Cambridge University Hospitals NHS
NHS Foundation Trust

Post-Implant Dosimetry for LDR Prostate Brachytherapy – what's the point?

Prostate Brachytherapy UK & Ireland Conference,

14th October 2022

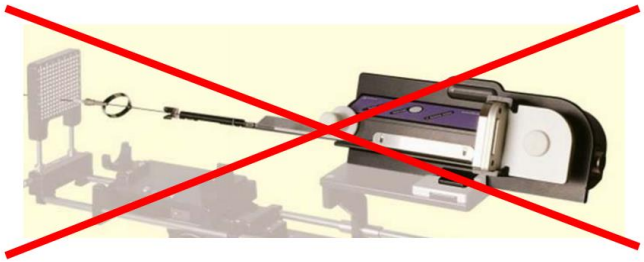
Together – Safe | Kind | Excellent



Background

- We have been treating prostate patients with Low Dose Rate (LDR) brachytherapy using I-125 loose seeds since 2006.

- Started with Nucletron/Elekta seed selectron system with Oncentra Prostate TPS



- In 2019 due to the end of life of the seed selectron we swapped to delivery using the Mick applicator to deliver loose AgX100 seeds. We kept with Oncentra prostate for planning.

- Treated over 970 patients so far, and are currently averaging about 75 patients a year.

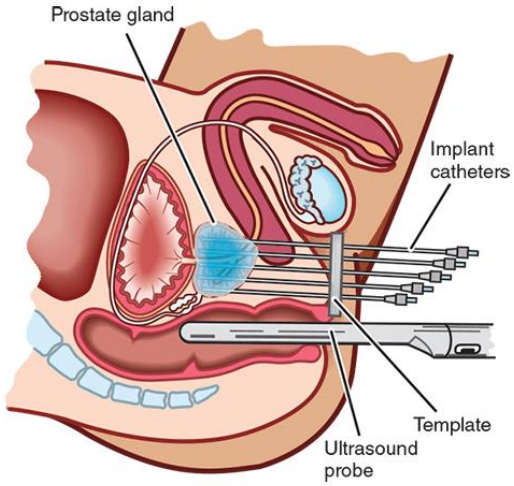
- Small experienced team: 2 oncologists, 1 urologist, 7 physicists

Dosimetry in Theatre

- Patients prescribed 145Gy (110Gy for those having EBRT boost)
- We plan to the following constraints (scaled appropriately for the 110Gy pts)

[agrees with the RCR Guidelines / GEC-ESTRO recommendations]

	Parameter	Constraint	Objective
Target (prostate)	$D_{90\%}$	≤185Gy	170–185Gy (Min 145Gy)
	V100%	≥98%	99%
	V150%	≤65%	55-60%
Urethra*	$D_{10\%}$	<150% (217.5Gy)	
	$D_{30\%}$	<130%(188.5Gy)	
Rectum*	D_{2cc}	≤145Gy	
	$D_{0.1cc}$	<200Gy	



All plans are planned within constraints.

Prostate generally within objectives – sometimes smaller prostates fail objectives due to fewer choices of seed positioning.

Sometimes struggle to cover anteriorly (above the urethra) as cannot place needles here due to anatomy

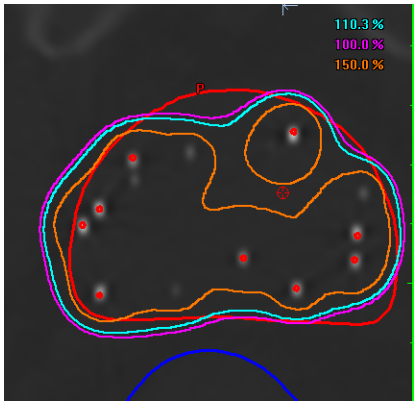
What is Post Implant Dosimetry (PIDs)?

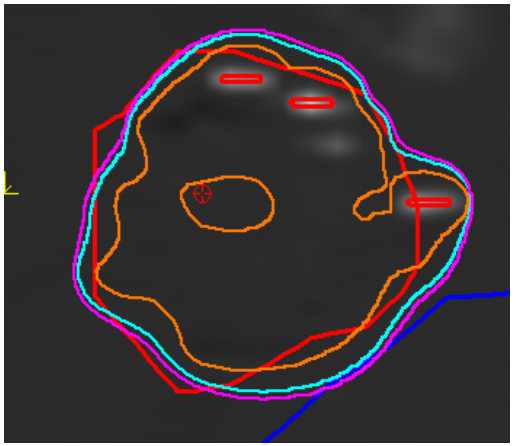
6 weeks after treatment all patients have a CT scan to localise the seeds

Important that gap is consistent to ensure swelling has reduced and allows better comparison between different patients.

Our process:

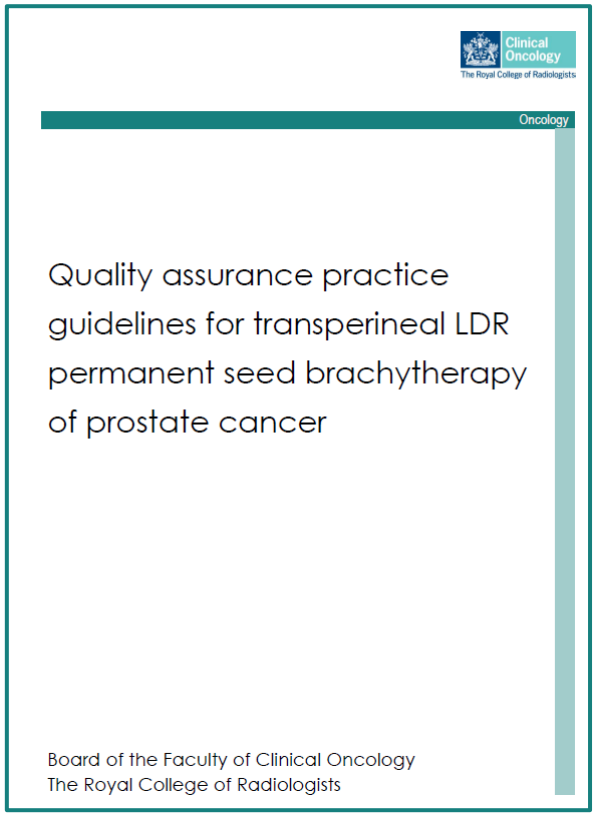
- Clinicians outline prostate and rectum in Raystation, then we send to Oncentra Prostate
- Use Oncentra Prostate to find all seeds (auto + manual)
- Calculate DVH, record in department spreadsheet and compare stats to RCR Guidelines
- If plan does not meet RCR minimum standards – contact Drs to review and discuss
- Also important to look at the isodoses! Save screen shot to share with team annually. Look for any significant areas of under-coverage to record in departmental spreadsheet – look for trends





Current PID Guidelines

- From RCR Guidelines (2012)


Clinical Oncology
The Royal College of Radiologists

Oncology

Quality assurance practice guidelines for transperineal LDR permanent seed brachytherapy of prostate cancer

Board of the Faculty of Clinical Oncology
The Royal College of Radiologists

Post-implant dosimetry should measure the following parameters:

- Target volumes: $D_{90\%}$, $V_{100\%}$ and $V_{150\%}$ for the prostate
- Organs at risk: $D_{10\%}$ and $D_{30\%}$ for the urethra (if possible); D_{2cc} and $D_{0.1cc}$ for the rectum.

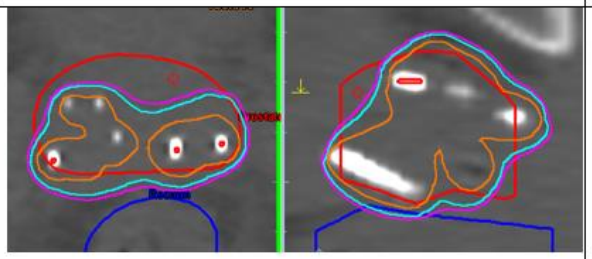
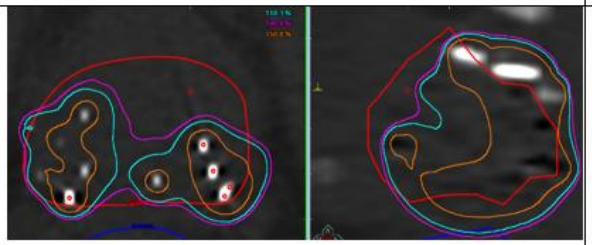
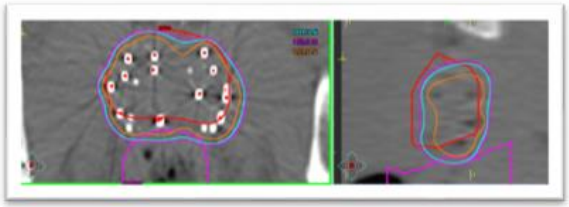
9. Minimum standards

Implant quality is considered satisfactory if the V_{100} for the prostate is ≥80% and poor or unsatisfactory if the V_{100} is <80%. The minimum target for the D_{90} for the prostate is 90% of the prescription dose and for the rectum D_{2cc} <prescription dose. The CT:ultrasound volume ratio should be recorded and be ≥0.9. If this is not established, further investigations into the target delineation are warranted.

In patients where it is determined that the implant quality is clinically sub-standard, a careful review of the case by the treating team is warranted, including careful review of the contouring accuracy and seed identification. In those cases where underdosing has occurred, the treating team should review the disease and patient characteristics and decide whether to accept an underdosing or consider further radiotherapy treatment. A further brachytherapy procedure may be conducted immediately following the first implant if this is deemed clinically necessary in the individual case. Such procedures require a good degree of experience and are not recommended for inexperienced centres.

What do our PID results look like?

PID Plan Dose Statistics												
		TARGET						RECTUM				
Seeds Identified	Volume (cc)	V(CT)/V(US)	D100 (Gy)	D90 (%)	V100 (%)	V150 (%)	V200 (%)	Volume (cc)	V100 (%)	D2cc (Gy)	D0.1cc (Gy)	PID with contraints in CP? Y/N
104	73.1	0.9	114.9	140.8	99.7	85.9	43.5	40.1	3.0	121.9	230.2	y
92	68.6	0.8	104.0	118.0	97.2	62.7	32.8	39.0	4.1	92.7	248.9	y
59	29.8	0.9	80.3	108.9	92.4	67.8	30.7	23.2	2.2	98.6	175.5	y
78	44.4	0.9	72.4	90.2	85.2	49.6	21.3	69.9	2.2	134.3	245.2	y
53	24.0	0.9	92.0	99.8	89.9	66.5	38.3	53.0	1.8	108.6	261.6	y
69	41.0	1.0	83.3	108.9	93.3	63.7	32.7	23.4	2.9	73.5	131.4	y
78	49.3	1.0	89.5	118.9	96.9	63.8	28.9	49.3	0.1	69.1	126.9	y
55	27.3	0.9	93.7	115.8	94.6	75.6	43.3	115.1	0.9	123.1	212.3	y
57	33.0	1.1	81.3	104.5	91.6	54.8	25.0	65.8	0.4	91.5	178.7	y
56	26.5	0.9	80.3	114.4	95.1	73.2	39.4	39.0				
92	67.7	1.0	67.7	107.6	93.2	55.4	28.3	33.3				
51	25.6	0.9	68.1	80.1	81.5	56.5	26.2	58.2				
70	40.4	0.9	90.9	131.8	97.7	82.8	52.2	28.9				
45	25.3	1.2	73.7	101.5	90.6	56.3	27.5	64.7				
70	38.5	0.9	87.9	115.3	95.3	61.0	29.3	23.7				
54	23.6	0.9	58.6	101.1	90.3	67.1	34.4	17.8				
75	55.7	1.1	70.6	109.2	92.9	61.3	26.0	31.9				
63	36.8	1.0	89.2	105.4	92.3	56.6	26.1	64.7				
75	42.7	0.9	97.4	123.2	97.9	65.8	30.0	82.8				
90	59.5	0.9	91.4	120.7	96.0	59.1	26.6	31.3				
69	46.6	1.1	99.8	116.7	96.0	57.2	24.2	65.8				

Pt	D90	V100	Image	Area missed
AD	108.9	92.4		Base ant
MS	90.2	85.2		Base ant
JW	99.8	89.9		base

What do we do with our PID results? – Annual Summary

Once a year we have a team meeting with the Oncologists, Urologist and Physicists.

Report on PIDs is reviewed

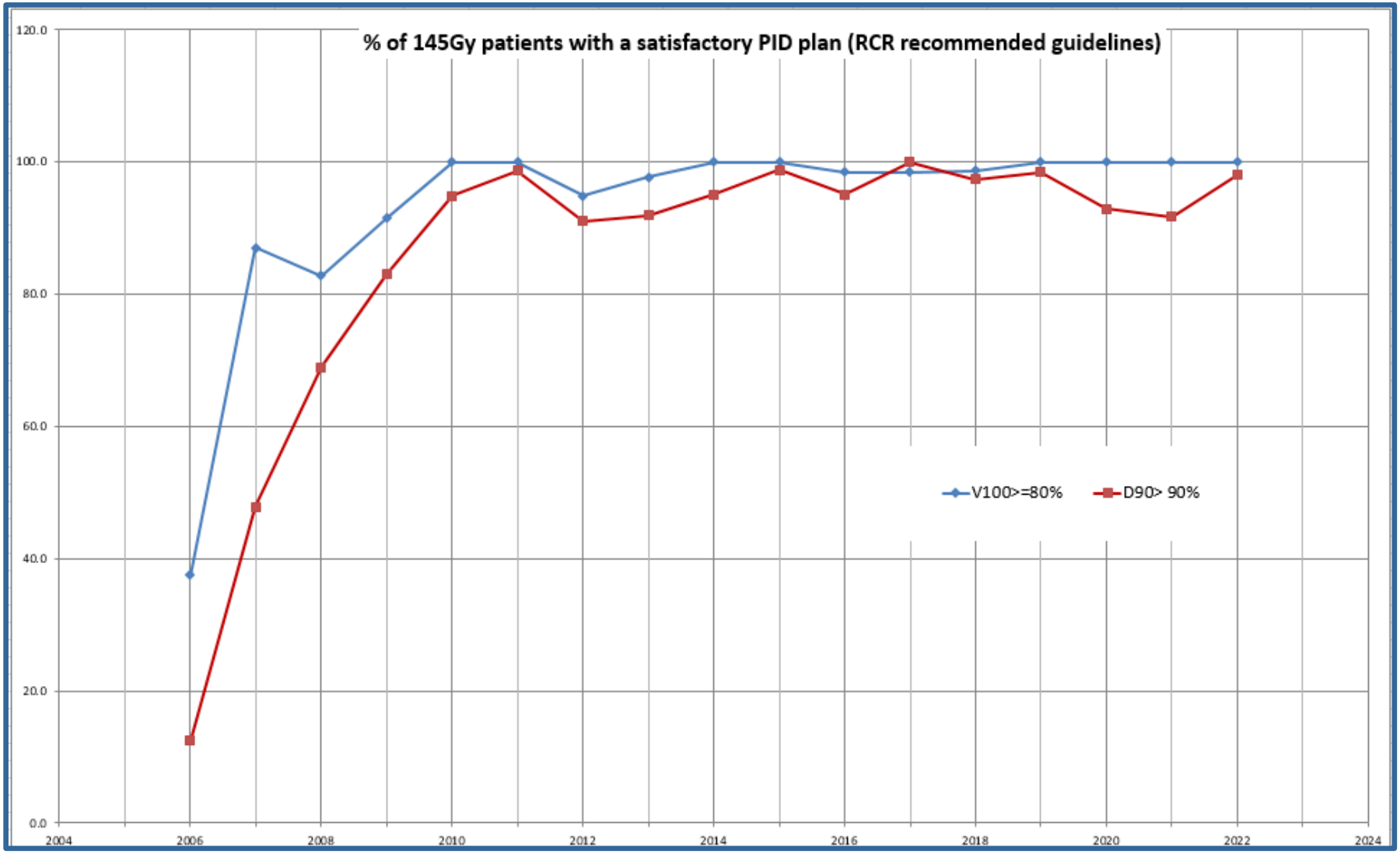
2022 so far (up to 14/09/22):

- 50 patients. 100% had V100>80% and 98% had D90>90%.
- 1 out of 50 does not pass RCR standards for good implant.
- Av volume = 42.5cc

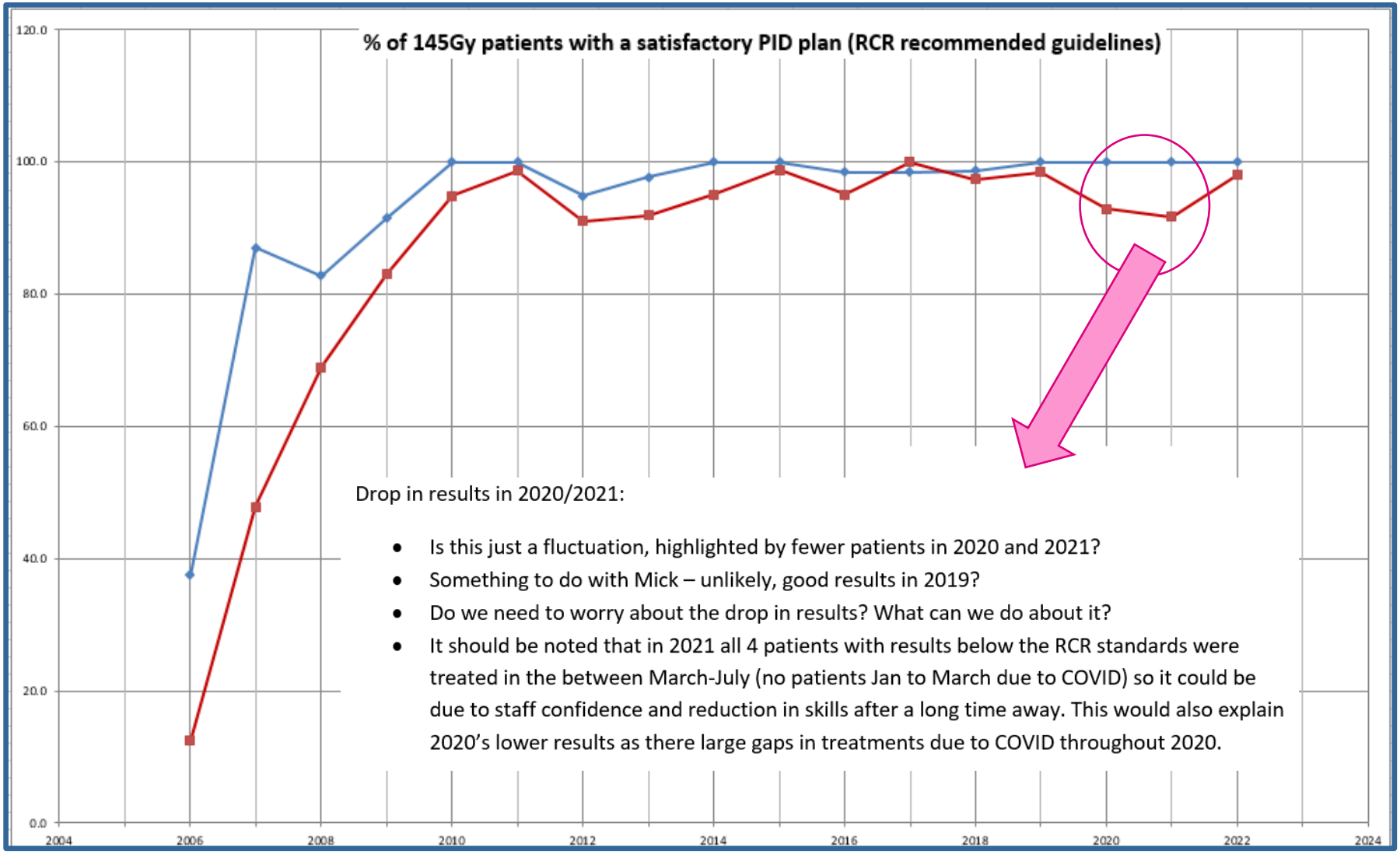
Comparing results year-on-year enables us to ensure high standards are kept and make sure staff and equipment changes aren't causing results to drop.

When we swapped delivery system in 2019 from Seed Selectron to Mick we used PID results ensure treatment standards were still good.

What do we do with our PID results? – Annual Summary



What do we do with our PID results? – Annual Summary



Drop in results in 2020/2021:

- Is this just a fluctuation, highlighted by fewer patients in 2020 and 2021?
- Something to do with Mick – unlikely, good results in 2019?
- Do we need to worry about the drop in results? What can we do about it?
- It should be noted that in 2021 all 4 patients with results below the RCR standards were treated in the between March-July (no patients Jan to March due to COVID) so it could be due to staff confidence and reduction in skills after a long time away. This would also explain 2020's lower results as there large gaps in treatments due to COVID throughout 2020.

What do we do with our PID results? – Annual Summary

		2018	2019	2020	2021	2022 So far
Theatre	Average Volume (cc)	41.6	41.0	34.7	38.9	**42.5**
PID	Average V100% (%)	94.5	94.1	92.8	93.5	**93.2**
	% pts with V100 ≥ 80%	100	100	100	100	**100**
	Average D90% (%)	112.8	111.8	108.2	112.2	**110.1**
	% pts with D90 ≥ 90%	100	98.5	92.9	91.3	**98.0**
	Average Rectum 2cc max (Gy)	119.9	115.8	107.2	111.2	**108.5**
	% pts with Rectum 2cc <200Gy	100	100	100	100	**100**
	[% pts with Rectum 2cc <145Gy]	85.5	92.5	92.9	87.0	**90.0**

Table above shows that although we have had 4 out of 28 patients fail RCR guidelines in 2021 year, our average D90% and V100% only dropped marginally in 2020, and results have improved in 2021 and 2022.

What do we do with our PID results? – Annual Summary

Difficult to compare visual isodoses, look at trends for areas of under-coverage to feedback to team

From 2021 Review:

Detailed analysis of missed areas for all patients this year – see separate doc I will circulate for screen shots of each pt.

In 36/46 cases we under-covered either the Anterior base, or whole base of the prostate and in 10/46 cases we under-covered the apex or anterior mid area of the prostate. This shows that we need to focus in theatre at the anterior needles in particular – especially as we often loose coverage due to some blocked needles anterior of the catheter – as well as the base and apex.

We could ensure we use as many grid positions as possible in the top two rows of the prostate to get good coverage in this area and clinicians should ensure they are stepping back the Mick slowly to try and reduce pull-back of seeds – although I know this is already being done. This was fed back to the team in Oct/Nov of 2021 and results seem better towards the end of the year so I think it has helped somewhat, but more improvement could be made.

- highlighted that we could have better coverage at the base of the prostate. We do sometimes see issues with 'pull back' of seeds, that would not have easily occurred with our old system do the seeds/spacer trains.
- Physicists are focussing on making sure the base is well covered in theatre plans and Clinicians are trying to ensure they twist and retract the Mick slowly to reduce the pull back of seeds to a minimum.

What do we do with our PID results? - Email updates

We keep notes from theatre on our department spreadsheet. Comments like “difficult implant – poor imaging due to large calcifications”.

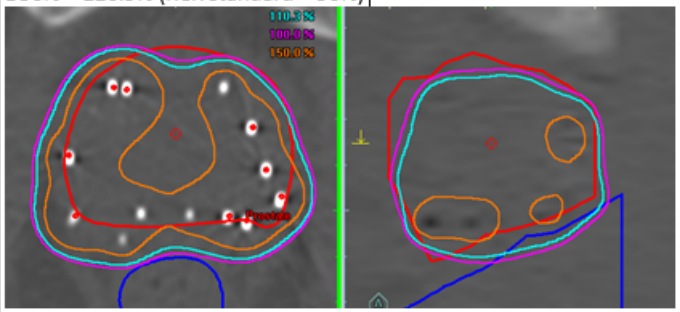
If we’ve done a PID for a case that has a comment suggesting that theatre did not go as well as planned it is nice to send an email to the theatre team.

99% of the time the PID results are excellent and I think it gives everyone a bit of boost to hear that we are doing well.

Done a load of PIDs today. All results fine, nothing exciting to report.

Just wanted to feedback on [redacted] because there was a note from theatre to say it was a difficult implant due to poor imaging and lots of black holes.
Results lovely. You obviously perform well when you can’t see anything.

V100% = 97.6% (RCR standard > 80%)
D90% = 126.9% (RCR standard > 90%)



Great work all

Katie

Are the RCR Guidelines enough?

Are the RCR guidelines too loose, we might be missing something?

The Royal College of Radiologists

- recommended 10 years ago, but they are still relevant to look for outliers and would be useful particularly to new centres in the setup stage.
- However, if 100% (or close) of our plans are meeting the RCR minimum standards for 'satisfactory implant', could we find some higher standards to aim for – What standards would give us a 'good' implant?
- Well established centres might be able to set local standards that they hope to achieve the majority of the time.

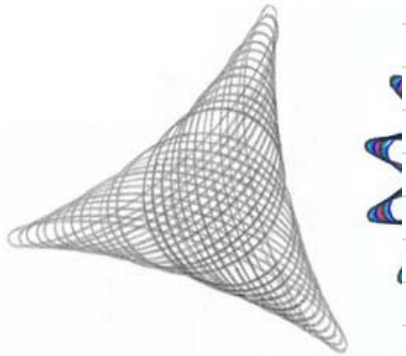
Things to consider:

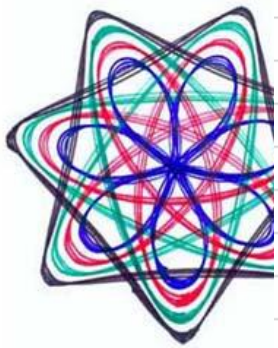
- What percentage of plans should pass for a good plan?
- Local standards may be particularly useful to identify changes in results due to method, equipment or staff changes in the future.
- Previous work by Stock and Sloane[1] demonstrated D90% > 140Gy (96.6%) resulted improved disease free-survival (also confirmed by Potters *et al* [2] and Henry *et al* [3])

[1] Stock RG, Stone NN, Tabert A, et al. A dose-response study for I-125 prostate implants. *Int J Radiat Oncol Biol Phys* 1998:41:101-8.
[2]Potters L, Cao Y, Calugaru E, et al. A comprehensive review of CT-based dosimetry parameters and biochemical control in patients treated with permanent prostate brachytherapy. *Int J Radiat Oncol Biol Phys* 2001:50:605-14.
[3] Henry AM, Rodda SL, Mason M, et al. The Effect of Dose and Quality Assurance in Early Prostate Cancer Treated with Low Dose Rate Brachytherapy as Monotherapy. *Clin Oncol* 2015:27:382-6.

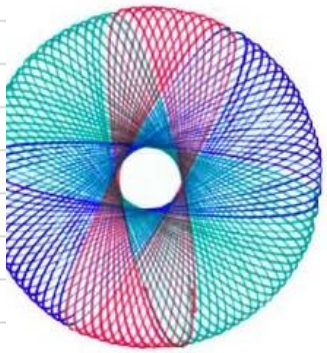
Setting our own local standards PID results

- Reviewed all PID data by year
- Felt that although our % passing the RCR guidelines were back up at pre-2020 levels again, we still see more seed movement than we used to see.
- V100% > 90% and D90% > 100% look like possible options for 'good' implants, as well as previously documenented D90%>96.6%



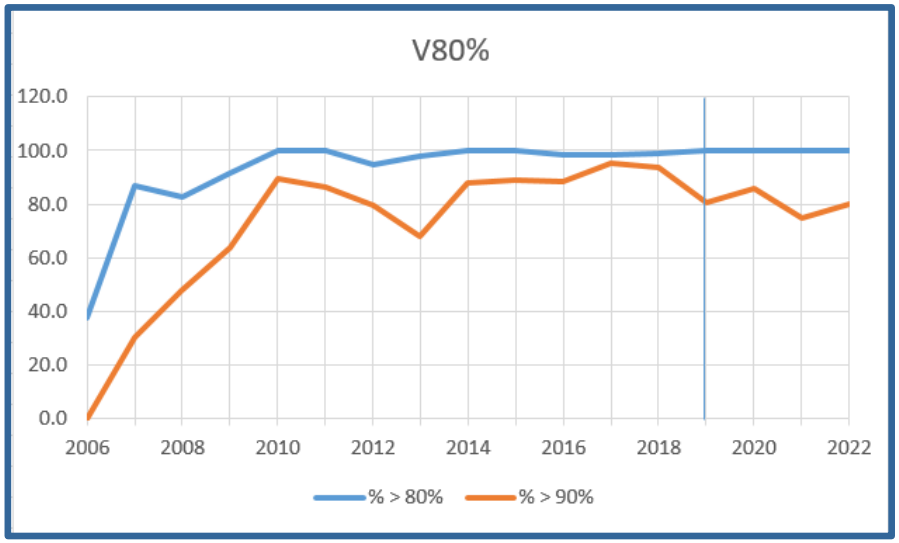


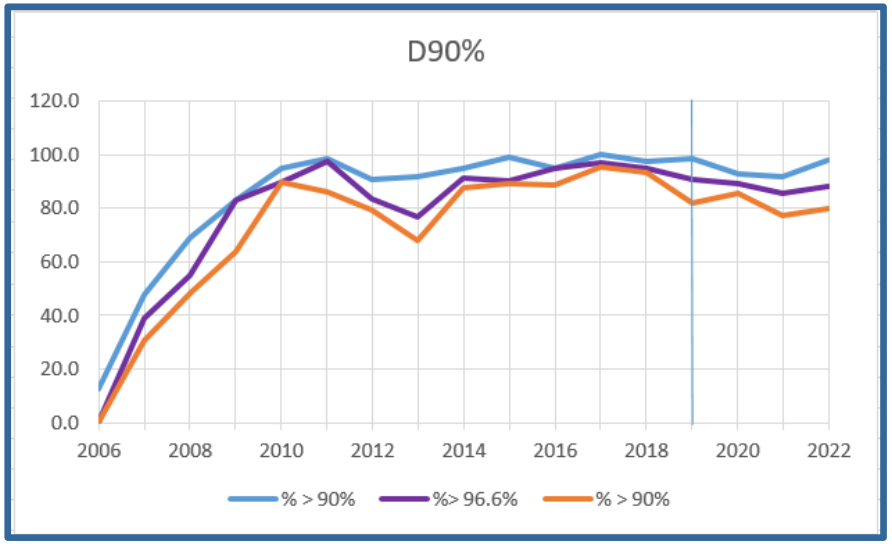
YEAR	V80%		D90%		
	% > 80%	% > 90%	% > 90%	% > 96.6%	% >100%
2006	37.5	0.0	12.5	0.0	0.0
2007	87.0	30.4	47.8	39.1	30.4
2008	82.8	48.3	69.0	55.2	48.3
2009	91.5	63.8	83.0	83.0	63.8
2010	100.0	89.7	94.9	89.7	89.7
2011	100.0	86.3	98.6	97.3	86.3
2012	94.9	79.5	91.0	83.3	79.5
2013	97.7	67.8	92.0	77.0	67.8
2014	100.0	87.8	95.1	91.5	87.8
2015	100.0	89.0	98.8	90.2	89.0
2016	98.4	88.5	95.1	95.1	88.5
2017	98.4	95.2	100.0	96.8	95.2
2018	98.7	93.4	97.4	94.7	93.4
2019	100.0	80.6	98.5	91.0	82.1
2020	100.0	85.7	92.9	89.3	85.7
2021	100.0	75.0	91.7	85.4	77.1
2022	100.0	80.0	98.0	88.0	80.0



What to use as local standards for PID results?

- Perhaps our results are not quite back up at the levels of 2018 – we swapped to Mick applicator delivery in 2019 and see more seed movement since then.
- This would have been more noticeable if we had been monitoring with higher standards





2019 in more detail	No. of Pts	V80%		D90%		
		% > 80%	% > 90%	% > 90%	% > 96.6%	% >100%
Pre-Mick	27	100.0	88.9	96.30	96.30	88.9
Post-Mick	40	100.0	75.0	100.0	87.5	77.5

- Do we care – are we over analysing? If results are satisfactory is that good enough?
- What can we do about it? (watch and wait, strands, seeds with source caps…….?)
- Is it just the Mick 'learning curve' still – delayed by COVID disruptions?

Conclusions

Hopefully I have answered - what *is* the point of PIDs?

- For the individual patient, will highlight any gross errors to the Doctor so they can make an informed clinical decision about what to do next
- For the clinical team –
  - Gives confidence that we are offering good treatment to patients
  - Ensures any changes in staff or system are well monitored
  - Feedback to team allows for constant improvement in methods
  - Could allow for local setting of higher standards than the RCR guidelines
  - Could allow for comparison of results across centres/regions
- What are we going to do?
  - Keep monitoring results against higher standards (V80%>90%, D90%>96.6%) as well as RCR guidelines. Where plans do not pass this make sure we highlight areas missed to clinical team – look for trends.
  - Review % passing higher standards in annual review early 2023 & discuss options

Any Questions?