

Collecting digital dose data. Very nice, but how can I do it?

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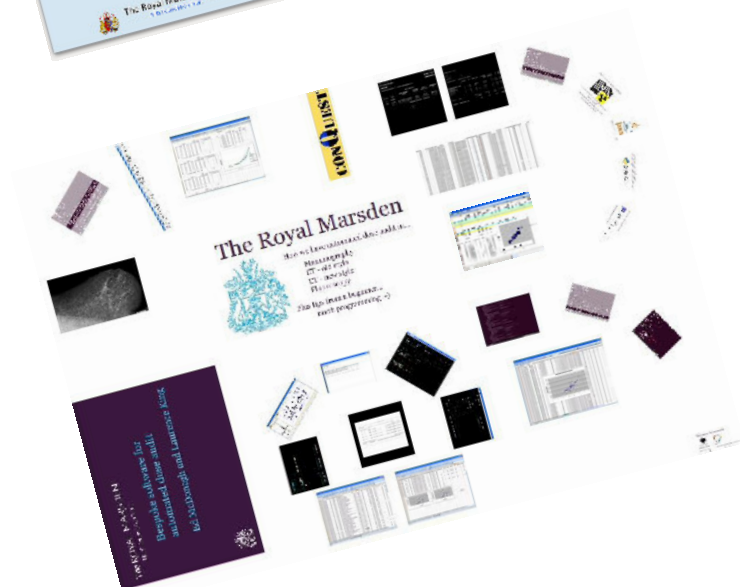
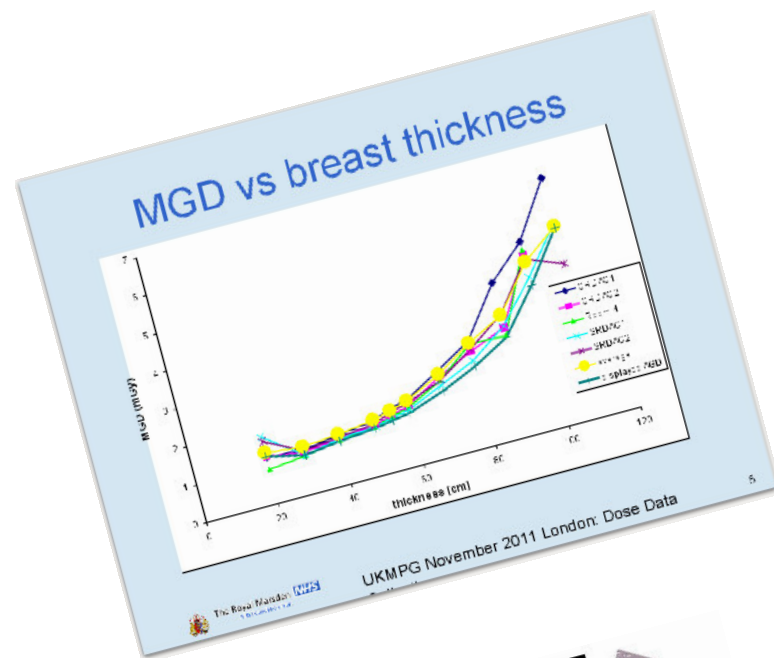
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Why am I doing this talk?





* probably

What am I going to talk about?

- Decision making process
- High level steps
- Commercial offerings
- Free and open source offerings
- My recommendations
- Links

What am I not going to talk about?

- Network and DICOM stuff you should ideally know
 - ▶ There will be something in the slides on the website
- Quite a lot of other things

Three options:



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- C

- B
- S

Digital analysis and reporting systems for diagnostic radiation doses

Information Paper for Radiology and Medical Physics Staff

Purpose

This information paper is for radiology and medical physics staff buying X-ray/CT equipment, a PACS or a dose data analysis system.

Key recommendation 1: Ensure that any new X-ray/CT equipment, PACS or dose analysis system meets interoperability standards so that digital dose data can be collated on a local, regional or national basis in order to assist optimisation.

Key recommendation 2: That the clinical and scientific validity of some of the features on offer are examined before implementation.

Issue

- Newer X-ray and CT modalities can export digital dose data to PACS or a dose analysis system using the DICOM* standard, facilitating the creation of a comprehensive database of radiation dose data. This will provide a valuable resource that can be used in setting diagnostic reference levels and for carrying out dose optimisation.
- Software is available to store and analyse these data and export them to other systems. The Department of Health (DH) (Health Protection) convened a Working Group to examine the information available on the market and to report to the NHS

Key recommendation 1: Ensure that any new X-ray/CT equipment, PACS or dose analysis system meets interoperability standards so that digital dose data can be collated on a local, regional or national basis in order to assist optimisation.

Key recommendation 2: That the clinical and scientific validity of some of the features on offer are examined before implementation.

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PACS group forum: goo.gl/qN4Le

Direct link to doc: goo.gl/5uU4q (PDF, 26 kB)

Basic high level steps

- A PC or virtual machine - Windows or linux

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- Blessing (and possibly money/resources) from IT and Radiology
- Some knowledge of networking and DICOM networking
 - See the primer at the end of this talk

Commercial options



GE Healthcare

DoseWatch



radimetrics

eXposure™



*Other products are/will be available

Open Source or free options

SIEMENS CARE Analytics –
Enhanced Dose Reporting



GROK -  **BRIGHAM AND
WOMEN'S HOSPITAL**
A Teaching Affiliate of Harvard Medical School
General Radiation Observation Kit

 **PixelMed Publishing**



DoseUtility

	Licence	Operating system	Software	Store SCP	Q-R SCU	Dose Screen	Dose Screen, plus Sample Images	Full data set	RDSR Use
Siemens CARE Analytics	Freeware	Windows	Excel	✓	✓				✓
Radiance Tessa Cook, Hospital of the University of Pennsylvania in Philadelphia, PA	Open source	Windows	XAMPP, Java	✓	✓	using GO CR			✓
GROK Brigham and Women's Hospital, Boston, MA	Open source	Windows / Linux / Mac	Java, PostgreSQL or MS SQL Server		✓		using PixelMed		
PixelMed DoseUtility David Clunie	Open source	Windows / Linux / Mac	Java	✓	✓	✓	✓	✓	✓
PixelMed DICOM toolkit plus OFFIS DCMTK plus Ed's code	Open source	Windows / Linux / Mac	Java, Python, MySQL, Excel	✓	✓	✓	✓	✓	✓

RDSR

request
details in its config
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	RDSR Make	Export to Excel	Patient data	Patient size	Suitable for dose audit	Extra features
Siemens CARE Analytics		✓	ID		✓	Export full data or collated monitoring data 
Radiance Tessa Cook, Hospital of the University of Pennsylvania in Philadelphia, PA	using PixelMed	Dump from database	ID, DOB	if in DICOM	Probably	Configurable exam set to apply conversion factors to effective dose. Web based dashboard Send to ACR Registry 
GROK Brigham and Women's Hospital, Boston, MA		Dump from database	ID, DOB	if in DICOM	Probably	Anatomical region matching
PixelMed DoseUtility David Clunie	✓	Not really	All	if in DICOM	Not without further processing	Anonymise and send to dose registry. Launch latest version from web – no install
PixelMed DICOM toolkit plus OFFIS DCMTK plus Ed's code	✓	✓	None	if in DICOM	✓	Work in progress...

	J	K	L	M	N	O	P	Q	R	S	T
1	Exposure Time (s)	Scanning Length (mm)	Nominal Single Collimation Width (mm)	Nominal Total Collimation Width (mm)	Pitch Factor (ratio)	Organ Characteristic	Body Size	X-ray Modulation Type	Pulsing	CareDose4D	Number of X-ray Sources (X-ray so
2	5.49	337	0.6	38.4	0.8	Abdomen	Adult	XYZ_EC	OFF	ON	1
3	11.84	727	0.6	38.4	0.8	Abdomen	Adult	XYZ_EC	OFF	ON	1
4	0.5	10	10	10		Abdomen	Adult	OFF	OFF	OFF	1
5	2	10	10	10		Abdomen	Adult	OFF	OFF	OFF	1
6	16.88	777	0.6	38.4	0.6	Abdomen	Adult	XYZ_EC	OFF	ON	1
7	0.5	10	10	10		Abdomen	Adult	OFF	OFF	OFF	1
8	2	10	10	10		Abdomen	Adult	OFF	OFF	OFF	1
9	16.02	737	0.6	38.4	0.6	Abdomen	Adult	XYZ_EC	OFF	ON	1
10	0.5	10	10	10		Abdomen	Adult	OFF	OFF	OFF	1
11	1.5	10	10	10		Abdomen	Adult	OFF	OFF	OFF	1
12	14.72	677	0.6	38.4	0.6	Abdomen	Adult	XYZ_EC	OFF	ON	1
13	0.5	10	10	10		Abdomen	Adult	OFF	OFF	OFF	1
14	2	10	10	10		Abdomen	Adult	OFF	OFF	OFF	1
15	16.41	755	0.6	38.4	0.6	Abdomen	Adult	XYZ_EC	OFF	ON	1
16	0.5	10	10	10		Abdomen	Adult	OFF	OFF	OFF	1
17	1.5	10	10	10		Abdomen	Adult	OFF	OFF	OFF	1
18	14.27	657	0.6	38.4	0.6	Abdomen	Adult	XYZ_EC	OFF	ON	1
19	0.5	10	10	10		Abdomen	Adult	OFF	OFF	OFF	1
20	1	10	10	10		Abdomen	Adult	OFF	OFF	OFF	1
21	18.8	865	0.6	38.4	0.6	Abdomen	Adult	XYZ_EC	OFF	ON	1
22	0.5	10	10	10		Abdomen	Adult	OFF	OFF	OFF	1
23	2	10	10	10		Abdomen	Adult	OFF	OFF	OFF	1
24	13.97	643	0.6	38.4	0.6	Abdomen	Adult	XYZ_EC	OFF	ON	1
25	0.5	10	10	10		Abdomen	Adult	OFF	OFF	OFF	1
26	1	10	10	10		Abdomen	Adult	OFF	OFF	OFF	1
27	15.1	695	0.6	38.4	0.6	Abdomen	Adult	XYZ_EC	OFF	ON	1
28	0.5	10	10	10		Abdomen	Adult	OFF	OFF	OFF	1
29	1	10	10	10		Abdomen	Adult	OFF	OFF	OFF	1
30	16.59	763	0.6	38.4	0.6	Abdomen	Adult	XYZ_EC	OFF	ON	1
31	0.5	10	10	10		Abdomen	Adult	OFF	OFF	OFF	1
32	1	10	10	10		Abdomen	Adult	OFF	OFF	OFF	1
33	13.41	617	0.6	38.4	0.6	Abdomen	Adult	XYZ_EC	OFF	ON	1
34	0.5	10	10	10		Abdomen	Adult	OFF	OFF	OFF	1
35	2	10	10	10		Abdomen	Adult	OFF	OFF	OFF	1
36	16.49	759	0.6	38.4	0.6	Abdomen	Adult	XYZ_EC	OFF	ON	1
37	5	173	0.6	38.4	0.9	Head	Adult	Z_EC	OFF	ON	1
38	5	173	0.6	38.4	0.9	Head	Adult	Z_EC	OFF	ON	1
39	5	173	0.6	38.4	0.9	Head	Adult	Z_EC	OFF	ON	1
40	0.5	10	10	10		Abdomen	Adult	OFF	OFF	OFF	1
41	2.5	10	10	10		Abdomen	Adult	OFF	OFF	OFF	1
42	9.24	568	0.6	38.4	0.8	Abdomen	Adult	XYZ_EC	OFF	ON	1
43	5	173	0.6	38.4	0.9	Head	Adult	Z_EC	OFF	ON	1
44	0.5	10	10	10		Abdomen	Adult	OFF	OFF	OFF	1
45	2	10	10	10		Abdomen	Adult	OFF	OFF	OFF	1
46	16.24	747	0.6	38.4	0.6	Abdomen	Adult	XYZ_EC	OFF	ON	1
47	0.5	10	10	10		Abdomen	Adult	OFF	OFF	OFF	1
48	3	10	10	10		Abdomen	Adult	OFF	OFF	OFF	1
49	5.74	353	0.6	38.4	0.8	Abdomen	Adult	XYZ_EC	OFF	ON	1
50	0.5	10	10	10		Abdomen	Adult	OFF	OFF	OFF	1
51	1	10	10	10		Abdomen	Adult	OFF	OFF	OFF	1
52	15.67	721	0.6	38.4	0.6	Abdomen	Adult	XYZ_EC	OFF	ON	1
53	0.5	10	10	10		Thorax	Adult	OFF	OFF	OFF	1
54	0.5	10	10	10		Thorax	Adult	OFF	OFF	OFF	1
55	4.79	441	0.6	38.4	1.2	Thorax	Adult	XYZ_EC	OFF	ON	1
56	5.2	320	0.6	38.4	0.8	Abdomen	Adult	XYZ_EC	OFF	ON	1
57	12.36	759	0.6	38.4	0.8	Abdomen	Adult	XYZ_EC	OFF	ON	1
58	0.5	10	10	10		Abdomen	Adult	OFF	OFF	OFF	1
59	1	10	10	10		Abdomen	Adult	OFF	OFF	OFF	1
60	16.85	775	0.6	38.4	0.6	Abdomen	Adult	XYZ_EC	OFF	ON	1
61	0.5	10	10	10		Abdomen	Adult	OFF	OFF	OFF	1
62	2	10	10	10		Abdomen	Adult	OFF	OFF	OFF	1

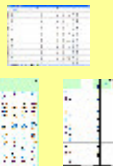
Organ Characteristic	Acquisition Protocol	Min CTDIvol	Ø CTDIvol	Max CTDIvol	Min DLP	Ø DLP	Max DLP
Abdomen	Liver	4.89 mGy	7.5 mGy	8.95 mGy	150.74 mGycm	211.398571428571 mGycm	290.48 mGycm
	TAP	1.18 mGy	10.0971501706485 mGy	27.8 mGy	29.37 mGycm	712.657645051195 mGycm	2114.36 mGycm
	PreMonitoring	1.17 mGy	1.1897238372093 mGy	2.4 mGy	1.17 mGycm	1.1897238372093 mGycm	2.4 mGycm
	TAP IV	2.49 mGy	8.62596774193549 mGy	20.68 mGy	147.47 mGycm	575.32064516129 mGycm	1310.09 mGycm
	DIEP	7 mGy	8.73375 mGy	11.94 mGy	221.31 mGycm	283.67125 mGycm	392.74 mGycm
	Liver Arterial	4.89 mGy	7.34909090909091 mGy	9.41 mGy	110.65 mGycm	200.006363636364 mGycm	294.7 mGycm
	Abdo	6.88 mGy	10.295 mGy	13.71 mGy	319.94 mGycm	387.295 mGycm	454.65 mGycm
	TA IV	3.49 mGy	5.7495 mGy	9.83 mGy	163.33 mGycm	304.306 mGycm	598.1 mGycm
	Panc	6.12 mGy	9.705 mGy	15.02 mGy	118.79 mGycm	231.965 mGycm	373.03 mGycm
	Panc Arterial	6.2 mGy	9.895 mGy	15.06 mGy	120.93 mGycm	237.4525 mGycm	371.5 mGycm
	TAP Venous	6.2 mGy	8.745 mGy	11.86 mGy	365.98 mGycm	588.9175 mGycm	815.81 mGycm
	330TAP IV	5.23 mGy	5.23 mGy	5.23 mGy	328.62 mGycm	328.62 mGycm	328.62 mGycm
	AbdoPelvis	5.65 mGy	7.19875 mGy	9.83 mGy	157.4 mGycm	309.51125 mGycm	509.95 mGycm
	Pre Liver	5.44 mGy	5.44 mGy	5.44 mGy	133.43 mGycm	133.43 mGycm	133.43 mGycm
	Liver Venous	5.65 mGy	8.63666666666667 mGy	12.03 mGy	109.02 mGycm	161.456666666667 mGycm	192.26 mGycm
	AbdoPelvis IV	5.27 mGy	8.200625 mGy	20 mGy	247 mGycm	407.908125 mGycm	1093.57 mGycm
	Pre adrenal	3.97 mGy	3.97 mGy	3.97 mGy	80.34 mGycm	80.34 mGycm	80.34 mGycm
	portal venous	4.47 mGy	4.47 mGy	4.47 mGy	108.31 mGycm	108.31 mGycm	108.31 mGycm
	15 min delay	4.01 mGy	4.01 mGy	4.01 mGy	81.19 mGycm	81.19 mGycm	81.19 mGycm
	Abdomen IV	5.74 mGy	7.56 mGy	11.9 mGy	126.52 mGycm	212.014285714286 mGycm	299.87 mGycm
	Pre Pancreas	11.31 mGy	11.31 mGy	11.31 mGy	264.2 mGycm	264.2 mGycm	264.2 mGycm
	Pancre Arterial	12.03 mGy	12.03 mGy	12.03 mGy	183.09 mGycm	183.09 mGycm	183.09 mGycm
	ThorAbdIV	3.59 mGy	8.47818181818182 mGy	19.07 mGy	178.98 mGycm	570.440227272727 mGycm	1264.53 mGycm
Head	Pre Brain	45.73 mGy	52.4527272727273 mGy	70.55 mGy	788.81 mGycm	926.896363636364 mGycm	1703.71 mGycm
	HeadSeq IV	45.22 mGy	52.8538095238095 mGy	62.22 mGy	780.01 mGycm	931.908095238095 mGycm	1287.9 mGycm
	Post Brain IV	47.26 mGy	56.3009090909091 mGy	68.68 mGy	815.2 mGycm	971.149090909091 mGycm	1184.68 mGycm
Thorax	PreMonitoring	1.17 mGy	1.17636363636364 mGy	1.2 mGy	1.17 mGycm	1.17636363636364 mGycm	1.2 mGycm
	CTPA	3.72 mGy	6.21814814814815 mGy	13.49 mGy	121.77 mGycm	209.237037037037 mGycm	431.29 mGycm
	Thorax IV	3.29 mGy	5.36964285714286 mGy	8.93 mGy	36.36 mGycm	191.7225 mGycm	455.19 mGycm
	Art Thorax IV	4.76 mGy	6.574 mGy	8.56 mGy	168.96 mGycm	240.384 mGycm	301.89 mGycm
	Thorax Hi Res	3.35 mGy	5.59692307692308 mGy	7.43 mGy	100 mGycm	206.18 mGycm	272.3 mGycm
Extremities	Knee	7.09 mGy	7.09 mGy	7.09 mGy	505.71 mGycm	505.71 mGycm	505.71 mGycm
AngioHead	Sinuses	4.76 mGy	6.255 mGy	7.75 mGy	84.91 mGycm	108.8 mGycm	132.69 mGycm

DLP

Organ Characteristic	Head					Thorax										Neck		Extremities		AngioHead	Pelv
Protocol □ □ □ Month□ □																					
	Pre Brain #	HeadSeq I#	Post Brain#			PreMonitor#	CTPA #	Thorax IV #	Art Thorax #	Thorax Hi I#		Neck IV #		Knee #		Sinuses #		Pelv			
201208	4360.44 m	5 3433.81 m	4 1038.06 m	1		3.51 mGyc	3 487.34 mG	3 932.81 mG	5 168.96 mG	1 596.54 mG		3 6461.61 m	21	0 mGycm		0 0 mGycm		0 0 mG			
201207	16031.28 r	17 4498.26 m	5 9644.58 m	10		16.38 mGy	14 2029.48 m	11 1364.07 m	8 1032.96 m	4 168.61 mG		1 8472.05 m	28	505.71 mG		1 217.6 mGy		2 406.			
201206	0 mGycm	0 11638 mG	12 0 mGycm	0		18.93 mGy	16 3132.58 m	13 2780.87 m	13 0 mGycm	0 1915.19 m		9 15517.91 r	52	0 mGycm		0 0 mGycm		0 0 mG			
201205	0 mGycm	0 0 mGycm	0 0 mGycm	0		0 mGycm	0 0 mGycm	0 290.48 mG	2 0 mGycm	0 0 mGycm		0 401.48 mG	2	0 mGycm		0 0 mGycm		0 0 mG			
Total	20391.72 r	22 19570.07 r	21 10682.64 r	11		38.82 mGy	33 5649.4 mG	27 5368.23 m	28 1201.92 m	5 2680.34 m		13 30853.05 r	103	505.71 mG		1 217.6 mGy		2 406.			

CTD|vol

Organ Characteristic	Head					Thorax										Neck		Extremities		AngioHead	Pelv
Protocol □ □ □ Month□ □	Pre Brain #	HeadSeq I#	Post Brain#	PreMonitor#	CTPA #	Thorax IV #	Art Thorax #	Thorax Hi I#	Neck IV #	Knee #	Sinuses #	Pelv									
201208	252.79 mG	5 199.07 mG	4 60.18 mGy	1 3.51 mGy	3 15.94 mGy	3 24.64 mGy	5 4.76 mGy	1 16.78 mGy	3 278.8 mGy	21 0 mGy	0 0 mGy	0 0 mG									
201207	901.17 mG	17 260.78 mG	5 559.13 mG	10 16.38 mGy	14 59.15 mGy	11 41 mGy	8 28.11 mGy	4 4.62 mGy	1 377.99 mG	28 7.09 mGy	1 12.51 mGy	2 9.4 r									
201206	0 mGy	0 650.08 mG	12 0 mGy	0 18.93 mGy	16 92.8 mGy	13 73.47 mGy	13 0 mGy	0 51.36 mGy	9 684.45 mG	52 0 mGy	0 0 mGy	0 0 mG									
201205	0 mGy	0 0 mGy	0 0 mGy	0 0 mGy	0 0 mGy	0 11.24 mGy	2 0 mGy	0 0 mGy	0 21.43 mGy	2 0 mGy	0 0 mGy	0 0 mG									
Total	1153.96 m	22 1109.93 m	21 619.31 mG	11 38.82 mGy	33 167.89 mG	27 150.35 mG	28 32.87 mGy	5 72.76 mGy	13 1362.67 m	103 7.09 mGy	1 12.51 mGy	2 9.4 r									

	RDSR Make	Export to Excel	Patient data	Patient size	Suitable for dose audit	Extra features
Siemens CARE Analytics		✓	ID		✓	Export full data or collated monitoring data 
Radiance Tessa Cook, Hospital of the University of Pennsylvania in Philadelphia, PA	using PixelMed	Dump from database	ID, DOB	if in DICOM	Probably	Configurable exam set to apply conversion factors to effective dose. Web based dashboard Send to ACR Registry 
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PixelMed DICOM toolkit plus OFFIS DCMTK plus Ed's code	✓	✓	None	if in DICOM	✓	Work in progress...

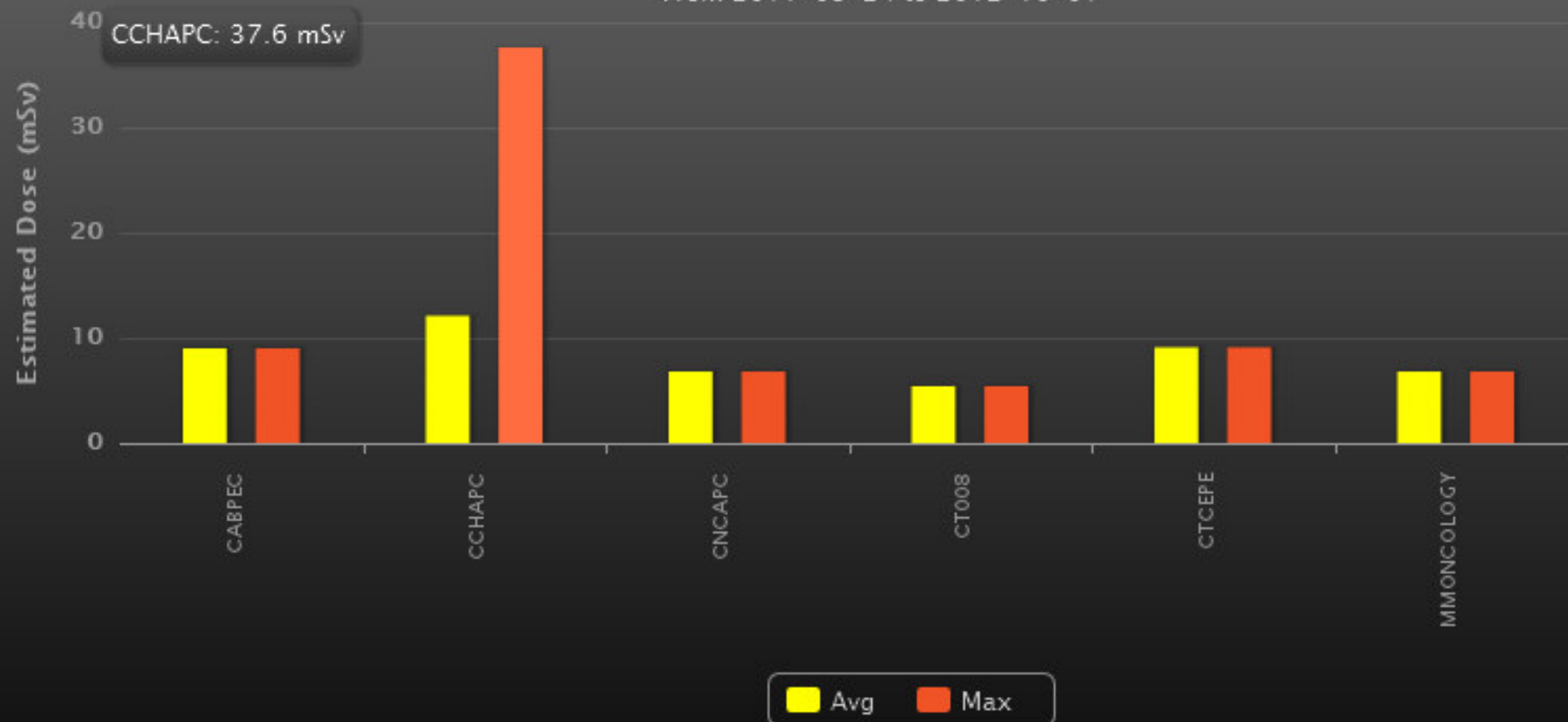
Start Date:

End Date:

[Last 7 days](#) | [30 d](#) | [90 d](#) | [RESET](#)

Average & Maximum Estimated Doses

From 2011-09-24 to 2012-10-01



	RDSR Make	Export to Excel	Patient data	Patient size	Suitable for dose audit	Extra features
Siemens CARE Analytics		✓	ID		✓	Export full data or collated monitoring data 
Radiance Tessa Cook, Hospital of the University of Pennsylvania in Philadelphia, PA	using PixelMed	Dump from database	ID, DOB	if in DICOM	Probably	Configurable exam set to apply conversion factors to effective dose. Web based dashboard Send to ACR Registry 
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PixelMed DICOM toolkit plus OFFIS DCMTK plus Ed's code	✓	✓	None	if in DICOM	✓	Work in progress...

My recommendations

- Start small - one modality
- If you have good Radiation Dose Structured Reports
 - use Siemens CARE Analytics

My recommendations

- Start small - one modality
- If you have good Radiation Dose Structured Reports
 - ▶ use Siemens CARE Analytics
- If you don't have good RDSR
 - ▶ use PixelMed (my code or DoseUtility) to create RDSR
 - ▶ use Siemens CARE Analytics

Networking primer

- Scanners and PACS and your dose server might be on different (connected) networks
- Each will have an **IP address**
eg 192.168.248.17
- Each will have a **subnet mask**
eg 255.255.255.0
- Combination of these determines the local addresses the devices can talk to
eg 192.168.248.0 to 192.168.248.254

.248.0 to 192.168.248.254

- If your two devices are not on the same subnet they will use a **Gateway** to find each other
- Alternatively, they might use **NAT** - pretend addresses that are translated into real ones by the gateway
- NAT makes life complicated because it takes a lot of config to make it work in two directions!

- There might also be a **firewall**
- This can block
 - ▶ Particular types of traffic
 - ▶ Particular ports
 - ▶ In particular directions
- You can use (ICMP) **Ping** to check routing works
 - ▶ Success doesn't mean DICOM will work
 - ▶ Failure doesn't mean DICOM won't work!

Each network service on a computer runs on a different 'port'

- web sites are on port 80
- secure web sites are on port 443
- ftp uses port 21 and 20
- email is sent on port 25

Different ports allow different network services to be run on a computer at once

The official DICOM port is 104 but lots of different ones are used

- GE like to use 4006
- Sectra PACS uses a different port for each modality, in the range 7000+

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 - ▶ In particular directions
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 - ▶ Success doesn't mean DICOM will work
 - ▶ Failure doesn't mean DICOM won't work!

DICOM networking primer

- C-Echo / DICOM Ping
 - ▶ Use remote node IP, AE Title, port
 - ▶ Should mean DICOM will work!
- C-Store / DICOM Send
 - ▶ From modality to dose server
 - ▶ Modality needs dose server details
 - ▶ IP address, AE title and port
- C-Find / DICOM Query

AE Title (Application Entity Title)

- The name used by that service
- eg PACS01 or RM1FLUORO

Most machines have one AET

Some have one per service

DICOM networking primer

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- C-Find / DICOM Query
 - ▶ From dose server to PACS
 - ▶ Dose server needs PACS details
 - ▶ IP address, AE title and port
- C-Move / DICOM Retrieve
 - ▶ From PACS to dose server
 - ▶ PACS needs dose server details in its config
 - AE title and IP address
 - ▶ AE title and port are passed in request

A note on SCP and SCU:

- SCP = Service Class Provider
- SCU = Service Class User

A PACS will be a C-Store SCP

A modality will be a C-Store SCU

Many devices will be both

Links

Siemens CARE Analytics

- See your local friendly Siemens salesman!
- Or go to goo.gl/o7iZS

Radiance

- radiancedose.com

GROK

- goo.gl/1Z57I

DoseUtility

- goo.gl/lK8AF

GE DoseWatch

- doseoptimization.com

Radimetrics eXposure

- radimetrics.com

DoseMonitor

- dosemonitor.com

PACS group forum with DH Statement link: goo.gl/qN4Le

Direct link to document: goo.gl/5uU4q (PDF, 26 kB)