From Audit :

of

Repeat Cone-beam verification imaging in pelvic radiotherapy

Ms. Edel O'Toole
Clinical Specialist Radiation therapist
Radiation Safety Officer
Radiation Oncology department

To ACTION

By

- *A MDT Quality Improvement Initiative*

To

- *Reduce unnecessary Imaging and dose*

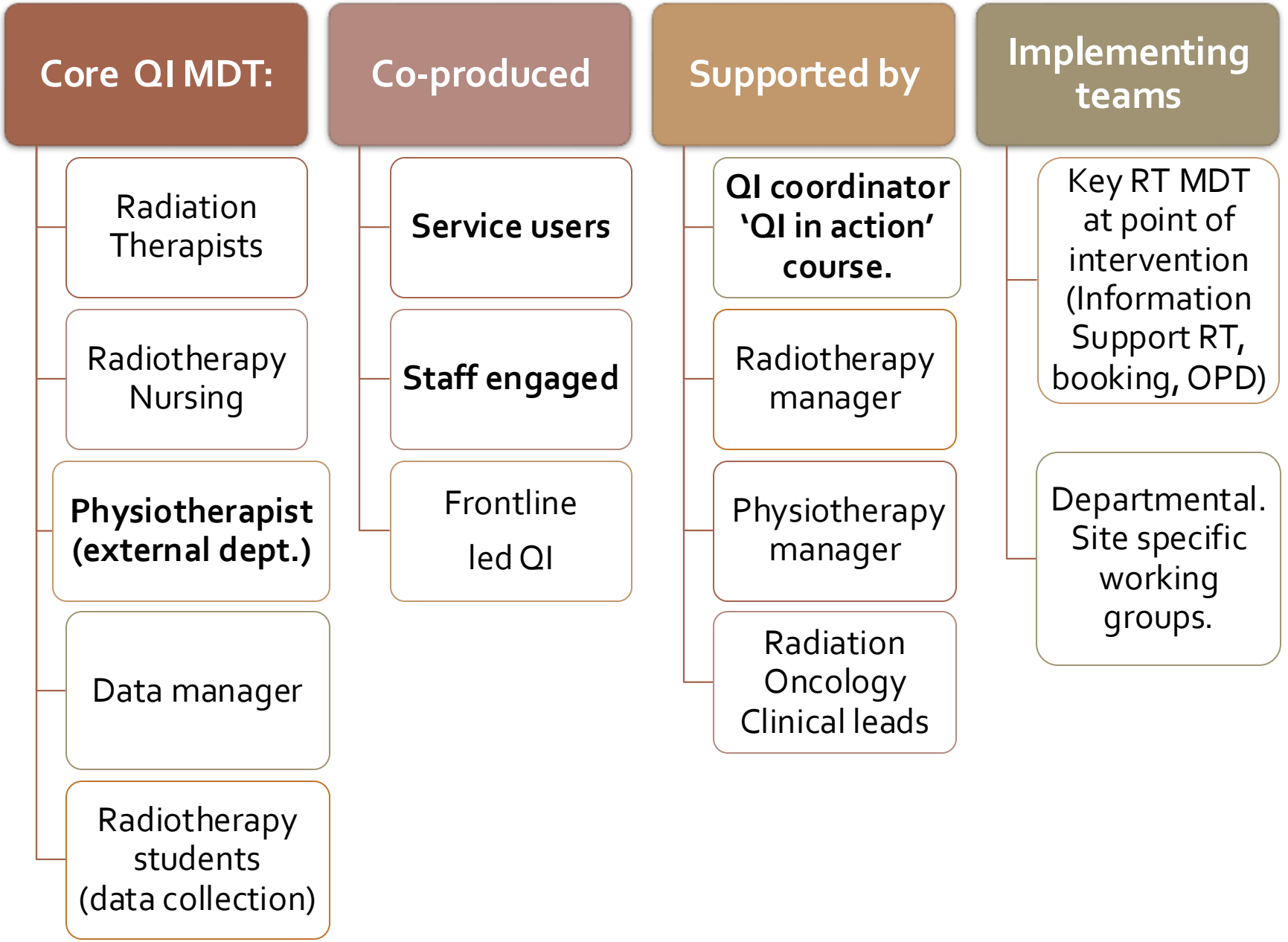
And
Improving Patient Experience & Service Efficiency

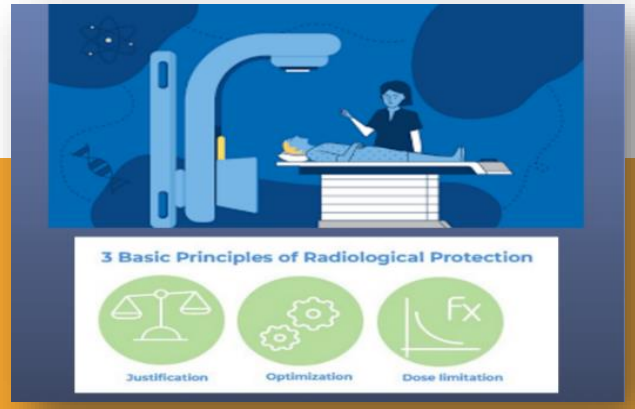
NOCA Annual conference 2026
Turning Audit Data into Better Care

MDT team Audit & QI

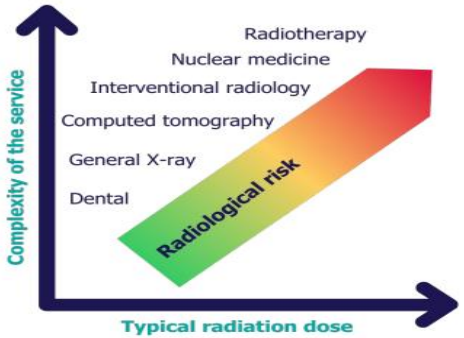
Edel O'Toole CSRT, RSO
Rachel McHugh, Senior Physiotherapist in Pelvic Health in Cancer Services
Margaret Walsh, Staff Nurse
Niamh Morrissey, Staff Nurse
Geraldine O'Boyle, ANP
Kaitlyn Mc Hugh, RT

Gerry Grealish ,QI Co-ordinator, West and Northwest





Project Identification Why Audit radiation?



This 2013 EU Council Directive defines clinical audit as:

"a systematic examination or review of medical radiological procedures which seeks to improve the quality and outcome of patient care through structured review, whereby medical radiological practices, procedures and results are examined against agreed standards for good medical radiological procedures, with modification of practices, where appropriate, and the application of new standards if necessary."

- Mandated Audit – Regulatory Basis
  - EU Basic Safety Standards Directive(2013/59/Euratom)
  - S.I. No. 256 of 2018 – Irish BSS Regulations
- HIQA Competent body for regulation of these
  - National Procedures for Clinical Audit (2024)
    - Proportionate to the risk within the service
  - Guidance on the establishment, use and review of DRLs for medical exposure ionising radiation (2023)
    - Recommends looking across system level doses population doses from exposures
- BSS Radiation Protection principles compliance
  - Justification (net benefit)
  - Optimisation (quality for dose)
  - Dose limitation (ALARA)
- RCR (U.K) recommends audit of repeat imaging.

Project Identification

Why suited to Audit

High-Volume, High-Frequency Task
Large prostate cohort, common repeat imaging

High-Risk Process
Avoidable dose, interruptions, pressure

High-Yield Audit Indicator
Repeat CBCTs measure avoidable exposure

Audits all three main RP* regulations (IRMER, IRR17, EURATOM BSS)

High Baseline, Improvement Potential
Significant practice variation identified

Robust, Reliable Data
Accurate EPR data for clear measurement

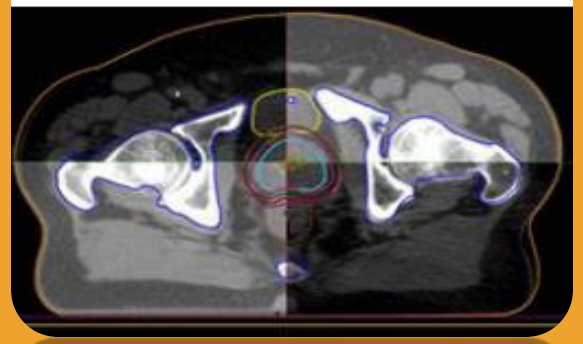
Supports HSE Safety Priorities
Addresses patient safety, workload & compliance

Radiation Protection & BSS Regulations
Clear standard for professionally relevant, safe practice

Established Imaging Audit Framework
Built on existing imaging audit strategy (since 2017) reviewing matching process, moves, independent checks, and time taken.

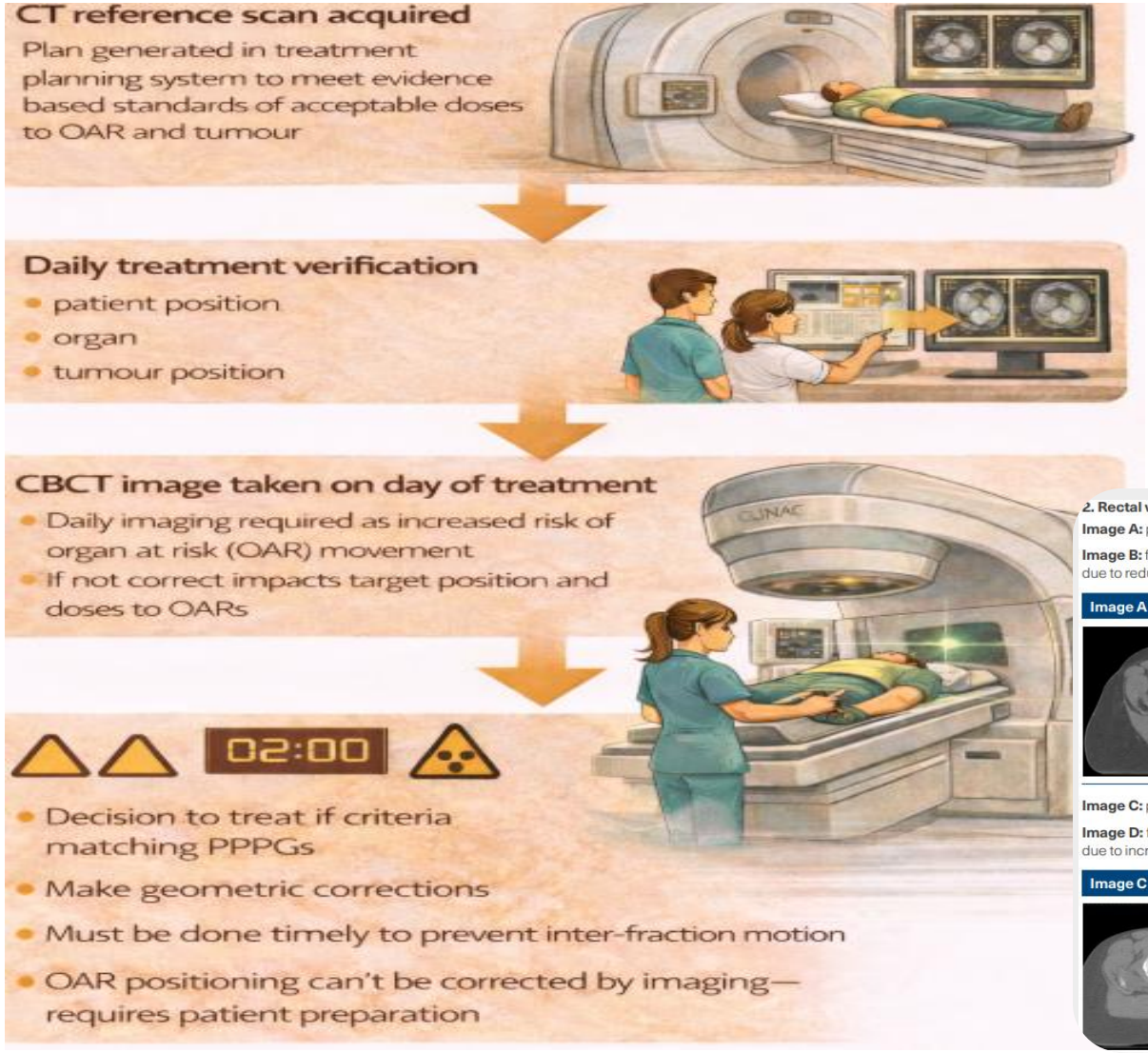
Example

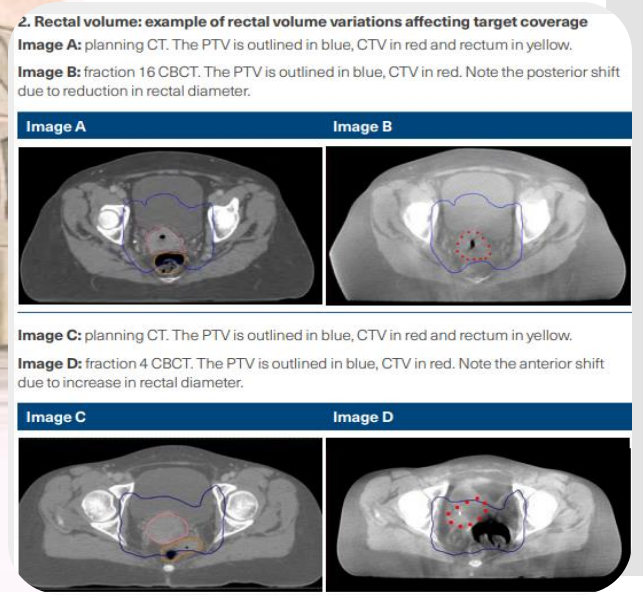
Checkerboard fusion of CBCT and reference data – prostate treatment.



Audit Metric -
Cone-beam (CBCT)

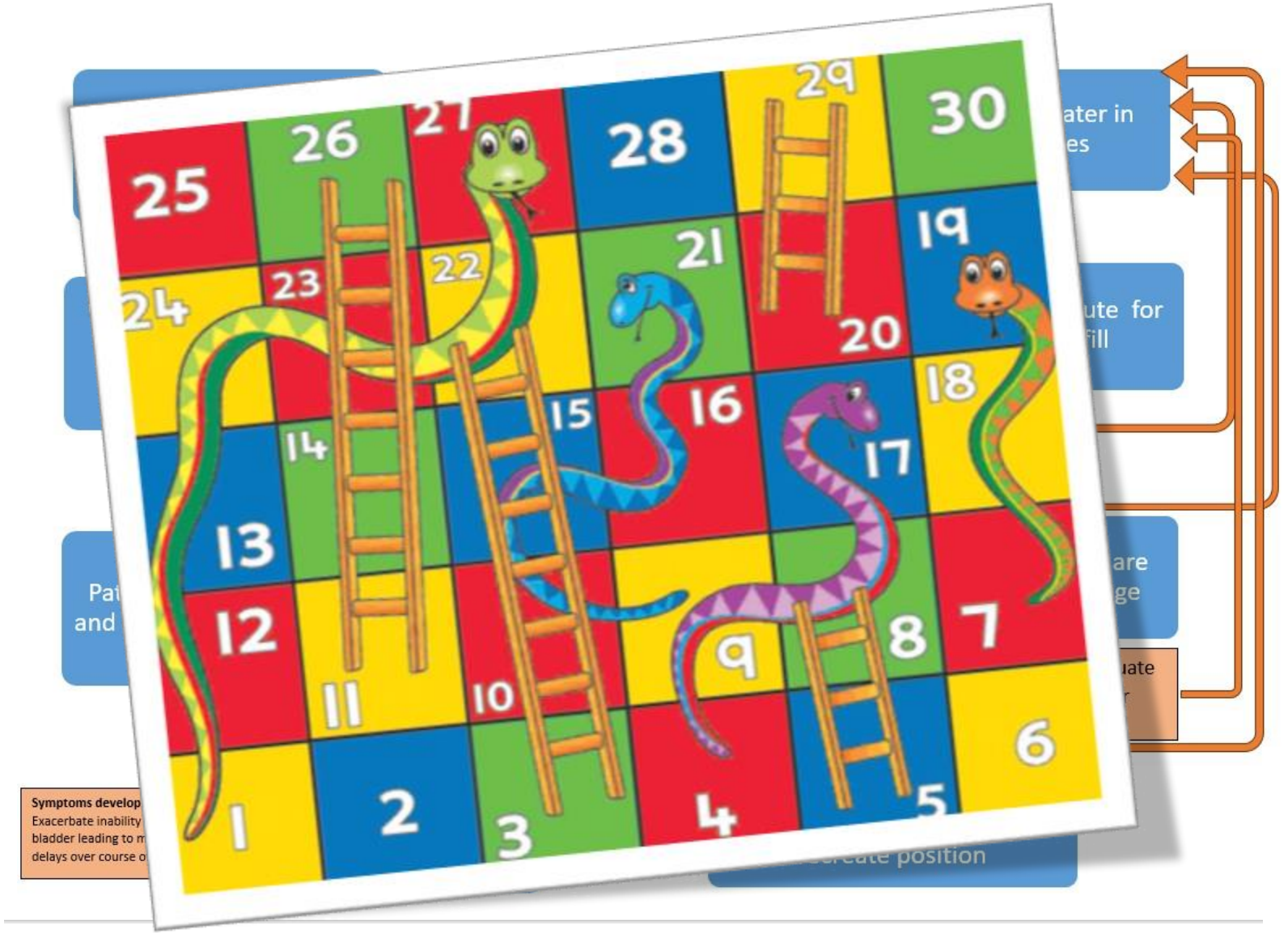
- Low-dose mini CT scan (approx. 10mGy)





Identify Topic

Process Audit – Repeat CBCTs in pelvis radiotherapy



AUDIT CYCLE

Aim : to ensure CB imaging is kept to as low as reasonably achievable in pelvic patients.

Standard: Maintain Failure rate of CB imaging to be less than 10%

Stage 1 Select Topic
- Audit of all additional cone beam (more than intended) in pretreatment radiotherapy verification
- MDT group established
- Reviewed extent and impact of the issue
- Surveyed staff and patients to understand impact

Stage 2 -Set Criteria & Standards
- Criteria is based on the BSS laws
- Justification, optimization and ALARA.
- Intended standard is to have 1 image a day
- 10% failure rate over cohort set as standard

Stage 3 Design Clinical Audit Tool and Collect Data
- Developed coding with in the HER that was linked to patient demographics
- Allowed to pull by delay related to radiation or no radiation
- Allowed to pull by reason for additional radiation e.g. organ at risk prep , patient position, response , patient related issues
- Allowed me to pull primary diagnosis and prescribed dose.

Stage 4 -Analyze Data and Compare Results with Standards
- Significant additional imaging
- Highest impacting pelvic
- Highest of Pelvic- Males and Prostate
- Sub category highest bladder
- bladder :rectum : 2.5:1;
- 3:1 - same patients

Stage 5 -Clinical Audit Report
- Target intervention on OAR prep specifically Bladder prep and in prostate patients would impact (80/20 rule)
- Would also be scalable to other pelvis sites/females
- Reported through hospital safety committee

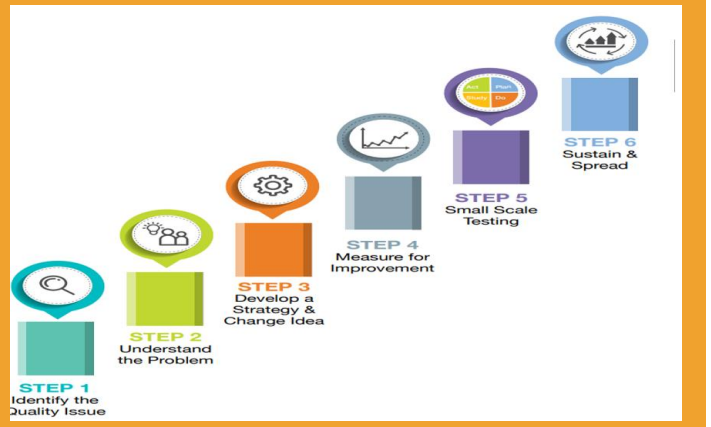
Stage 6 -QI Plan and Action
- QI methodology – PDSA, driver diagrams, Smart AIMs,
- All Pelvis sites changed
- Two main interventions :
  - PFE education (achieved via staff training, ISRT upskilling , posters, patient leaflet)
  - Improving tolerance- patient education on urge suppression /evacuation leaflet

Stage 7 -Re-audit
- Improvement seen
- Incidence additional CB reduced 158
- Bladder rectum ratio 2;1
- Hours delays reduced by 39.5 hours
- 43.5% improvement to baseline

Stage 6 QI Plan and Action
- QI methodology -Prior interventions stand
- New interventions
  - focus on prostate as higher impact:
  - Q4 24 enema protocol introduced for prostates
  - IPSS scores reviewed and bladder volume adapted baseline
- Improve use of non-ionizing US / CT 3D recon on scout to verify bladder adequate without radiation dose.

Stage 7 Re-audit
- CB reduced 106
- Hours reduced 26.5
- 51% reduction
- 2:1 same patient
- Bladder rectum ratio 1:1
- Now 73% reduction from baseline
- No longer have the highest repeated imaging.
- Additional captured no of times radiation saved.

Quality Improvement Plan

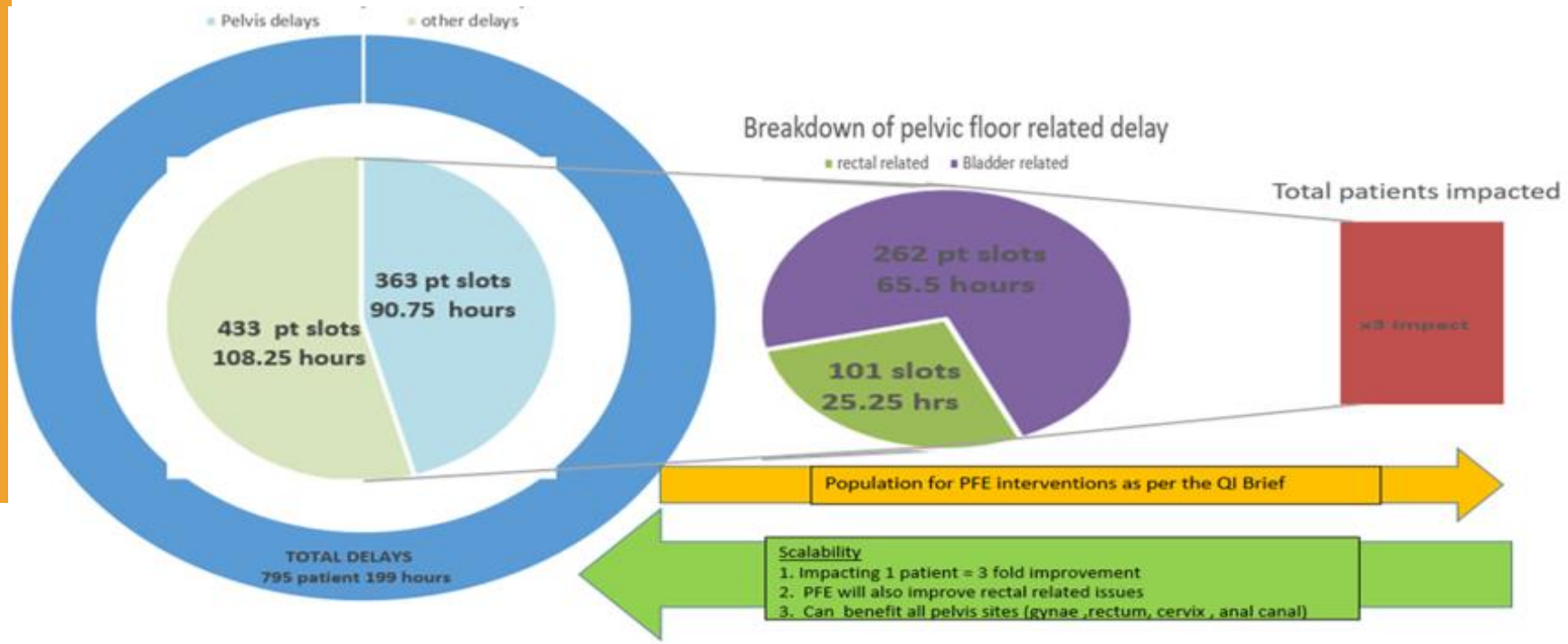


- Following completion of the baseline audit, the project progressed through a full audit-to-QI cycle,
- Suited to QI methodology., Not predetermined solution ,Not generalizable

QI Tools & Frameworks	Qualitative Methods	Quantitative Measures
Problem statement	Patient survey (baseline)	Baseline audit data
SMART aim	Staff feedback	Imaging frequency
Stakeholder map	MDT discussions	Time taken per episode
Process map	Process observation	Compliance rates
Driver diagram	Root cause analysis insights	Failure rates
Model for Improvement	5 Whys	Run charts
HSE 7 Steps to QI	Fishbone diagram	Re-audit (PDSA 1 & 2)
PDSA cycles (structure)	Perceived patient burden	Staff competency baseline

Baseline Audit *Q4 2023*

- Three month period-
  - Total 795 delays were recorded (199 hours)
  - 50% related to the pelvis cohort
  - 45% related to OAR prep (363slots- 90.75 hours)
- 2.5:1 ratio of bladder-related to rectal-related delays.
- 3:1 ratio - reoccurred in the same patients
- 24% failure rate of the total images exposed in this time



Understand the problem

Quantified issue at scale

Larger that anticipated

Looked over cohort not 'patient' related

Impacting on national KPIS – limiting new starts /capacity

Impacting significantly on overruns/overtime costs

Official and complaints received about delays/ increased length of stay daily/communication .

Well known problem to staff/patients

Long accepted as inevitable/unable to improve

Patients:embarrassment, anxiety, prolonged visits

Staff :92% staff reported stress during treatments

Regulatory compliance
BSS contravene ALARA
Radiation Safety procedures – Justification, optimization
Local PPPGS
HIQA guidance

Cumulative dose risk

PFE /physio known to impact but no service available

Episodes prior year HIQA reportable errors

- all cited time pressures
- All related to patients who had issues tolerating bowel/bladder prep

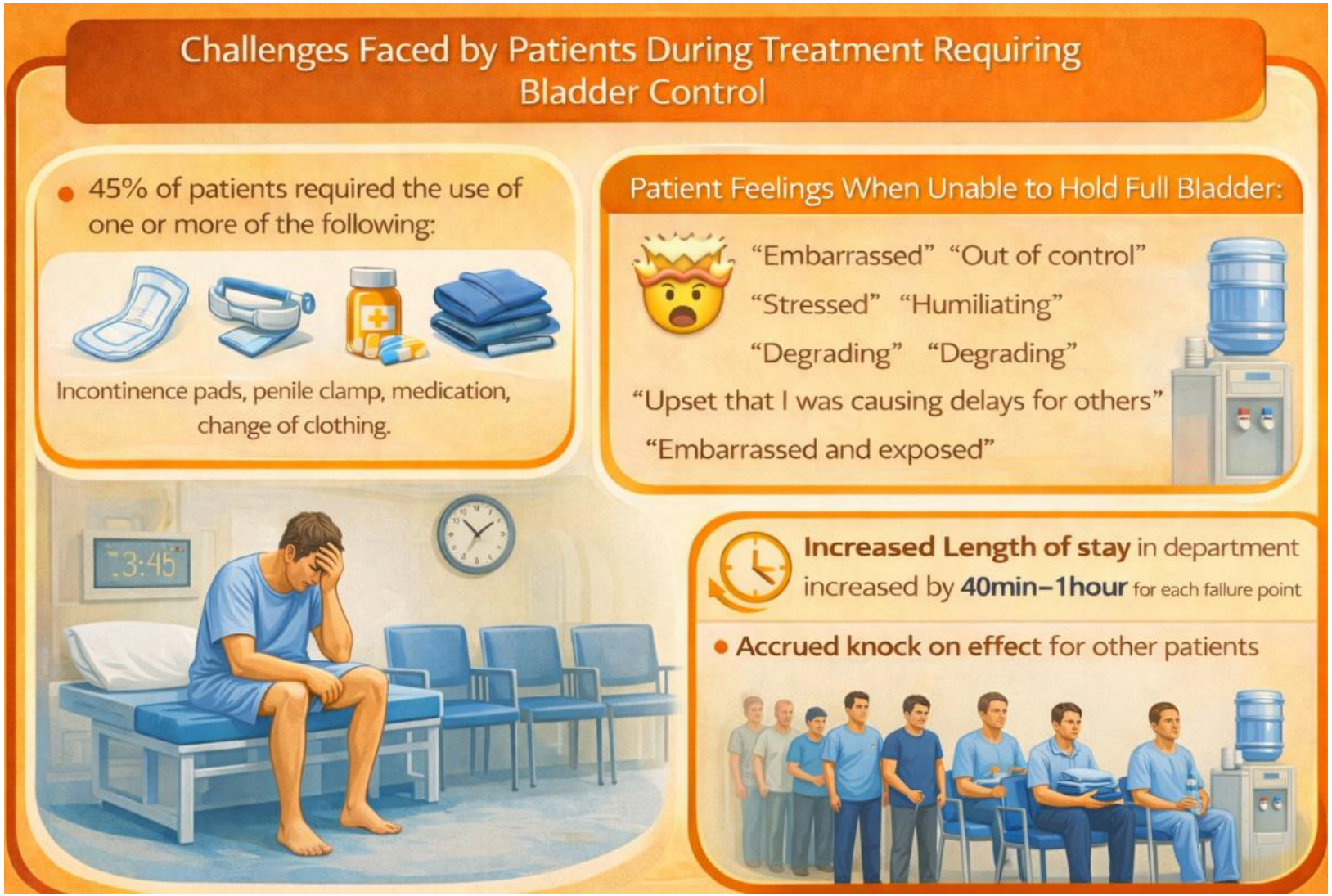
** errors reportable were not clinically* significant

- . Quality Improvement Guide and Toolkit 2024HSE

Impact on Patient

40 surveyed

STEP 2
Understand the Problem



Impact on safety

Improving OAR Reproducibility

- reproducible target coverage
- Reduces side-effects
- dose as calculated in the TPS

Potential Treatment Gaps

- Dept protocol: max 2 **additional** images/day
- Gaps – clinically undesirable (BED/tumour control)

Notifiable Errors (HIQA) <18months

- Average reporting frequency: bimonthly
- Key contributing factors: imaging complexity, time pressures, OAR prep variability, patient tolerance

- Individually low dose but increased cohort dose estimate contributes

CBCT (10.1 mGy)	Cohort Cumulative dose (mGy) (mGy)	CT equivalents (~390mSV)	X-ray equivalents (~0.1mSV)
363	3666 mGy (3.67 Gy)	≈ 9.4 CTs	≈ 36,600 X-rays

Impact on staff

- Stressful working environment
  - 92% surveyed reported feeling stressed when treating patients with difficulty holding a full bladder.
  - 2nd victim in errors occurred.
  - Delays per working day were approx. 3 hours overrun per treatment machine.
    - Working outside operational hours
    - No other support staff just 2 RTs
  - Possible impact on recruitment and retention of staff
    - Burnout
    - 3hours delays daily.
    - 32% working day (8-6pmservice) staff time spent on delays

Getting to the root cause

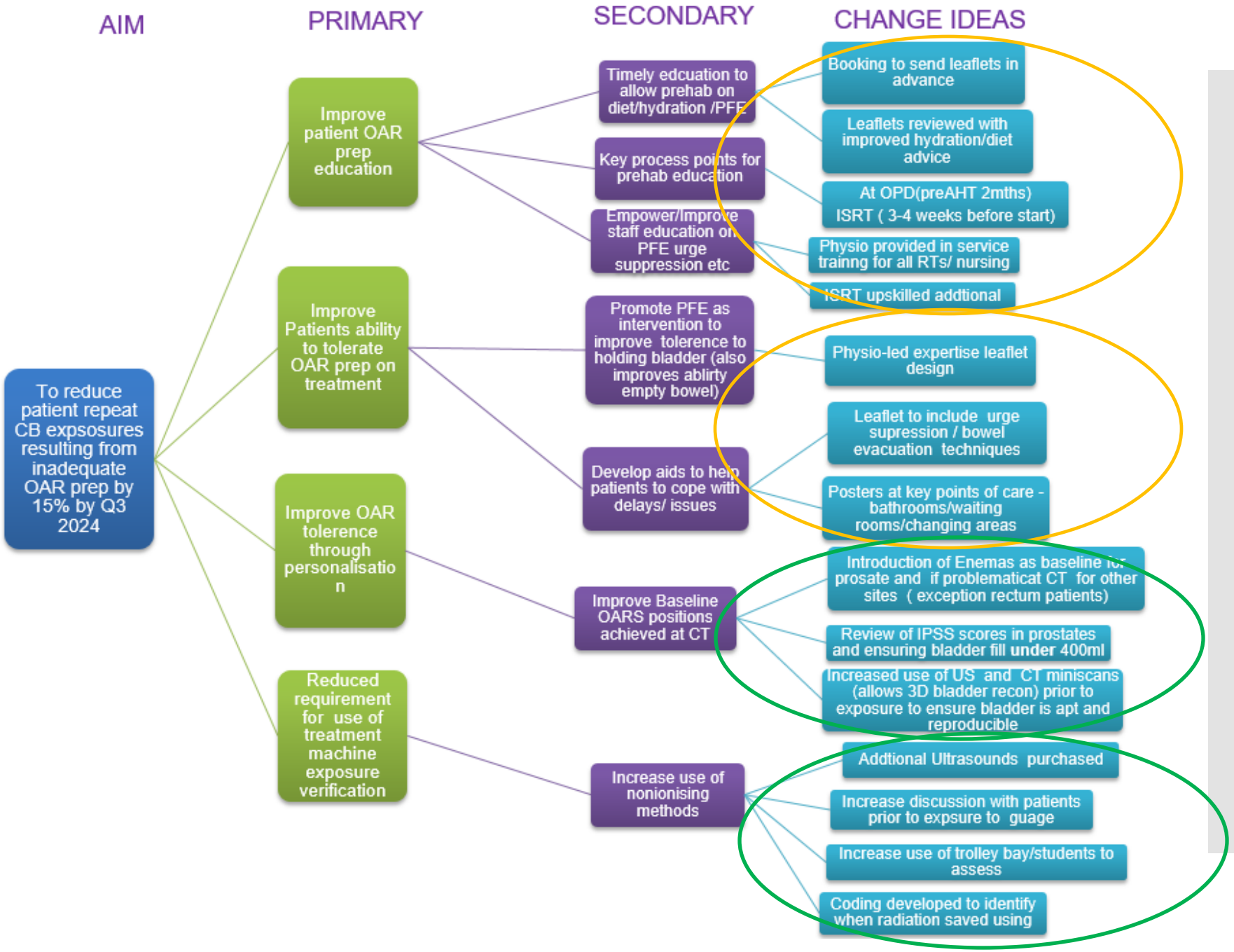
The 5 Whys

Issue- There are substantial delays in the radiotherapy department associated with prostate cancer patients in UHG.

1. **Why is that?-** Patients have issues filling their bladders sufficiently and holding full bladders for their scans.
2. **Why is that?** They have reduced bladder capacity as a side effect of their prostate cancer/they aren't used to holding large volumes in their bladders.
3. **Why is that?-** They haven't been educated on pelvic floor exercises and their use in urge suppression and bladder retraining
4. **Why is that?** They are not routinely seen by physiotherapy prior to their radiotherapy treatment

Root Cause-There isn't an established role/staffing for pelvic health physiotherapists in the Radiotherapy Department.

Interventions



Change idea PFE as initial intervention

Evidence and experience suggest:

- **Recurrence in the same patients**
  Repeated issues occurring **in the same individuals** suggest the issue is **patient-related,** not random or treatment-specific.
- **Grounded in front-line clinical experience**
  Radiation therapists consistently report that **men with** pelvic surgery **do better than expected** with less complications and quicker recovery when started prehab early which includes PFE.
- **Evidence-based for similar long-term side-effects**
  Comparable late effects have been successfully managed using the same principles.
- **Prehabilitation can prevent complications**
  There is growing evidence that **early intervention can help reduce severity** and incidence of later problems.

Gap in service

- No physio assigned
- 72% of patients were unaware of PFEs & 50% of staff were unaware PFE advice was not being given.

Patient Survey

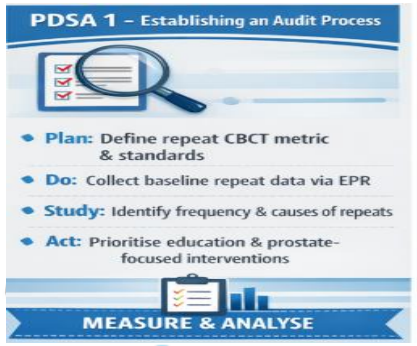
- 50% of patients surveyed were not aware of the role of pelvic floor muscle training in aiding to hold a full bladder.
- Preference re education: 65% preferred in-person education

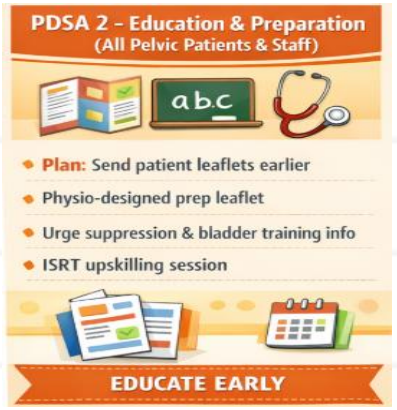
Staff Survey

- 72% radiotherapy staff were not aware re how to use the pelvic floor muscles to help hold a full bladder.

Tests of change Results

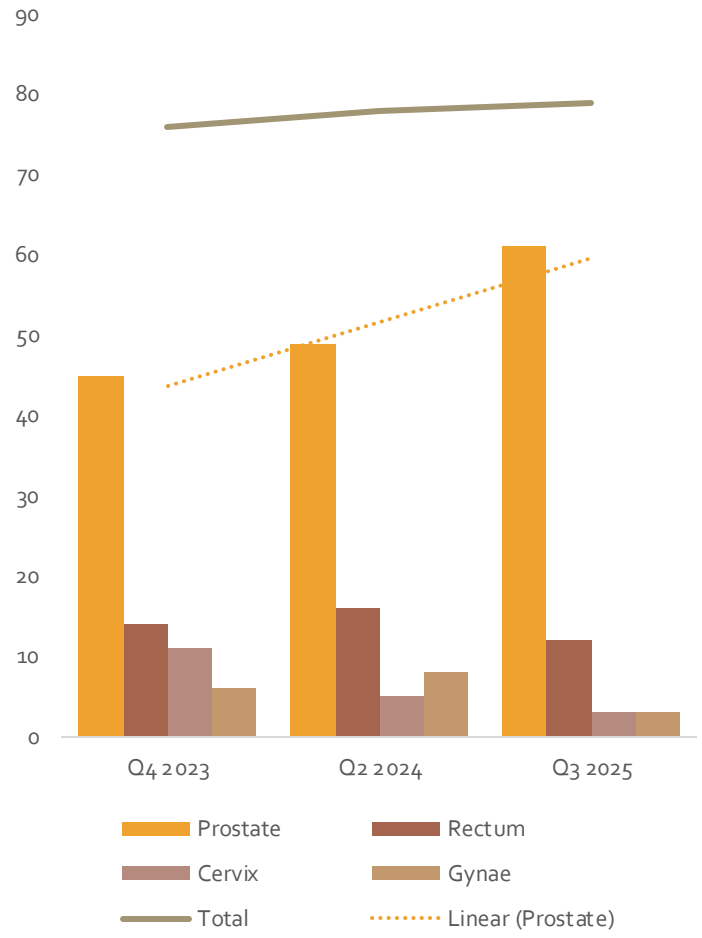
(data measured at audit points only)



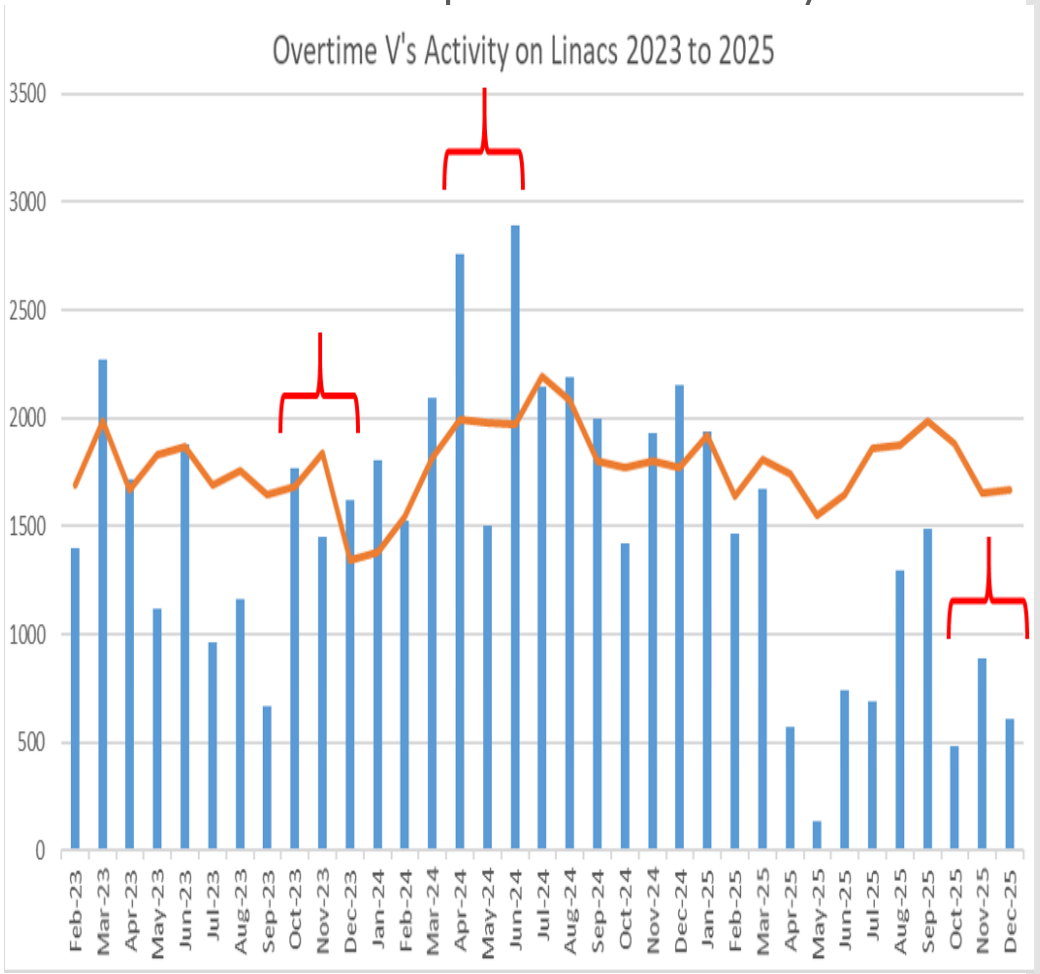


Results

Total number new pelvic patients in time periods audited



Over all department activity



The outcomes leading to better care

- Reduced dose to patient
- Reduced time/ pressure on staff
- Reduced errors (>260 Days Elapsed days)
- Improved reproducibility of OARs
- Reduced breaks on treatment
- Reduced rescan doses
- Improved Radiation safety compliance
- Increased use non ionizing imaging

Improvement sustained over time

- Already scaled to other Pelvic sites
- Scaling audit process to non pelvis sires
- System continuously monitor
- Electronic coding/ monitoring
- Allowing to look at other delays also
- Low cost intervention-education and equipment based

Reduced delays

- Reduced associated costs
- PFE proven intervention for long-term Prehab / earlier intervention impact

- Scaled to all pelvic sites/all sexes
- Leaflet/verbal education
- Phone and face – face education

- Improved patient experience
- Improved education
- Earlier PFE prehab improve long term toxicity /late side effects.
- Personalizes to baseline symptoms
- Reduced distress/treatment related anxiety
- Maintaining dignity

- Reduced overtime costs
- Use of QI to improve
- Use of low cost interventions
- Use of technology/Improved use EHR
- Reduces rescan /rework
- Gap in service (no physio) addressed within resources
- Transferrable process to other sites /

- Reduced delays
- Reduced LOS in dept.
- PFE more timely in prehab than post treatment
- More time for patient daily interactions

Outcomes patient

Reduction in ratio patients impacting now 2:1

F.R % reduction
18 percentage points
(24% → 6%)
Meeting KPI

Reduced CBs 264 (73%)
Knock on impacts
Reduce LOS daily

Pelvis no longer the highest repeat CB imaging site

Audit period	Time frame	Repeat CBs	% of total (FR = 1580 images)	Patients (n=)	% vs baseline	Key interventions for patients	Notes
Baseline	Q4 2023	363	24%	124	100%	Establishment of delay coding in EHR (radiation vs non-radiation; subcategories)	~50% related to pelvis 3:1, same patients
1st Re-audit	Q2 2024	205	13%	–	56.5%	Phase 1 (PDSA): PFEs; patient & staff training; physio-led staff training; PFE leaflet; urge suppression & bowel evacuation leaflet; posters	CBCT reduced by 158; 43.5% improvement
2nd Re-audit	Q3 2025	99	6%	45	27%	Phase 2 (Baseline OAR-optimisation Prostate focused enemas volume recon at CT; IPSS review increased US use treatment	CBCT reduced by 106; 51% reduction; ~2:1 same patient; no longer highest cause of repeat imaging

Outcomes Radiation safety

Clinical & Safety Impact

- Repeat verification imaging reduced → ALARA & dose optimisation achieved across cohort
- Increased use of non-ionising US for bladder verification-175 avoided repeat CBCTs
  - 51 detected via ultrasound in last audit
  - 124 avoided through clinical judgement/patient discussion
- ≈73% dose reduction across the cohort during audit period

Safety Outcomes

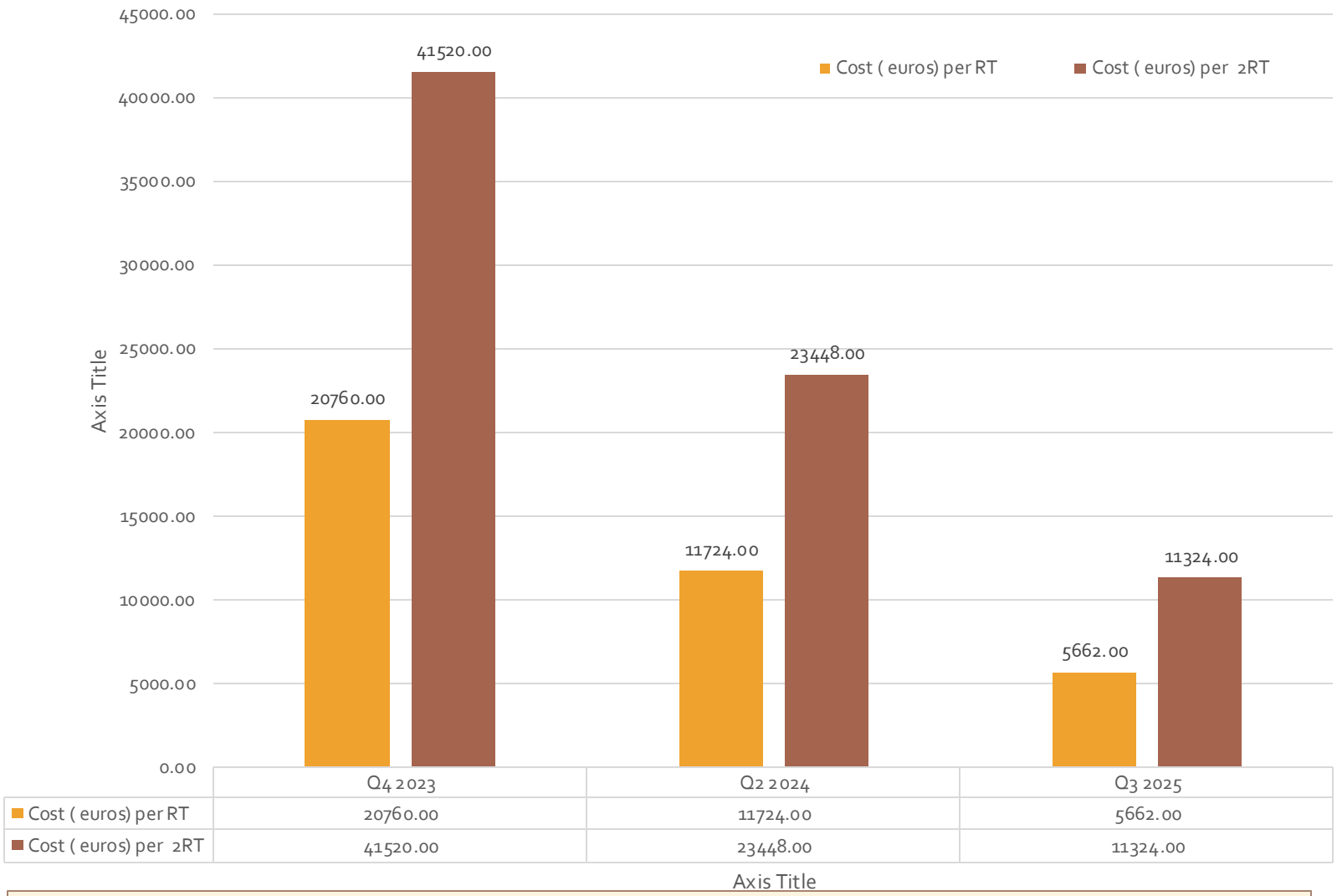
- No imaging-related incidents since Nov 2024 (Prior 18months as bimonthly

Workload & Environmental Improvements

- Reduced interruptions and environmental pressures
- Operational challenges captured: tight slots, OOH work, multiple delays (data capture ~50% of delays)
  - Increased catch-up capacity
  - Scheduled safety-pause huddles

CBCT Scans per Year	Cumulative Dose (mGy)	Cumulative Dose (Gy)	CT Equivalent	X-ray Equivalent	Dose Saved vs 363 (mGy)	Dose Saved vs 363 (Gy)
363 (baseline)	3666	3.67	≈ 9.4	≈ 36,600	–	–
205	2071	2.07	≈ 5.3	≈ 20,700	1595	1.60
99	1000	1.00	≈ 2.6	≈ 10,000	2666	2.67

Impact on service – reduced overtime costs

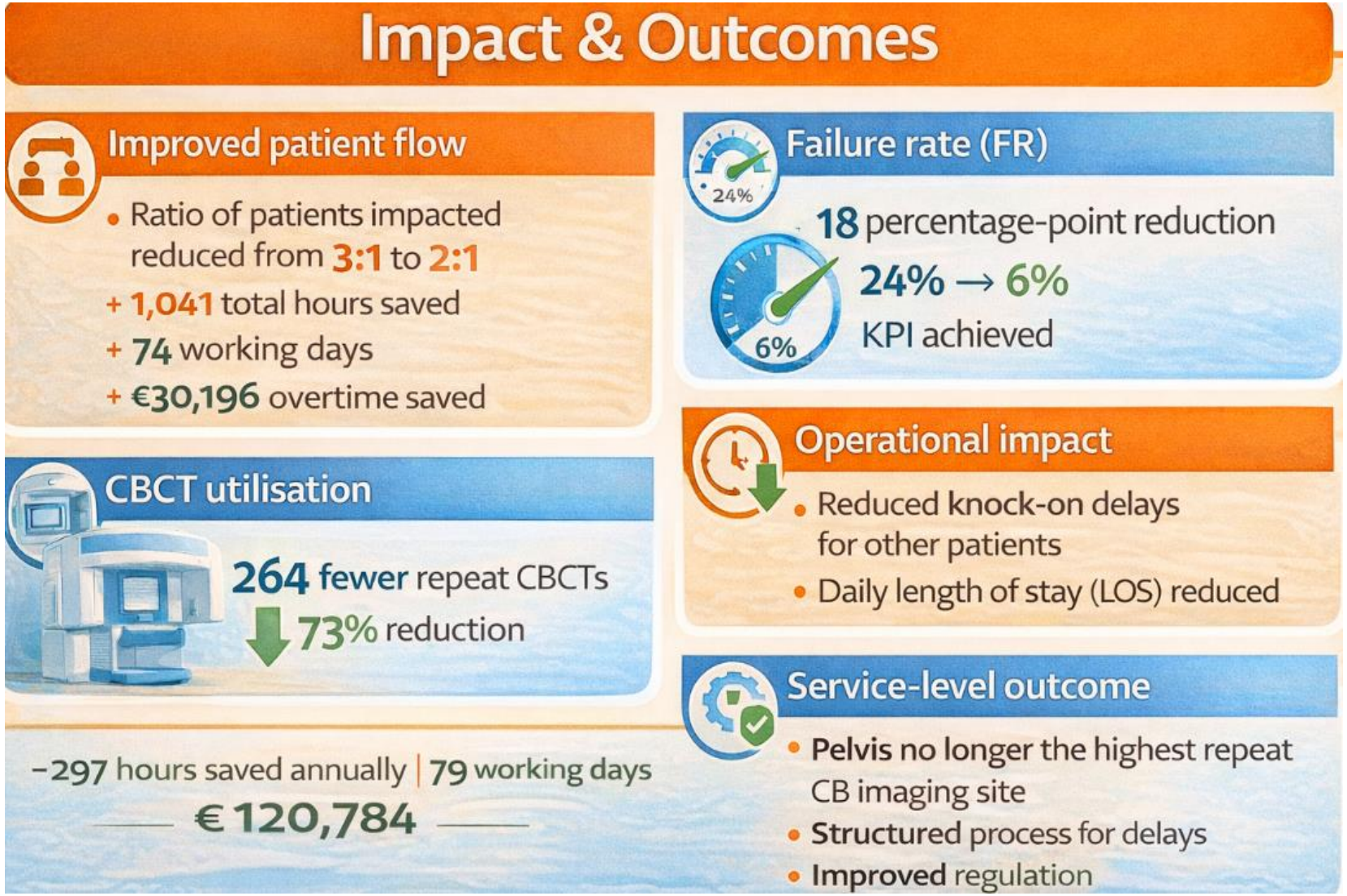


Note this is costed at standard rate pre hour per radiation therapist required.
Treatment must be delivered by 2 RTs at all times so these **numbers can be doubled** for true effect

Outcomes on Service

Audit Phase	Time Frame	No. Rpt CBs	Total time equivalent 15min slot	% vs Baseline	Cost/RT (€57.19/hr)	2×RTs	Notes
Baseline	Q4 2023	363 CBs	90.75	-	€20,760	€41,520	High rate of repeat CBCT. ~50% pelvis related OAR 2.5:1 bladder/rectum 3:1 same patients
1st Re-audit	Q2 2024	205 CBs	51.25	56.5%	€11,724	€23,448	CBCTs reduced 158; 39.5 hrs saved; 43.5% improvement
2nd Re-audit	Q3 2025	99 CBs	24.75	27%	€5,662	€11,324	CBCTs reduced by 106; 26.5 hrs saved; 51% reduction.
Total Improvement	Baseline → Final	264 CBs	74.25 hours	73% (7.4 working days)	€15,098	€30,196	Sustained reduction prep No longer highest cause of repeat imaging
Est. Annual Impact	**Extrapolate**	**1,056**	**297hours**	**73% 29.7 working days**	**€60,392**	**€120,784**	**Conservative extrapolation based on observed improvement**

Summary


Impact & Outcomes
Improved patient flow
• Ratio of patients impacted reduced from 3:1 to 2:1
+ 1,041 total hours saved
+ 74 working days
+ €30,196 overtime saved
Failure rate (FR)
24%
18 percentage-point reduction
24% → 6%
6%
KPI achieved
CBCT utilisation
264 fewer repeat CBCTs
73% reduction
Operational impact
• Reduced knock-on delays for other patients
• Daily length of stay (LOS) reduced
–297 hours saved annually | 79 working days
€120,784
Service-level outcome
• Pelvis no longer the highest repeat CB imaging site
• Structured process for delays
• Improved regulation

Scale & Sustain

Scale

- Immediate inclusion of all pelvic cases
- Data maturity demonstrated through trends over time
- Expanded focus to the next treatment site
- Scalable to other radiotherapy (RT) departments
- Use of EHR for auditing, designed to be scalable within the department

Sustain

- Sustainability considered from project inception
- MUSIQ sustainability score >135/168 (Cincinnati)
- Met all QI drivers for change within the HSE QI framework
- Embedded within a continuous audit process
- Imaging working group MDT established to review ongoing
- Improvements sustained over time and across re-audit cycles

Reflections & 'quick wins '

Reflections

- Audit as a catalyst for change-Large-scale data enabled a root-cause analysis and a systems-based approach to improvement.
- Patient voice as a driver..
- Strengthened MDT collaboration.
- Value of structured QI programme

Quick Wins

- Improved understanding of patient experience-need for additional support.
- Effective EHR use enabled improved data management and operational insight.
  - Used to support business cases (e.g. porter support)
  - Daily quantification - forward planning and rationalisation of overtime

Positive Outcomes & Feedback

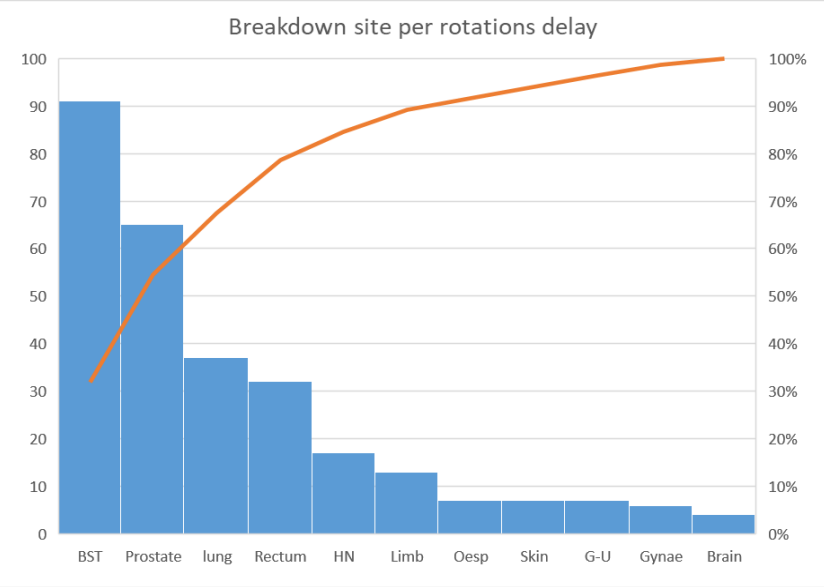
- Positive feedback to the college-Routine involvement of RT students-Supported development of future QI capability
- Project and QI course cited as commendable good practice during a HIQA inspection

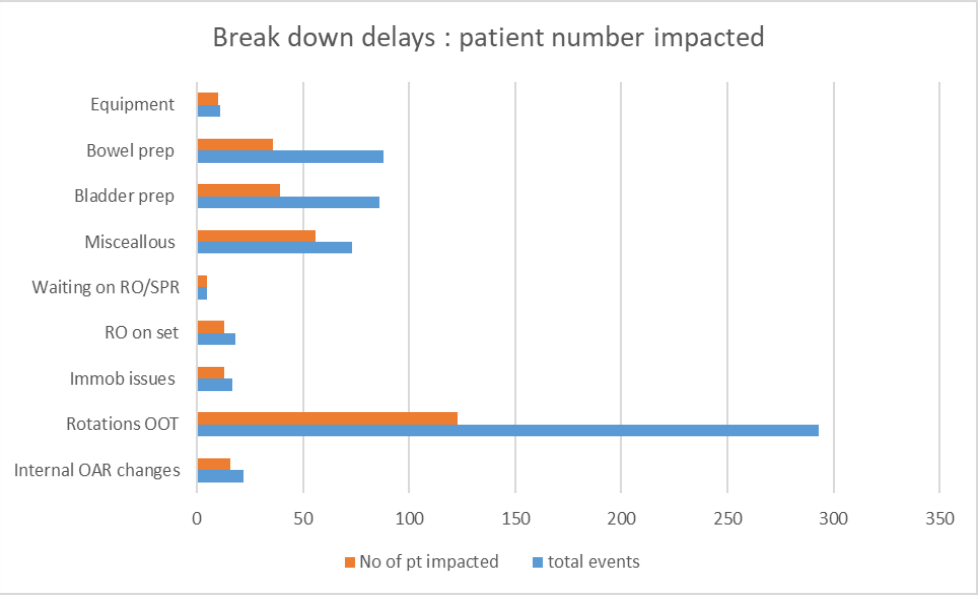
Environmental Benefit

- Increased machine utilisation and reduced unnecessary exposure
- Resulted in a measurable reduction in carbon footprint

What's next

- Continue to monitor pelvic delays
- Delays reviewed and rotations setup issue mainly pertaining to breast patients highest contributor – so focus on these
- Imaging dose critical here as younger cohort, radio - sensitive contralateral breast tissue
- Apply the same QI methodology to improve but will require different intervention





The End ！


Thank you for listening!
We'll try PFEs!
Bladder training works!
Urgency ≠ emergency.

References

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