What's *NEXT*?

The U.S. Food and Drug Administration (FDA) and the Conference of Radiation Control Program Directors, Inc. (CRCPD) have a cooperative agreement to characterize radiation doses of patients in the current practice of diagnostic radiology. Every one-to-two years the *Nationwide Evaluation of X-ray Trends (NEXT)* program surveys a nationally representative sample of U.S. clinical facilities for radiation exposure associated with a particular modality. In 2000 a survey of computed tomography (CT) obtained data on patient dose, corresponding clinical technique factors, quality assurance practice, and procedure workload. Randomly selected in samples proportional to state populations, 265 facilities volunteered for the survey, which was carried out by radiation control agency personnel of 39 states participating in the program.

To adequately represent the broad scope and variety of procedures making up CT, the survey was comprised of two parts, both focusing on the most frequently used CT unit at each facility: (1) During site visits, *NEXT* program surveyors measured free-in-air exposure at the gantry isocenter as well as exposure in the center hole and in a peripheral hole of a standard FDA adult head CT dosimetry phantom. Interviews with facility x-ray technologists provided information about technique factors and workload, particularly for routine exams of the adult head (i.e., brain and posterior fossa). (2) A separate questionnaire captured techniques and procedure workloads for the other principal routine adult examinations: abdomen, pelvis, chest, sinus, skull, etc. Data were also obtained about quality assurance practice, pediatric CT workloads, and the numbers and types of all of the CT units available at the facilities.

Additional information about *NEXT* surveys is available from the CRCPD (http://www.crcpd.org/NEXT.asp and http://www.crcpd.org/publications.asp) and from the FDA (http://www.fda.gov/cdrh/radhlth/next.html).

The information and recommendations contained herein are advisory. Their use and implementation are at the discretion of the reader. Any mention of commercial products, their sources, or their use in connection with material reported is not to be construed as an explicit or implicit endorsement by CRCPD or FDA.

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Average Facility Workload

Most Frequently Used CT Unit [1]	**Procedures per Week** [2] Adult	Pediatric
Brain, Posterior Fossa, Orbits, Sinus, Neurospine	35	3.9
Body Exams	48	2.0
Interventional Procedures	1.4	0.024
Radiotherapy Treatment Planning	1.3	0.044
All Procedures	86	5.6

All Procedures (Adult and Pediatric) on ALL CT Units [3]	**124 per week**

1) The unshaded table refers exclusively to estimates for only *one* CT unit at each facility, namely, the single most frequently used unit. On average there are 1.3 CT units per facility.
2) Not all respondents constrained category estimates to sum precisely to estimated totals of all procedures, and such discrepancies are reflected by the average values presented in the table.
3) The gray shaded portion at the bottom corresponds to estimations for *all* CT units at each facility, not restricted to the most frequently used unit. The total 124 per week is based on a sample size N=230; standard error = 9.3 CT procedures per week.

Distribution of CT Facilities and Total Annual CT Workload

CT Facility Type	**Percentage of Sample** (N=265)	**Number of U.S. CT Facilities**[1]
Hospital	72.5%	5193
Single-specialty Practice	23.8%	1704
Multi-specialty Practice	3.0%	216
Mobile Practice	0.4%	27
Other	0.4%	27
Total	100%	7167

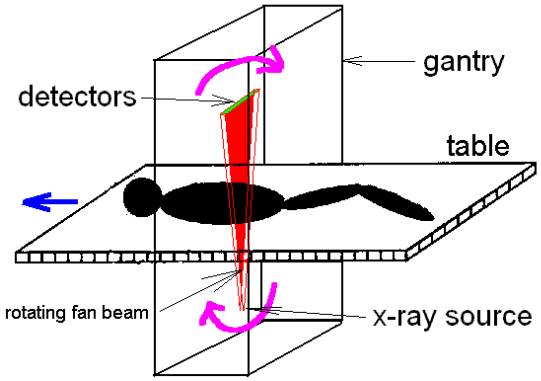
Annual Number of CT Procedures[2]	**46 million**	standard error **4 million**

1) Inferred from 2000 *NEXT* CT survey statistics and from percentage of hospitals in 50 States and D.C. reporting CT availability (*AHA Guide*™ 2000-2001 edition).
2) Estimated as the product of 7167 facilities and 124 CT procedures (adult & pediatric) per week per facility.

CRCPD Publication #NEXT_2000CT-T

Nationwide Evaluation of X-Ray Trends

2000 Computed Tomography



Conference of Radiation Control Program Directors, Inc.

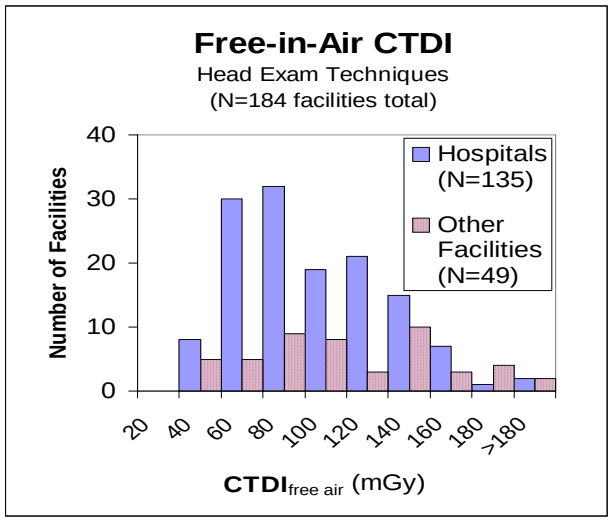
and

Food and Drug Administration
Center for Devices and Radiological Health

United States Department of Health & Human Services
Leading America to Better Health, Safety and Well-Being

Procedure[1]	Distribution Quartiles	Number of Procedures per Week	Technique Set: Slice thickness[2,9] (T, mm)	Technique Set: Table increment[3,9] (I, mm)	Technique Set: Dose Drivers: Pitch[4,9]	Technique Set: Dose Drivers: Scanning Length[9] (L, mm)	Technique Set: Dose Drivers: kVp[9]	Technique Set: Dose Drivers: mAs per rotation[9]	Technique Set: Dose Drivers: Fraction of Procedures with **Two** Contrast Phases	Radiation Dosimetry: $CTDI_{free\ air}$[5] (mGy)	Radiation Dosimetry: $CTDI_{vol}$[6] (mGy)	Radiation Dosimetry: DLP[7] (mGy-cm)	Radiation Dosimetry: E[8] (mSv)
Head[9]	First	8	7 / 5	7 / 5	**1 / 1**	80 / 40	120 /120	280 / 282	0.10	59	43	568	1.4
	Median	20	10 / 5	10 / 5	1 / 1	96 / 45	120 / 120	340 / 340	0.25	83	58	766	1.7
	Third	40	10 / 5	10 / 7	1 /1	**100 / 54**	**130 / 140**	**400 / 400**	**0.50**	116	75	1009	2.5
	Your facility's values?												
Abdomen +Pelvis[10]	First	10	7	7	**1**	400	120	200	0.01	39	11	509	8
	Median	21	8	10	1	450	120	240	0.10	51	15	749	13
	Third	39	10	12	1.5	**500**	**120**	**269**	**0.50**	74	19	949	18
	Your facility's values?												

1) Routine examination of adult patient with the most frequently used CT unit at the facility. Note: For the procedures presented, the first, median, and third quartile values of the number (n) of simultaneously acquired tomograms (images, slices) per rotation are equal to 1. 2) Nominal thickness (T) of tomographic section imaged. 3) For axial scanning, the table moves in steps of increment I per rotation. For helical scanning, the table moves continuously at a feed rate of I per rotation. 4) Pitch is the ratio I/(nT), where n is the number of simultaneously acquired tomograms per rotation (note 1); T and I are defined in notes 2 and 3. 5) Computed tomography dose index free-in-air ($CTDI_{free\ air}$) at the isocenter. $CTDI_{free\ air}$ approximates the average air kerma free-in-air at the isocenter. Note that per ICRU Report 47, 1 roentgen (R) exposure corresponds to 8.76 milligray (mGy) air kerma. For head exams $CTDI_{free\ air}$ is determined from measurements with head exam techniques. For body exams, $CTDI_{free\ air}$ is determined from measurements with filtration for body exams, with fixed 5-mm slice thickness, and each value is normalized to account for the mAs and kVp for abdomen-pelvis exams. 6) $CTDI_{vol}$ is the "volume $CTDI_w$," i.e., the weighted computed tomography dose index ($CTDI_w$) divided by the pitch. $CTDI_w$ approximates the average dose in the central tomographic section of a cylindrical dosimetry phantom undergoing multiple scans. $CTDI_{vol}$ approximates the average dose in the volume swept out by this central tomographic section as the table moves an increment I. 7) Dose-length-product (DLP) = $CTDI_{vol}$ × scanning length L. (Note: This definition applies for each facility's DLP values, not for the quartile points tabulated here.) 8) Effective dose (E) of the procedure, including all contributions from non-contrast and contrast phases. A procedure with effective dose value E carries the same risk of radiation detriment (e.g., cancer morbidity, mortality) as that associated with a whole-body dose of equivalent value in millisieverts (mSv). 9) The routine head exam scans the brain and posterior fossa regions. 61% of facilities change techniques for scanning the brain versus the posterior fossa. When two values appear in a cell, the quartile value on the left refers to the brain, whereas the quartile value on the right refers to the posterior fossa. Single values in cells of the head procedure refer to the combination brain+posterior fossa. *Values for the head exam refer to axial scanning only.* 10) *Values for the abdomen+pelvis exam refer to helical (spiral) scanning only.*



Note the broad spread, from 21 mGy minimum to 253 mGy maximum. Can facilities with values larger than the third quartile point (116 mGy) reduce doses and maintain acceptable images?

How Does Your Facility Fit into the State-of-Practice?

The preceding table presents quartile points for some of the technique parameters and associated radiation doses of the two most common CT procedures — routine exams of the head and of the abdomen+pelvis. For each column listing a parameter, entries in rows labeled "first," "median," and "third" quartiles correspond respectively to those percentile points for which 25%, 50%, and 75% of the numbers of survey sample values are smaller in magnitude. For example, for head exams, in 75% of all facilities sampled the value of $CTDI_{vol}$ is *less* than 75 mGy. Another example, for abdomen+pelvis exams: only 25% of the facilities sampled use two phases (no-contrast + contrast) as opposed to just one phase in *more* than half of such exams.

How does your facility measure up? Scanning length, kVp, mAs, and multiple contrast phases drive the dose: the larger they are, the larger the dose. These parameters can be controlled by the operator according to facility protocol. At your facility, do any of the values of these parameters *exceed* the third quartile values found in the survey? Pitch also influences dose: the smaller the pitch, the larger the dose. Does the pitch used in your facility's exam of the head or abdomen+pelvis fall *below* the first quartile value (pitch = 1) found in the survey? Such quartile points may be considered as "reference values," bounds within which most facilities conduct their practice (Joel E. Gray et al., *Radiology* Vol. 235, No. 2, pp. 354-358, May 2005).

If the value of any of the parameters your facility uses for these exams exceeds the third quartile value (or, for pitch, falls below the first quartile value), it is worthwhile to confer with a medical physicist and facility radiologists to adjust the protocols: *Without compromising the diagnostic efficacy of the procedures, try to bring technique values and corresponding dose indices to within the national norms suggested by these survey results.*