SLEMENS

California Law: Dose Tracking Software

SOMATOM Definition

California Law: Dose Tracking Software

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This talk is not a discussion of California, per se. The California law has provoked several other U.S. states into developing their own laws (Ct, Tx, etc.). More importantly, the software described in this talk was developed in response to the Ca Law, and it is now available world-wide. It is this RESPONSE to the California law that is the topic of this presentation.

California Law: Dose Tracking Software (new technology for managing CT dose)

DISCLOSURE: I have worked with several companies working on Dose-Tracking software so that they get it right, but have received no money, gifts, or stock in return for this participation. Nothing presented herein is intended to be an endorsement for any specific company.

California Law: Dose Tracking Software (new technology for managing CT dose)



What got us here (review)

California Senate Bill 1237 (review)

Actual Requirements of the Law

Unintended (positive) Results of the Law

Summary

Mad river hospital, No. Calif





Get the News... Not the Paper

Radiation Overdoses Point Up Dangers of CT Scans

Written by Humboldt Online Editor on 16 October 2009

New York Times Raven Knickerbocker, then an X-ray technologist at Mad River Community Hospital in Arcata, Calif., activated a CT scan 151 times



on the same area of the head of 2 ½-year-old Jacoby Roth, investigators concluded.

California hospital fined \$25,000 for pediatric CT radiation overdose

By <u>Cynthia E. Keen</u> AuntMinnie.com staff writer March 24, 2009

Parents sue California hospital over pediatric CT radiation overdose

By <u>Cynthia E. Keen</u> AuntMinnie.com staff writer November 20, 2008

A rural California hospital is being sued by parents of a child who underwent a CT exam during an emergency department visit for a neck injury. The parents allege that their 23month-old boy received radiation burns and has permanent chromosomal damage due to excessive radiation exposure from the CT scan, which took over an hour to perform.





Cedars-Sinai, Los Angeles





2. 0.5. Department of Health & Human Services			>>> www.hhs.gov
EDA U.S. Food and Drug Administration	A-Z Index	Search	9
Home Food Drugs Medical Devices Vaccines, Blog	od & Biologics Animal &	t Veterinary Cosme	etics Radiation-

Safety Investigation of CT Brain Perfusion Scans: Update 12/8/2009



CT perfusion imaging





CT perfusion: 40 CT scans of the head





time



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120 kV 20 mA Scan 4070 ms Sice 400.00 mm Tit: 0.000000 SCOUD MODE

Contrast: VVVV / VVL 1193 / 130



Dose report from CT Head Perfusion Study

LightSpeed VCT

Exam Description: BRAIN ANGIO/PERFUSION

	Dose Report						
Series	Туре	Scan Range (mm)	CTDIvol (mGy)	DLP (mGy–cm)	Phantom cm		
1	Scout	-	-	-	-		
2	Axial	139.000-11.500	60.57	242.29	Head 16		
2	Axial	l2.000-\$133.000	60.57	848.00	Head 16		
202	Axial	1231.250-1231.250	114.40	57.19	Head 16		
3	Helical	I253.000-\$121.375	156.71	6198.51	Head 16		
4	Axial	137.000-\$0.500	60.57	242.29	Head 16		
4	Axial	S-0.000-S135.000	60.57	848.00	Head 16		
5	Cine	\$35.000-\$70.000	4371.42	17485.70	Head 16		
		Total	Exam DLP:	25921.98			

CTDI_{vol} of 4371 mGy

CTDI_{vol} of 4371 mGy

Scanner	kVp	Sub-	Scanner	CTDI (H	ead, mGy/	100mAs)
Group		group		Air	Centre	Perip
GE.o	80	GE.o.080	GE LightSpeed VCT	14.8	8.3	10.0
GE.o	100	GE.o.100	GE LightSpeed VCT	24.2	15.3	17.4
GE.o	120	GE.o.120	GE LightSpeed VCT	35.0	23.7	26.1
GE.o	140	GE.o.140	GE LightSpeed VCT	46.9	33.1	35.5

25.3 mGy /100 mAs

4371 / 25.3 = 172 times $35 \times 172 = 6046 \text{ mGy CTDI}_{air}$ $6046 \times 1.386 \text{ (ISL}) = 8,381 \text{ mGy} = 8.3 \text{ Gy}$ $8.3 \times \frac{1}{2} \approx 4.1 \text{ Gy}$

What went wrong?

Automatic Exposure Control

A short treatise on Automatic Exposure Control in CT





A short treatise on Automatic Exposure Control in CT



Siemens' CT scanners

A short treatise on Automatic Exposure Control in CT



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CA Legislative Activities

Sen. Padilla introduced SB 1237 in Feb 2010

 Radiation Control: Health Facilities and Clinics
 Governor signed SB 1237 on September 29, 2010

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SB 1237/ SB 38

The most important provision of the law:

Commencing July 1, 2012

Must record the radiation dose (CTDI_{vol} and DLP) of CT studies in the radiology report

Most radiologists use digital dictation to generate their clinical interpretation



UC DAVIS MEDICAL CENTER	Patient	Name:			Exar	n no:			
LightSpeed16 ctri Dose Report	Accessi	on Numbe	er:		A	kpr 2009			
Ser: 999 lmg: 1 / 1 Toble Rec					Li	ghtSpeed16			
	Exam Description: CT CHEST WITH CONTRAST								
			Dose R	eport					
	Series	Туре	Scan Range (mm)	CTDIvol (mGy)	DLP (mGy-cm)	Phantom cm			
	1	Scout	-	-	-	-			
	2	Helical	1510.250-1700.250	15.55	349.79	Body 32			
	4	Helical	150.000-1395.000	17.48	661.77	Body 32			
	4	Helical	1230.750-1715.750	16.09	834.64	Body 32			
	4	Helical	1230.750-1725.750	7.98	421.68	Body 32			
			Tota	I Exam DLP:	2267.88				
			1/	1					
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Decembrance Senis Type: Conclusion (CDual B27 Flummum Senis Type: Senis Senis (Senis Senis Sen	9		0000						
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Legislators Make the Laws



Staff at the California Radiological Health Branch have to enforce the laws

Jerry Helmsley

C-CAMP* contributors

- John Boone: University of California Davis
- Christopher Cagnon: UC Los Angeles
- Melissa Martin: Therapy Physics, Inc. Gardena, CA.
- Michael McNitt-Gray: UC Los Angeles
- Thomas R. Nelson, UC San Diego
- J. Anthony Seibert: University of California Davis

*California Clinical and Academic Medical Physicists

Frequently Asked Questions (FAQs)

H&S Code Section 115113(a)(1) Repeating of a CT examination, unless otherwise ordered by a physician or a radiologist, if the following dose values are exceeded:

(A) 0.05 Sv (5 rem) effective dose equivalent.

(B) 0.5 Sv (50 rem) to an organ or tissue.

(C) 0.5 Sv (50 rem) shallow dose equivalent to the skin.

2. What does "repeating a CT examination unless otherwise ordered by a physician or radiologist" mean?

This means that a technologist must repeat an examination due to instrument malfunction, wrong technical factors, incorrect positioning, or miscommunication, which render the image non-diagnostic.

 After reviewing H&S Code Section 115113(a)(1), it appears that <u>all the dose</u> values referenced in this Section have to be exceeded, to trigger the reporting requirement for a <u>repeat</u> CT examination. Is this true?

If the CT examination is repeated, <u>all</u> dose values listed in this subsection would need to be exceeded before mandatory reporting is required.

4. Assume that a CT scanner breaks during a procedure and the technical factors are high enough to exceed the dose values referenced in this subsection. The actual patient exposure time is unknown. How do we calculate radiation doses?

Frequently Asked Questions (FAQs)

H&S Code Section 115113(a)(3) CT or therapeutic exposure that results in unanticipated permanent functional damage to an organ or a physiological system, hair loss, or erythema, as determined by a qualified physician.

7. What defines "unanticipated" in Section 115113(a)(3)?

If the patient received instructions concerning the risks and potential consequences of a procedure, and has given consent prior to the procedure being performed, then the facility has met the definition of an anticipated event.

Due to age, health status, or confounding medical conditions the radiation exposure(s) can cause organs or physiological system to fail. If this unanticipated event occurs, then it must be reported.

8. Hair loss or erythema is usually a transient event. Do we report all unanticipated events or just permanent events?

Report all unanticipated hair loss or erythema episodes.

 Section 115113(a)(3) references unanticipated permanent functional damage. Is a facility required to report radiation-induced cataracts, if they are repaired?

Yes, if the cataracts are found by a qualified physician to have been an unanticipated consequence of the procedure.

Computed Tomography Dose Limit Reporting Guidelines for Section 3 – 115113

California Dose Reporting Law

Three sections to the Health and Safety Code: (115111, 115112, 115113) Senate Bill SB 1237, enacted November, 2010 Section 3 in force January 1, 2011

Recommendations of the California Clinical and Academic Medical Physicists (C-CAMP) (ver. 5.0/2010-Dec-06)

Patient Effective Dose Threshold: 50 mSv $E = DLP \times k$

DLP Triggers for Effective Dose for Reporting Incorrect/Repeated Exams (Siemens scanners only)

	0 yr old	1 yr old	5 yr old	10 yr old	adult
head and neck	3840	5880	8770	11900	16120
head and neဋk	4540	7460	12500	15620	23800
neck	2940	4160	4540	6320	8470
chest	550	830	1200	3840	3570
abd/pelvis	440	720	1080	3330	3330
trunk (C/A/P)	490	770	1140	3570	3330

DLP in mGy*cm

UC Dose Optimization and Standardization Endeavor





UC DOSE



UC DOSE researchers interviewed 4 different DOSE REPORTING software companies, and finally went with one.

We negotiated that all 5 medical centers would receive this software FREE for 18 months, and we would work with the vendor to make it robust and useful.





The Structured Dose Report with Radimetrics Feed



The Structured Dose Report with Radimetrics Feed



The Structured Dose Report with Radimetrics Feed

Report: Gaga, Lady – MRN: 1234567 EXAM DATE [5/24/2012 12:35 pm] **INDICATION:** Ш DOSE: [There were two exposure events in this study: Series 1: CTDI=12.4, DLP=496, 32 cm Series 2: CTDI=13.2, DLP=577, 32 cm See <u>www.ucdavis.edu/CTdose</u> for further information.] FINDINGS: [] **IMPRESSION:** []





CT scans per day

Dashboard Patients Examinations Protocol Editor Protocols	Dosimetry Calibration Configuration					Administrator 🔀 1514/1514	Settings Log	
Overview Utilization Distributions +								
Prior Month 9/09/01/2011 09/30/2011							E 2 E	
Device Monitor		- ×	Device Monitor				□ ×	
Volume Examinations Activity			Volume Examinations	Activity				
AM 10:50AM 10:55AM 11:00AM 1*	1:05AM 11:10AM 11:15AM	11:20AM 11:25AM	60 -			• • • • • • • • • • • • • • • • • • •		
Chest WITHOUT/Tho 00173254 HEAD WIO(Head (CT C/A/P WITh 00173250 001	HThorax (I HEAD WO/Head (CT) 173259 00173260	HEAD WITH/Head (C' 00173258		. 🚺	wee	kends		
Chest WITHOUT/Tho 00173253		HEAD W/O/Head (CT 00173261						
			50					
		Zoom:						
	0/01/2011 📅 []		40					
Device Monitor			40					
Volume Examinations Activity	Patient							
00354646 CT HEAD WITHOUT/Head	00068660 DEJAEGER. BLC	OSSOM						
Performed: 2011-10-10 11:42 PM	F DO8: 1928-12-01 Age:	83						
00354641 CT CHEST WITH/Thorax Performed: 2011-10-10 9:56 PM	00141616 BASSOLINO, RC M DOB: 1967-05-11 Apr:	DLLAND	30	i i 🖂 i				
00354640 CT CERVICAL-TRAUMAISpine Performed: 2011-10-10 9:50 PM	00141616 BASSOLINO, RC M DOB: 1967-05-11 Apr:	DLLAND						
00354608 CT Chest WITH/Thorax	00078653 GILLS, FABI	IAN						
Performed: 2011-10-10 6:19 PM	M D08: 1934-01-11 Age:	π	20 — — —					
00354603 CT HEAD WITHOUT/Head	00141609 IALONGO, BO	DBBIE						
Performed: 2011-10-10 5:41 PM	F 008: 1962-03-05 Age:	49						
00354212 CT Wrist/ Hand/Orthoped Performed: 2011-10-10 4:30 PM	M D08: 1996-12-03 Age:	15						
00354213 CT HEAD WITHOUT/Head	00141522 TIEFENAUER, IS	SMAEL	10					
Performed: 2011-10-10 4:16 PM	M DOB: 1919-06-19 Age:	92						
00354211 CT Lumbar/Spine	00138764 GILLHAM, BR	COKS						
Performed: 2011-10-10 4:03 PM	M DOB: 1953-01-15 Age:	58						
00354206 CT Lumbar/Spine Performed: 2011-10-10 3/45 PM	00141520 VALLIERE, C M DOB: 1954-05-13 Apr:	57						
III 10	0/11/2011				- Hid Sep 1 2011 - Fil Se	, , , , , , , , , , , , , , , , , , , 		

Individual patient's cumulative effective dose by organ



Software based analysis of CT doses Break-down of CT procedures for different CT scanners



Dose by scanner

re base oftwal analysi



Dose by Device (CT)

Dose by scanner type





Software based analysis of CT doses CT protocol review

Protocol					
Modality: CT v Name: Abdomen-Stone Protocol Revision: 1					Update Previet
Information Contrast Imaging Protocol Diagrams Dose Reference Levels Revision History Linked Protocols		155%	↓ 1 / 3)	· IÞ 🕐 📃 🤉	
Head Neck Chest Anatomy +	Body	/		C	CT Protocol
Anatomy Selection Selecton		, 	- 1		
Circulatory	Abdol	men-Stone Protoc			
Nervous	Referen	ce:			
Respiratory Reproductive	Indication Patient P	ns: Abdominal pain, ba osition: Head First-Su	ck pain, known or pine	suspected kidney stone	
B Skin	Networki	ng: Send dose report to	PACS		
	CTABPV CTABP	Codes: VO	Exam Overvi Topogram Abdomen/pelvis	ew:	
	Oral Cor	ntrast			
	Туре	Wate	ər		
	LightS	peed VCT			
	Series 1	: Stonr I-		Scan:	Top of Kidney to SP
	Scan Mo	de Helical		Recon 1: Retro	
	Tube Rot	ation 0.5		Orientation	AXIAL
	Interval	5.0		Interval	0.625
	kV	120.0		DFOV	Skin to skin
	Speed	55		Comments:	Son
	Gantry Ti	lt 0		Do NOT send to PACS	
	SFOV	Large		Reformat 2: Coronals	
M. M.	DFOV	Skin to sk	kin	Orientation	CORONAL
	DMPR	OFF		Thickness	3.0
	Commen	ts:		DFOV	Skin to skin
	mA: <200	llow up sone use Noise in)lbs: min 75 max 250, >20	Olbs min 75 max	Window	Standard
	350			Reformat 3: Sagittals	
				Orientation	SAGITTAL
				Interval	3.0
				DFOV	Skin to skin Standard
				WINDOW	Standard
Caption					

Protocol review: "What IF" scenarios



SSDE modification to CTDIvol



Protocol review across sites (abd-pelvis)



multiple sites.

Rapid review of dose reports by patient

Dashboard	Worklists Reports Patients Examinations Protocol Editor Protocols	Configuration Administration Radimetrics	Kate MacGregor	139/139	2) 😫 🖴 🚺	J
High Doses Ches	st			Sort 👻		= 2 3	J
	00383692X CT CHEST/ABDOMEN/PELVIS W IV C/A/P WITH/Abdomen Performed: 2012-11-27 11:35 AM Brilliance 64 CT222222	xamination Dose Report	Tue Aug 21	SSDE	DLP Head /A TC y-cm	DLP Body 1523.1 mGy-cm	•
×2	00383755X CT NECK/CHEST WITH IV CONTRAST Chest/NECK C+ ARMS-//Thorax Performed: 2012-11-29 9:45 AM Brilliance 64 CT222222	is patient {MRN: 00068871X} received a total of {1} exposure event(s) during this CT exam diation dose values for each series are: posure Event: 1; Scan/Series: 3; Anatomic Area: Chest/Abdomen/Pelvis; Phantom: 32 cm): 1523 e dose indicators for CT are the volume Computed Tomography (CT) Dose Index (CTDIvol	ination. The CTDIvo n; CTDIvol (mGy): :) and the Dose Len;	ol and DLP 21; DLP (mGy- gth Product	Head /A y-cm	DLP Body 714.6 mGy-cm	
	00384822X CT CHEST/ABDOMEN/PELVIS W IV C/A/P WITH/Abdomen Performed: 2012-12-29 11:12 AM Brilliance 16P CT - OR	LP), and are measured in units of mGy and mGy-cm, respectively. These indicators are not m the CT scanner acculsition factors and may substantially underestimate or overestimate 00155652X FONCECA, Rene X F DOB: 1982-08-29 Age at Exam: 30y	patient dose, but va the absorbed dose 27.2 mSv	alues generated based on patient 23.7 mGy	Head N/A mGy-cm	DLP Body 1390.3 mGy-cm	
	00384513X CT CHEST/ABDOMEN/PELVIS W IV C/A/P WITH/Thorax Performed: 2012-12-23 9:28 AM Brilliance 16P CT - OR	00148831X ALLATEEF, Karole X F DOB: 1972-07-30 Age at Exam: 40y	ICRP 103 25.4 mSv	SSDE 24.7 mGy	DLP Head N/A mGy-cm	DLP Body 1259.6 mGy-cm	
12	00384830X CT THORAX WITH IV CONTRAST CHEST WITH/Thorax Performed: 2012-12-29 1:33 PM Brilliance 16P CT - OR	00148257X RENTFRO, Rene X F DOB: 1967-03-30 Age at Exam: 45y	ICRP 103 12.8 mSv	SSDE 21.7 mGy	DLP Head N/A mGy-cm	DLP Body 587.4 mGy-cm	
x3	00383570X CT NECK/CHEST/ABD/PELVIS W IV C/N/AP C+ ARMS-/+/Thorax Performed: 2012-11-21 9:04 AM Brilliance 16P CT - OR	00154784X ZECH, Trudy X F DOB: 1967-08-16 Age at Exam: 45y	ICRP 103 28.7 mSv	SSDE 24.4 mGy	DLP Head N/A mGy-cm	DLP Body 1620.6 mGy-cm	
7 of 7 exams.	00381713X CT THORAX WITH IV CONTRAST PE/Thorax Performed: 2012-10-11 6:00 PM	00153730X BELLI, Alise X	ICRP 103 17.8	SSDE 33.4	DLP Head N/A	DLP Body 797.9	V

Dose Alerts for patients with high doses

Alerts								□ ×
My Alerts 👻 W	/arning 🗾	Category	✓ New to all	► A#	ŧ:			Sort Forward Acknowled
								Acknowledge
Type Status	Date/Time	Patient	Examination		C	ose		Description
	2013-02-15 10:52:33	00064603X KUO, Jesus X F DOB: 1956-06-16 Age: 57y	00386138X CT ABDOMEN/P Abdomen WITH/Abdomen Performed: 2013-02-05 2:39 PM Brilliance 64 CT222222	ICRP 103 26.2 mSv	SSDE 21.3 mGy	DL P Head N/A mGy-cm	DLP Body 1361.1 mGy-cm	Examination dose reference level exceeded: ICRP 103. Ma:
<u> </u>	2013-02-15 12:10:26	00156675X NARDONE, Tyson X M DOB: 1948-03-12 Age: 65y	00386691X CT ABDOMEN/P Abdomen WITH/Abdomen Performed: 2013-02-20 1:13 PM Brilliance 64 CT222222	ICRP 103 27.1 mSv	SSDE 20.6 mGy	DL P Head N/A mGy-cm	DLP Body 1744.3 mGy-cm	Examination dose reference level exceeded: ICRP 103. Ma:
_	2013-02-15 13:00:57	00153385X PANCHO, Chas X M DOB: 1965-09-07 Age: 47y	00387035X CT ABDOMEN/P Abdomen WITH/Abdomen Performed: 2013-02-28 11:49 AM Brilliance 64 CT222222	ICRP 103 24.1 mSv	SSDE 22.9 mGy	DL P Head N/A mGy-cm	DLP Body 1538.2 mGy-cm	Examination dose reference level exceeded: CTDIvol Body. 150.00
Δ	2013-02-15 10:17:19	00154627X TESKA, Ulysses X M DOB: 1951-10-29 Age: 61y	00385878X CT ABDOMEN/P Abdomen WITHOUT/Abdomen Performed: 2013-01-30 7:08 AM Brilliance 64 CT222222	ICRP 103 20.9 mSv	SSDE 19.1 mGy	DL P Head N/A mGy-cm	DLP Body 1335.9 mGy-cm	Examination dose reference level exceeded: CTDIvol Body. 150.00 M
_	2013-02-15 10:32:55	00156292X LEMP, Constance X F DOB: 1945-09-13 Age: 67y	00385993X CT ABDOMEN/P Abdomen WITHOUT/Abdomen Performed: 2013-02-02 9:06 AM Brilliance 64 CT222222	ICRP 103 37.4 mSv	SSDE 27.4 mGy	DL P Head N/A mGy-cm	DLP Body 1961.1 mGy-cm	Examination dose reference level exceeded: ICRP 103. Ma:
Δ	2013-02-15 10:32:56	00156292X LEMP, Constance X F DOB: 1945-09-13 Age: 67y	00385993X CT ABDOMEN/P Abdomen WITHOUT/Abdomen Performed: 2013-02-02 9:06 AM Brillance 64 CT222222	ICRP 103 37.4 mSv	SSDE 27.4 mGy	DL P Head N/A mGy-cm	DLP Body 1961.1 mGy-cm	Examination dose reference level exceeded: CTDIvol Body. 150.00
	2013-02-15 10:56:40	00156393X FOSHER, Boyd X	00386168X CT ABDOMEN/P	ICRP 103	SSDE	DL P Head	DLP Body	Examination dose reference level exceeded: CTDIvol Body.
1 to 50 of 139 alerts.								

CTDI_{vol} based Dose Alerts by CT protocol (red=alert)



SSDE based Dose Alerts by CT protocol (alerts gone)



Before & After implementation of IR Software

GE CT Scanner Head CTDIvol: 2010

GE CT Scanner Head CTDIvol: 2013



Before & After implementation of IR Software



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California Law: Dose Tracking Software Summary

- Several CT accidents happened in California
- A CT DOSE law was passed
- Software to address the law has been developed
- It provides excellent CT protocol evaluation
- Medical Physicists should become more involved in CT protocol evaluation

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Introduction



