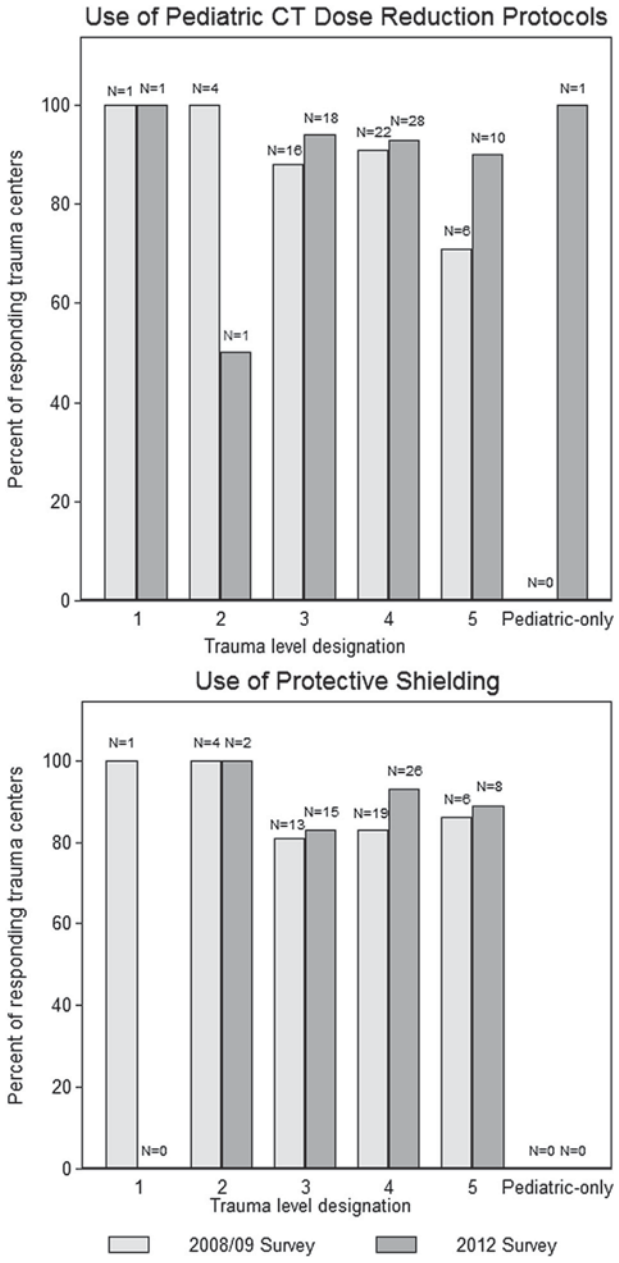

Fig 2. Dose reduction efforts across trauma level designations in 2008-2009 and 2012. Data from 2008-2009 were obtained from previous publication [18]. No significant differences comparing dose reduction efforts across trauma level designations and survey years ($P > .05$). One level 1 TC reported having a CT scanner that cannot use shielding due to its automatic tube current modulation technology; in this case, use of shielding would increase the radiation dose and is, therefore, not employed.

responding TCs reported using pediatric dose-reduction protocols, leaving limited room for improvement in 2012. Currently, Washington State does not have any state regulations for users of CT scanners to monitor or report dose. Therefore, the variation we observed in estimated dose may be due to the lack of monitoring or enforcement. Ideally, all TCs should have pediatric dose-reduction protocols in place, and substantial variation in dose should not be present. Variation in dose may also be attributed to the wide range of machines present in TCs, including older models. Modern CT scanners have dose-reduction options, such as automatic tube current modulation, which automatically decreases or increases the tube current depending on anatomy being scanned. Over time, one would expect institutions to upgrade to more modern machines that provide more dose-reduction technology than older scanners. Our survey did not explicitly ask about these options, which might have resulted in an overestimation of estimated dose for institutions with such modern scanners. Finally, the unit of analysis for this study was the institution, and individual impacts were not captured. Although we did not observe significant

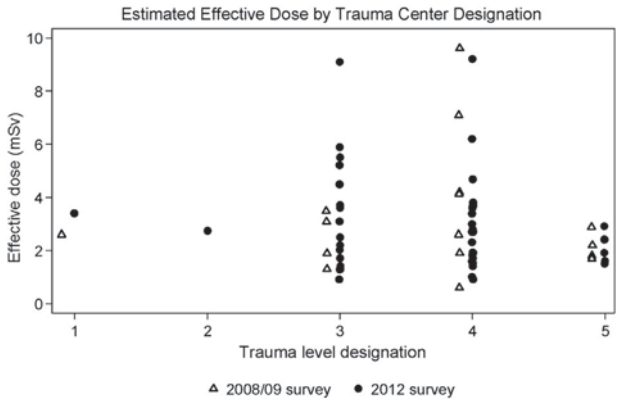

Fig 3. Estimated effective dose (mSv) across TC levels in 2008-2009 and 2012. Dose estimates based on calculations for a female infant (aged 1 year). Data from 2008-2009 reprinted from *JACR* [18] with permission from Elsevier. TC = trauma center.

changes from 2008-2009 to 2012, if one institution shows improvement of CT practices (either adoption of a pediatric protocol or reduction in estimated ED), many patients will be affected.

The wide variation observed among level 3 and 4 TCs provides evidence for additional efforts to reduce exposure to CT radiation among pediatric patients. Educational campaigns, such as Image Gently and the local web module, are crucial to support ongoing learning and skill development among CT radiologists and technologists. Appropriate, pediatric dose-reduction protocols should be employed at each institution. Educational efforts and institutional protocols are necessary to reduce pediatric radiation dose from head CTs. Involvement on the part of the radiologist, technologist, and physicist, if available, is critical for dose-reduction efforts. Forming a CT protocol review committee and reviewing protocols periodically aids in dose reduction. Studies have shown that systematic use of CT dose-reduction protocols can result in significant dose reduction while maintaining image quality [34,35].

This study has several limitations. First, the outcome measures from this study are based solely on self-report. We did not confirm or evaluate the compliance with the use of a dedicated pediatric protocol or shielding at each hospital. Dose calculations are general estimates based on information provided by respondents. If a respondent inaccurately reported one of the dose inputs, the estimated dose may be erroneously high or low. We were not able to verify the results of the surveys with institutions. In addition, information about image quality at each institution is not known. We are, therefore, not able to make conclusions about the relationship between image quality and dose for individual institutions. Second, it is possible that institutions may collaborate as radiology groups, thus sharing decisions about protocols. We were not able to measure this aspect in this study. Finally, although we were only to access raw data for 17 responses from the 2008-2009 survey to conduct comparisons, our data were also compared with the published 2008-2009 results.

In summary, we conducted a statewide survey of Washington TCs to evaluate pediatric head CT practices and estimated radiation dose in 2012 and describe changes since 2008-2009. The variation in pediatric head CT imaging protocols and radiation dose continues among Washington State TCs. For level 3 and 4 TCs, there was more than 10-fold variation in mean ED in 2012, similar to wide variation observed in 2008-2009 among level 4 TCs.

TAKE-HOME POINTS

- Most Washington State TCs employ pediatric dose-reduction protocols for head CTs.
- There is wide variation in estimated dose among level 3 and 4 TCs in 2012.
- Survey responses were much more complete in 2012 than 2008-2009, suggesting improved understanding of the importance of pediatric dose-reduction efforts.
- Educational efforts and institutional protocols are necessary to reduce pediatric radiation dose from head CTs.

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SUPPLEMENTARY DATA

Supplementary data can be found online at http://dx.doi.org/10.1016/j.jacr.2013.07.004

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Understanding Protocols for Pediatric Head CT
Washington State Trauma Center Survey

Thank you for completing this survey that will help us understand the use of protocols for head CT scans among pediatric trauma patients in Washington State Trauma Centers.

1. Hospital information	
Your hospital name	
Your hospital city	
Your email address	_____ *(Write in)*
Does your hospital have a pediatric radiologist?	☐ Yes ☐ No ☐ Do not know
What is the number of CT scanners that are on site at your hospital? *(Check one box)*	☐ 0 → *Continue to Section 6 (End).* ☐ 1 ☐ 2 ☐ 3 or more
Does your hospital perform head CT scans on 0-10 year old children being seen for trauma?	☐ Yes ☐ No → *Continue to Section 6 (End).*
Does your hospital have a dedicated protocol for a pediatric trauma patient having a head CT scan?	☐ Yes → Year implemented: _____ ☐ No ☐ Do not know

2. CT scanner information	
For the CT scanner most often used to scanning heads of pediatric patients, please provide the following information:	
What is the name of the CT manufacturer? *(Check one box)*	☐ General Electric ☐ Siemens ☐ Philips ☐ Toshiba ☐ Other _____ *(Write in)*
What is the name of the CT model? *(For example: VCT, LightSpeed, Flash, etc)*	_____ *(Write in)*
Is this scanner a single or multidetector CT?	☐ Single ☐ Multidetector → Number of channels: _____
Is this scanner accredited by American College of Radiology or another accreditation body?	☐ Yes ☐ No ☐ Do not know

3. Protocol scan parameters (0-18 month old patient)	
*Please provide the typical scan parameters that would be used for a pediatric patient between **0 and 18 months old** receiving a head scan.*	
To confirm, does your hospital perform head CT scans on trauma patients 0 to 18 months old?	☐ Yes ☐ No → *Continue to Section 6 (End).*
Kilovoltage (kV) *(For example: 80 kV, 100 kV)*	_____ kV
Tube current (mA) *(For example: 200 mA, 300 mA)*	_____ mA
Rotation time (s) *(For example: 0.5s, 1.0s)*	_____ s
Scan mode	☐ Axial ☐ Helical → Pitch: _____
Total beam collimation. *(For example: 0.625mm x 64 channels (40 mm),* *5mm x 4 channels (20 mm),* *5mm x 2 channels (10 mm))*	_____mm x _____channels (_____mm)
Anatomy scan range *(For example: Top of head to base of head; Top of head to shoulders)*	_____ *(Write in)*

4. Protocol scan parameters (18 months - 9 year old patient)	
*Please provide the typical scan parameters that would be used for a pediatric patient between **18 months and 9 years old** receiving a head scan.*	
To confirm, does your hospital perform head CT scans on trauma patients aged 18 months to 9 years old?	☐ Yes ☐ No → *Continue to Section 6 (End).*
Are the scan parameters that you use for a child aged 18 months to 9 years the same as those in Section 3 above?	☐ Yes → *Continue to Section 5.* ☐ No → *Continue to the next question.*
Kilovoltage (kV) *(For example: 80 kV, 100 kV)*	_____ kV
Tube current (mA) *(For example: 200 mA, 300 mA)*	_____ mA
Rotation time (s) *(For example: 0.5s, 1.0s)*	_____ s
Scan mode	☐ Axial ☐ Helical → Pitch: _____
Total beam collimation. *(For example: 0.625mm x 64 channels (40 mm),* *5mm x 4 channels (20 mm),* *5mm x 2 channels (10 mm))*	_____mm x _____channels (_____mm)
Anatomy scan range *(For example: Top of head to base of head; Top of head to shoulders)*	_____ *(Write in)*

5. Protective shielding	
Does your hospital use external shielding to protect organs during head CT scans?	☐ Yes ☐ No → *Continue to Section 6 (End).* ☐ Do not know → *Continue to Section 6 (End).*
Which organs are shielded? *(Check all that apply)*	☐ Eyes ☐ Thyroid ☐ Other *(Write in)* _____
What type of shielding is used? *(Check all that apply)*	☐ Bismuth ☐ Lead ☐ Other *(Write in)* _____

6. End

Thank you very much for your time and contribution to this effort to understand pediatric head CT scanning use and protocols.

The first respondent from each trauma center will receive a $5.00 Starbucks® eGift Card. If you would like to receive a gift card, please be sure that you provided an email address in Section 1.

Please **return this survey** using the stamped envelope that we provided to the following address:

Harborview Injury Prevention and Research Center
Attn: Janessa Graves, Pediatric CT protocol study
UW Box 359960
325 Ninth Avenue
Seattle, WA 98104

If you have any questions about this survey or our work, please email ctmodule@uw.edu or call 206-744-9861.

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