



## Dashboards for CT doses

Matthew Dunn

Head of Radiation physics

[Matthew.dunn@nuh.nhs.uk](mailto:Matthew.dunn@nuh.nhs.uk)

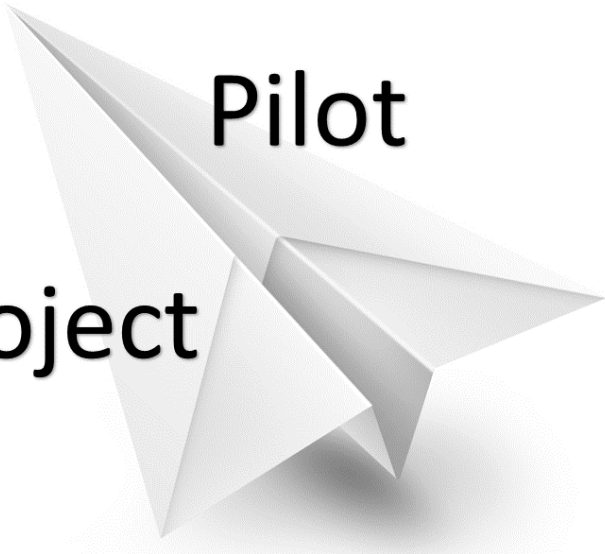


# Project background

**Official title:**

**Optimising CT doses by using analytics tools to increase operator involvement in patient dose auditing.**

MSc project – Paul Stringer (STP trainee) – **he did all the clever parts!!!**



**Pilot**  
**Project**

# So why a dashboard

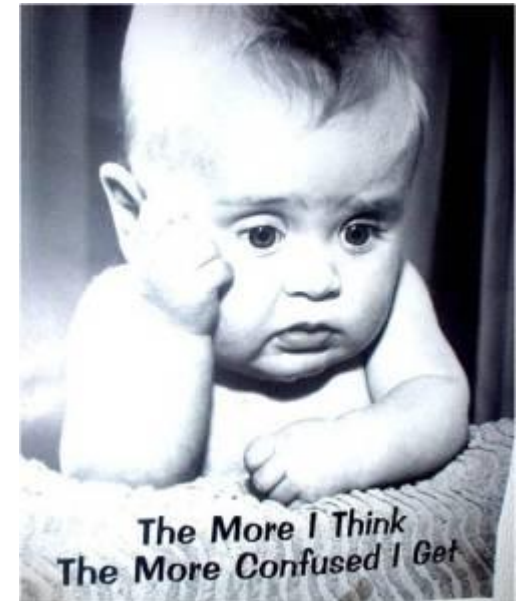


## User feedback regarding the current dose management system

- Difficult to get the data you want.
- Need more training to use it.
- Analysis of excel downloads is time consuming.

## Outcome

Little radiographer interaction with the data.



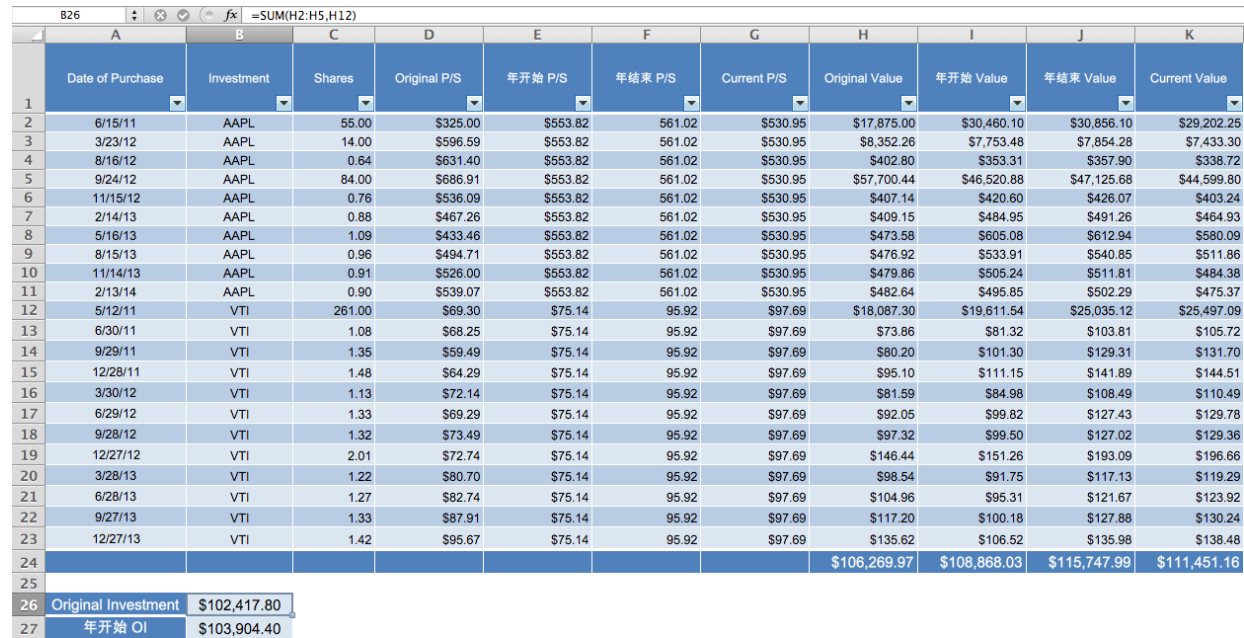
# Why are dashboards great?

- Fast access to analysed data (can be live)
- Good for tracking progress
- Easy to use and understand
- Easy to find and share the relevant information



# What system does it replace?

- Manual analysis of excel download data
  - Time consuming
  - Delay in accessing the information – waiting for physics
  - Unable to drill down easily without filters etc



	A	B	C	D	E	F	G	H	I	J	K
	Date of Purchase	Investment	Shares	Original P/S	年开始 P/S	年结束 P/S	Current P/S	Original Value	年开始 Value	年结束 Value	Current Value
1											
2	6/15/11	AAPL	55.00	\$325.00	\$553.82	561.02	\$530.95	\$17,875.00	\$30,460.10	\$30,856.10	\$29,202.25
3	3/23/12	AAPL	14.00	\$596.59	\$553.82	561.02	\$530.95	\$8,352.26	\$7,753.48	\$7,854.28	\$7,433.30
4	8/16/12	AAPL	0.64	\$631.40	\$553.82	561.02	\$530.95	\$402.80	\$353.31	\$357.90	\$338.72
5	9/24/12	AAPL	84.00	\$686.91	\$553.82	561.02	\$530.95	\$57,700.44	\$46,520.88	\$47,125.68	\$44,599.80
6	11/15/12	AAPL	0.76	\$536.09	\$553.82	561.02	\$530.95	\$407.14	\$420.60	\$426.07	\$403.24
7	2/14/13	AAPL	0.88	\$467.26	\$553.82	561.02	\$530.95	\$409.15	\$484.95	\$491.26	\$464.93
8	5/16/13	AAPL	1.09	\$433.46	\$553.82	561.02	\$530.95	\$473.58	\$605.08	\$612.94	\$580.09
9	8/15/13	AAPL	0.96	\$494.71	\$553.82	561.02	\$530.95	\$476.92	\$533.91	\$540.85	\$511.86
10	11/14/13	AAPL	0.91	\$526.00	\$553.82	561.02	\$530.95	\$479.86	\$505.24	\$511.81	\$484.38
11	2/13/14	AAPL	0.90	\$539.07	\$553.82	561.02	\$530.95	\$482.64	\$495.85	\$502.29	\$475.37
12	5/12/11	VTI	261.00	\$69.30	\$75.14	95.92	\$97.69	\$18,087.30	\$19,611.54	\$25,035.12	\$25,497.09
13	6/30/11	VTI	1.08	\$68.25	\$75.14	95.92	\$97.69	\$73.86	\$81.32	\$103.81	\$105.72
14	9/29/11	VTI	1.35	\$59.49	\$75.14	95.92	\$97.69	\$80.20	\$101.30	\$129.31	\$131.70
15	12/28/11	VTI	1.48	\$64.29	\$75.14	95.92	\$97.69	\$95.10	\$111.15	\$141.89	\$144.51
16	3/30/12	VTI	1.13	\$72.14	\$75.14	95.92	\$97.69	\$81.59	\$84.98	\$108.49	\$110.49
17	6/29/12	VTI	1.33	\$69.29	\$75.14	95.92	\$97.69	\$92.05	\$99.82	\$127.43	\$129.78
18	9/28/12	VTI	1.32	\$73.49	\$75.14	95.92	\$97.69	\$97.32	\$99.50	\$127.02	\$129.36
19	12/27/12	VTI	2.01	\$72.74	\$75.14	95.92	\$97.69	\$146.44	\$151.26	\$193.09	\$196.66
20	3/28/13	VTI	1.22	\$80.70	\$75.14	95.92	\$97.69	\$98.54	\$91.75	\$117.13	\$119.29
21	6/28/13	VTI	1.27	\$82.74	\$75.14	95.92	\$97.69	\$104.96	\$95.31	\$121.67	\$123.92
22	9/27/13	VTI	1.33	\$87.91	\$75.14	95.92	\$97.69	\$117.20	\$100.18	\$127.88	\$130.24
23	12/27/13	VTI	1.42	\$95.67	\$75.14	95.92	\$97.69	\$135.62	\$106.52	\$135.98	\$138.48
24								\$106,269.97	\$108,868.03	\$115,747.99	\$111,451.16
25											
26	Original Investment			\$102,417.80							
27	年开始 OI			\$103,904.40							

# How did we approach the development

- Need actionable information
  - not a vanity project
- Designed around the users and their tasks
- Input and feedback



# How did we approach the development

- Need actionable information
  - not a vanity project
- Designed around the users and their tasks
- Input and feedback



# Software package



---

Sense™

- Trust wide business intelligence tool
- Deployed on all PC's
- Developers can obtain development account
- Can link to live data or uploads e.g. from excel



# Software package



All indicators include UCC data from 01/11/17 unless stated

This week, ending 22/09/2019

69.8%

Last week, ending 15/09/2019

71.5%

Yesterday's performance

68.2%

Current Month- Sep-19 :

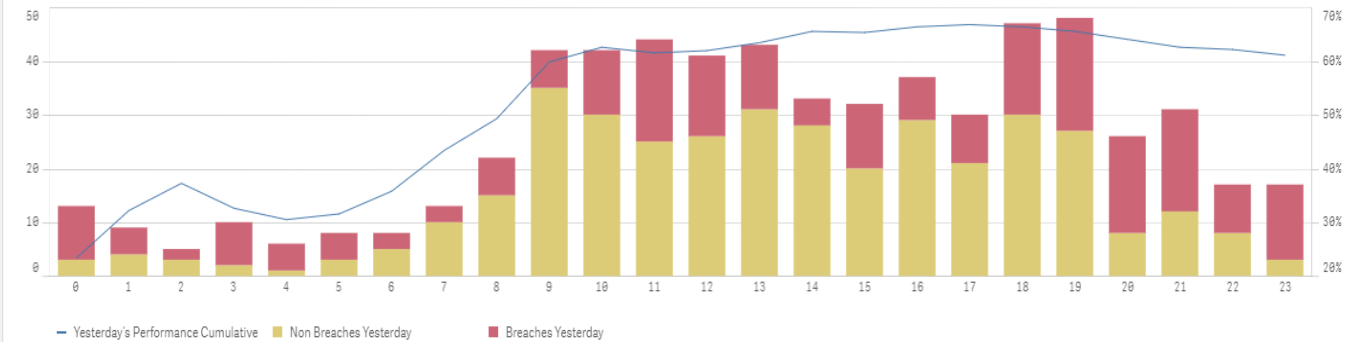
70.4%

YTD performance

## NUH Performance & Attendance

Activity Date	Q	Performance	Attendances
<b>Totals</b>		<b>70.0%</b>	<b>5392</b>
18/09/2019		68.2%	771
17/09/2019		73.4%	768
16/09/2019		68.0%	835
15/09/2019		69.0%	751
14/09/2019		69.3%	785
13/09/2019		65.8%	725
12/09/2019		76.4%	757

## Yesterday's Attendance & Performance by Hour (excluding UCC)



# Task based dashboard

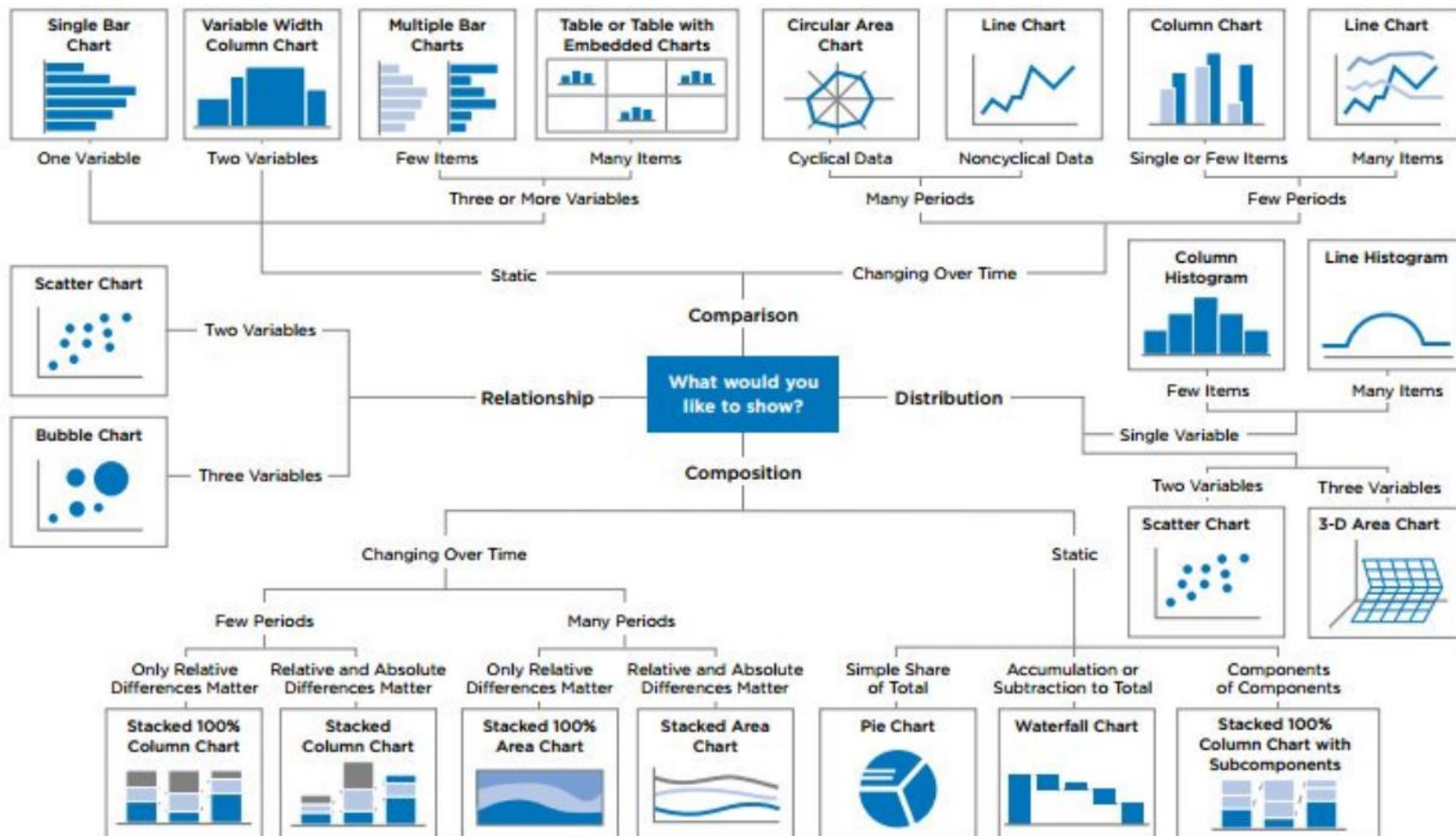
Page	Purpose
<b>Dose Trends</b>	Plots trends lines for CTDI value and DLP which can be filtered to display data from a specific protocol, scanner, or period.
<b>Current Dose Values</b>	Provides a side by side comparison of mean CTDI and mean DLP values delivered by each scanner for the selected protocol, alongside NDRLs.
<b>Outlier Assessment</b>	Plots CTDI against DLP for the select unit and protocol allowing outlier cases to be identified and group. Trends in protocol use can also be examined.
<b>Dose Histograms</b>	Displays dose and irradiation event distribution data, to allow a quick assessment of procedural compliance.
<b>Dose Distributions</b>	Displays dose distribution data allowing the viewer to review the range of doses delivered for each protocol by a given device.
<b>Protocol Checker</b>	The protocol checker lets the viewer look for CRIS coding errors in the look up table Dosewatch uses to group like studies.

Table 1: An outline of the different task-based pages produced.

# Task based dashboard



## SELECTING THE APPROPRIATE CHART FOR STRATEGY PRESENTATIONS



# Demo



## Dose trends

This tool lets you review the variation in dose values over the course of the selected year.

Use the 'series type' filter to ensure localizer data is removed.

### Choose filters here

Protocol

- CTPA
- C spine
- CT abdo pelvis
- CT head
- CT Head Paed
- CT KUB

Series type

- Series type
- Constant angle
- Spiral
- Stationary

Device

Device  
QMC - B-Floor West Block CT 2

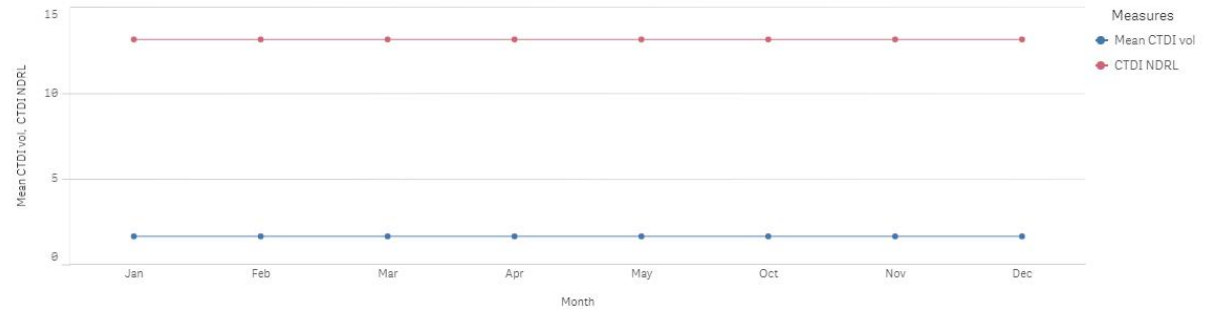
Num. Series Non Loc...

- 0.00
- 3.00
- 4.00
- 1.00
- 2.00
- 5.00

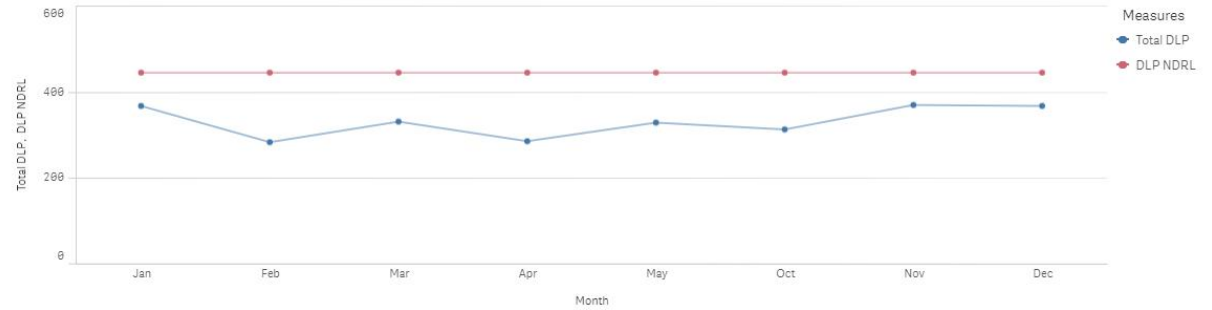
Year

- 2018
- 2019

CTDI vol



DLP



# Demo

## Dose Histograms

This tool displays a dose histogram that lets you identify the frequency of scan which were higher or lower than the average dose.

... [X] [✓]

Q Protocol

- CTPA
- C spine
- CT abdo pelvis
- CT head** ✓
- CT Head Paed
- CT KUB
- CT AA
- CT plain chest

Series type

Series type

- Constant angle
- Spiral
- Stationary

Q Num. Series Non Loc...

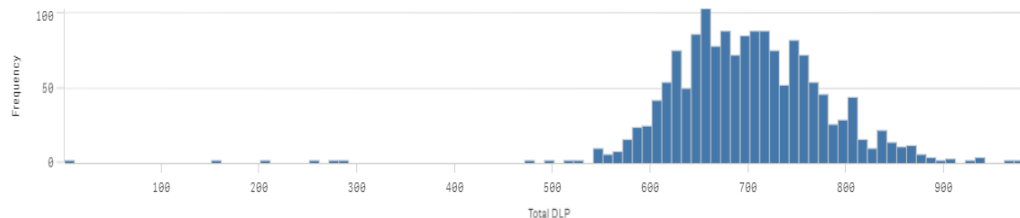
	0.00
	1.00
	2.00
	3.00

Q Device

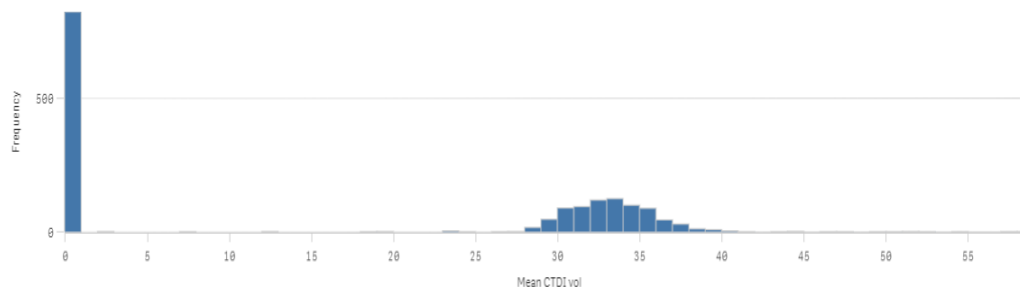
- QMC - B-Floor West Block CT 2** ✓
- City - CT DEPT ROOM 2
- City - CT DEPT ROOM 3
- QMC - A&E CT 4



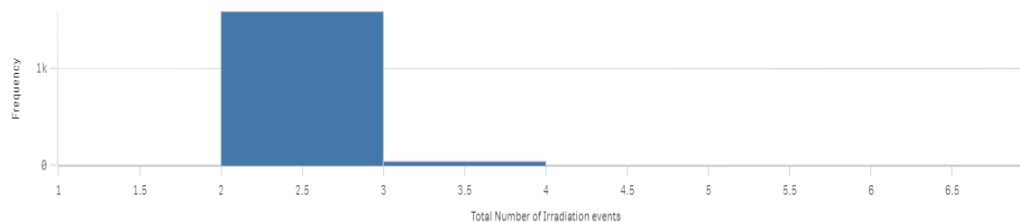
DLP Distribution data



CTDI vol Distribution data



Total number of Irradiation events



# Demo



## Current dose values



This tool lets you compare the average doses delivered by different scanners, for a selected protocol.

### Choose filters here

Q Protocol

Q Series type

- CT head
- C spine
- CT AA
- CT abdo pelvis
- CT Head Paed
- CT KUB

- Constant angle
- Sequenced
- Spiral
- Stationary
- Undefined

Q Num. Series Non Localizer

0.00

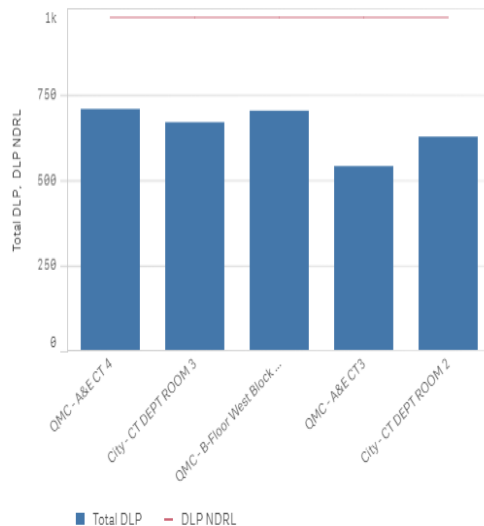
1.00

Q Year

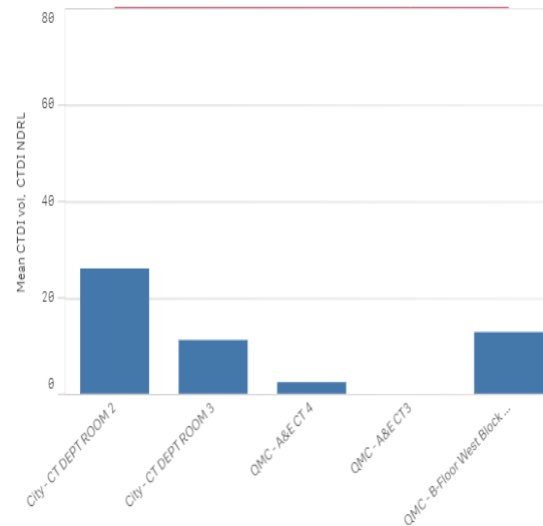
Q Month

- |      |     |
|------|-----|
| 2018 | Jan |
| 2019 | Feb |
|      | Mar |
|      | Apr |
|      | May |
|      | Oct |

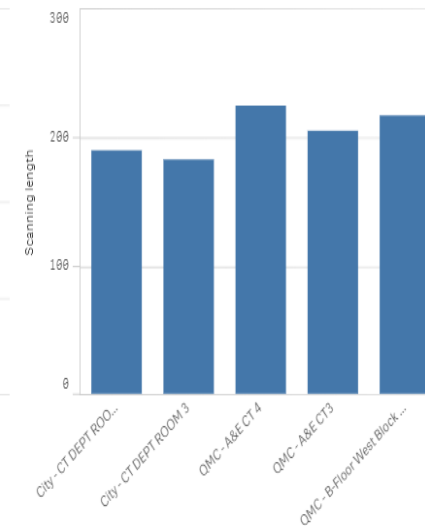
DLP



Mean CTDI vol



Scanning length



### Dose values for the selected CT Protocol

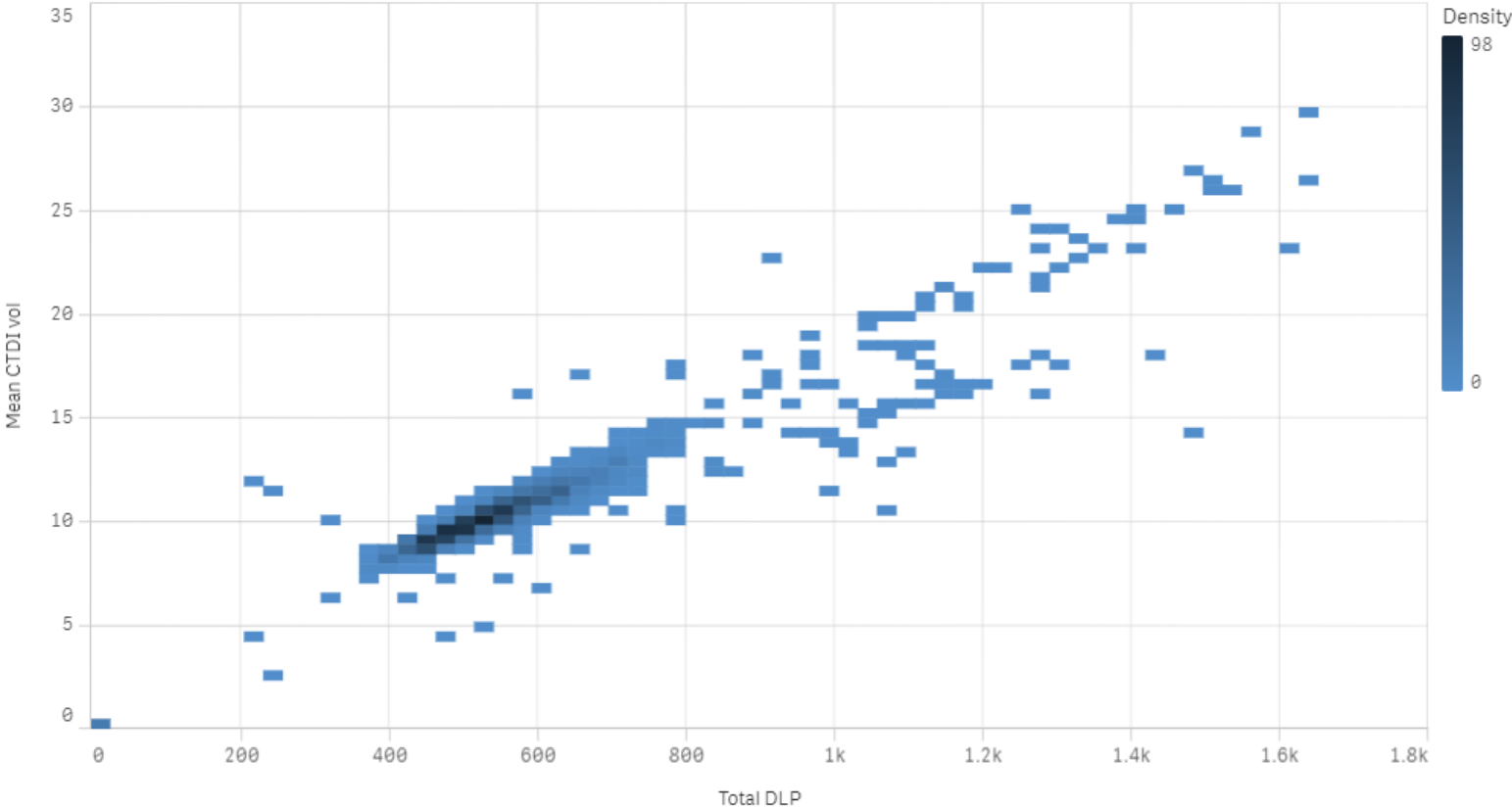
Device	Total DLP	Total DLP NDRL	Mean CTDI vol	CTDI NDRL	Scanning Length	Number of studies
City - CT DEPT ROOM 2	624.30	970	26.00	80	189	422
City - CT DEPT ROOM 3	666.43	970	11.16	80	182	1836
QMC - A&E CT 4	705.30	970	2.40	80	224	14875
QMC - A&E CT 3	538.00	970	0.00	80	205	5121
QMC - B-Floor West Block CT 2	700.20	970	12.80	80	217	1660



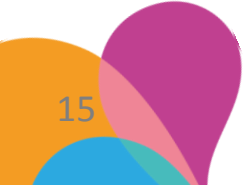
# Demo



Mean CTDI vol vs DLP \*



\* Providing overview of 1.7k dimension values.



# Task based outcomes

Aspect	Summary of findings
<b>Dose trends</b>	Doses were consistent in general. However, C Spine and CT Abdo/pelvis doses increased in December 2018 on CT3AE (QMC).
<b>Current doses values</b>	All below NDRLs. CT2 (CHC) doses were consistently highest and CT3 (CHC) the lowest, except for CT head.
<b>Outliers</b>	Distinct outliers were identified for most scans - this is being further investigated.
<b>Dose distributions</b>	Distributions were consistent between scanners. CT Abdo/Pelvis displayed the greatest DLP range.
<b>Coding errors</b>	Coding issues were identified for all protocols. CT head was the most impacted. Of concern 33% of “Landmarx sinuses” examinations were coded as CT head. Sinus examinations are much lower dose than CT head. This has the impact of understating NUH audited CT head results.
<b>Inconsistent practice</b>	For CT Abdo/pelvis a higher number than average of irradiation events was reported when imaging on the A&E scanners, as expected. A higher number than average of irradiation events was also reported, for C-Spine imaging on CT2 (CHC).

Table 8: This is a summary of CT team leaders' page-based task findings.



# Outcome/conclusions

CT team leaders found the system to be easy to use, accessed it frequently, and reported multiple actionable findings.

This is a comparable result with **Oliveri A et al. European Radiology Aug2016**

<b>Study goals</b>	<b>Outcomes</b>
<b>How can dose auditing be improved using business analytics tools?</b>	The CT dashboard has allowed the introduction of a weekly 'bottom-up' auditing process using available dose data, as opposed to an annual top-down approach.
<b>How can dose data be best visualised to aid the dose auditing process?</b>	CT team leader feedback identified dose trend plots and dose histograms to be the most useful visualisations to have available and to share with the MPE.
<b>Which metrics reported by dose audits do radiographers find useful? What are they reacting to?</b>	Current dose values and dose trend data was valued highest. The CT team leaders reacted strongly to the outlier data, wanting to understand how such cases could be avoided.
<b>Can improving staff interaction with dose and related data provide new insights for service improvement?</b>	The CT dashboard has enabled a greater audit frequency. CT Team leaders and staff have begun proactively reporting coding errors. Training needs have been identified and acted upon. It has also been recommended to use the usage data to plan team resources.

Table 10: A Summary of the study's outcomes