

Physics Community of Practice Patient Specific Quality Assurance Summary of Survey Results

MARCH 2020

Physics Community of Practice Working Group Members

- Gordon Chan (Chair), Juravinski Cancer Centre
- Lee Chin (Co-chair), Odette Cancer Centre
- Ady Abdellatif, Walker Family Cancer Centre
- Jean-Pierre Bissonnette, Princess Margaret Cancer Centre
- Lesley Buckley, Ottawa Hospital Regional Cancer Centre
- Daria Comsa, Southlake Regional Cancer Centre
- Dal Granville, Ottawa Hospital Regional Cancer Centre
- Jenna King, Simcoe Muskoka Regional Cancer Centre
- Patrick Rapley, Thunder Bay Regional Health Sciences Centre
- Aaron Vandermeer, R.S. McLaughlin Durham Regional Cancer Centre
- Julie Kraus (CCO Lead), Cancer Care Ontario

Introduction

- The Cancer Care Ontario (CCO) Physics Community of Practice (CoP) working group identified Patient-Specific Quality Assurance (PSQA) as a priority quality initiative. The main objective for the initiative was to improve the quality and safety in IMRT or VMAT delivery.
- The working group distributed a survey on the current practice of PSQA across Ontario in December, 2018. The purpose of this survey was to get a snapshot of the current state of practice of PSQA to help identify areas of improvement, and guide the creation of a Best Practice Guidance document, available in the Physics CoP section of the CoP Products on the CCO website (<https://www.cancercareontario.ca/en/radiation-treatment-program-hub>), to standardize PSQA. The focus was PSQA activities on regular linacs using IMRT or VMAT, including SBRT. PSQA activities typically included either measurement or delivery log calculation, and excluded pre-delivery calculation based software. SRS and PSQA of specialized machines such as TomoTherapy or CyberKnife were also excluded.
- The survey questions covered topics such as PSQA measurement, calculation and evaluation methodology, equipment, frequency, troubleshooting, feedback, procedure, process, and documentation. In addition, there were two general questions about PSQA for HDR and LDR brachytherapy.

Physics CoP – PSQA Survey Results

- The participating centres were instructed to submit answers that reflected the collective view or opinion of their department, and/or represented the typical process that a physicist or physics assistant was expected to follow.
- Each centre was asked to complete the survey by the physicist(s) in charge of or most familiar with PSQA at their site. Only one response was required from each centre. All centres completed their surveys within 2 months. Their responses were anonymized in the post survey analysis.
- During the post survey analysis, the CCO lead contacted a number of centres on behalf of the working group for follow-up or clarification of their responses. In some cases, we changed their selections based on their comments or follow-up responses.
- The following slides provide a summary of the Physics CoP PSQA provincial survey results. Most of the questions are associated with one or more Key Quality Indicators (KQIs) from the Best Practice Guidance document. The associations are displayed at the end of the questions. The readers can refer to the summaries of the KQIs, which are provided here in the Appendices.

Physics CoP – PSQA Survey Results

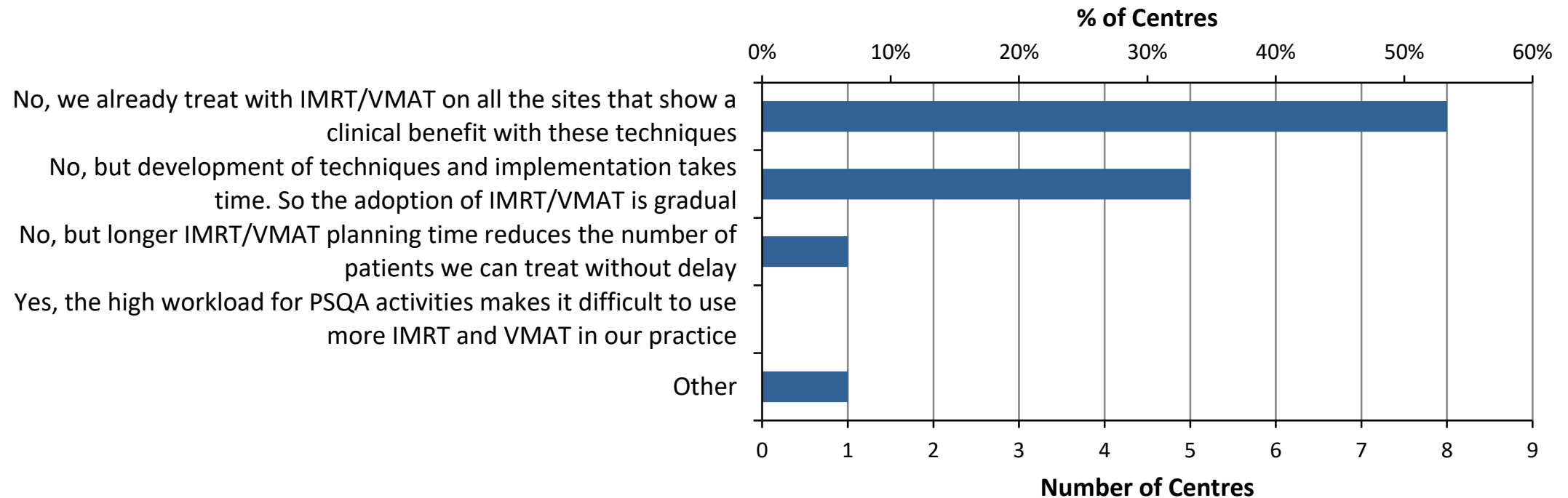
Question 1: Please list your Regional Cancer Centre below in case there is any follow up and/or clarification questions required

**15 Regional
Cancer Centres
responded**

<i>LHIN</i>	<i>Regional Cancer Centre</i>
Erie St. Clair	Windsor Regional Cancer Centre
Southwest	London Regional Cancer Centre
Waterloo Wellington	Grand River Cancer Centre
Hamilton Niagara Haldimand Brant	Juravinski Cancer Centre
Hamilton Niagara Haldimand Brant	Walker Family Cancer Centre
Central West/Mississauga Halton	Carlo Fidani Peel Regional Cancer Centre
Toronto Central North	Odette Cancer Centre
Toronto Central South	Princess Margaret Cancer Centre
Central	Southlake Regional Cancer Centre
Central East	R.S. McLaughlin Durham Regional Cancer Centre
South East	Southeastern Ontario Cancer Centre
Champlain	Ottawa Hospital Regional Cancer Centre
North Simcoe Muskoka	Simcoe Muskoka Regional Cancer Centre
North East	Northeastern Ontario Regional Cancer Centre
North West	Thunder Bay Regional Health Sciences Centre

Question 2: Do PSQA activities prevent your centre from expanding the IMRT/VMAT practice?

[KQI: A2]

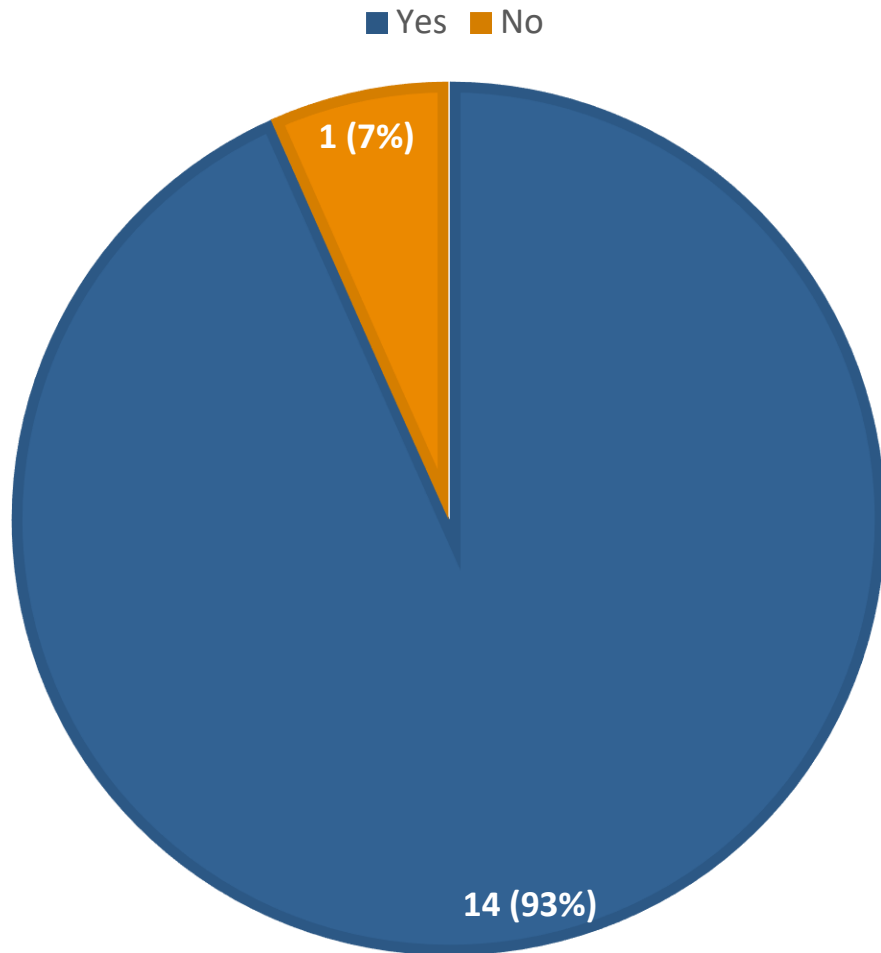


Summary: PSQA activities did not appear to be a main reason to prevent any centre from expanding their IMRT/VMAT practice in general, as no centre selected “Yes”. Eight (53%) centres responded that IMRT/VMAT adoption was gradual because their development of techniques and implementation took time.

Comment:

- One centre commented that PSQA activities prevented them from using VMAT for same-day palliative treatments.
- “Clinical Operation hours put pressure on the amount of time available at the end of day for PSQA”
- “... the number of patients plan we measure every day is getting nearly unmanageable”

Question 3: Does your centre discuss and learn from PSQA failures? [KQI: E3]



Summary: All but one centre responded that they discussed and learned from PSQA failures, though the feedback mechanism varied widely among different centres.

Comment:

- Many centres discussed PSQA failures informally, but one commented “the process would benefit from being formalized”.
- Three centres stated having very few PSQA failures and one stated no failures.
- Three centres commented learning from PSQA failures had led to changes in planning practices and one led to improvement of beam models.
- One wrote that their QA guidelines required them to discuss PSQA failures with at least one other physics colleague.

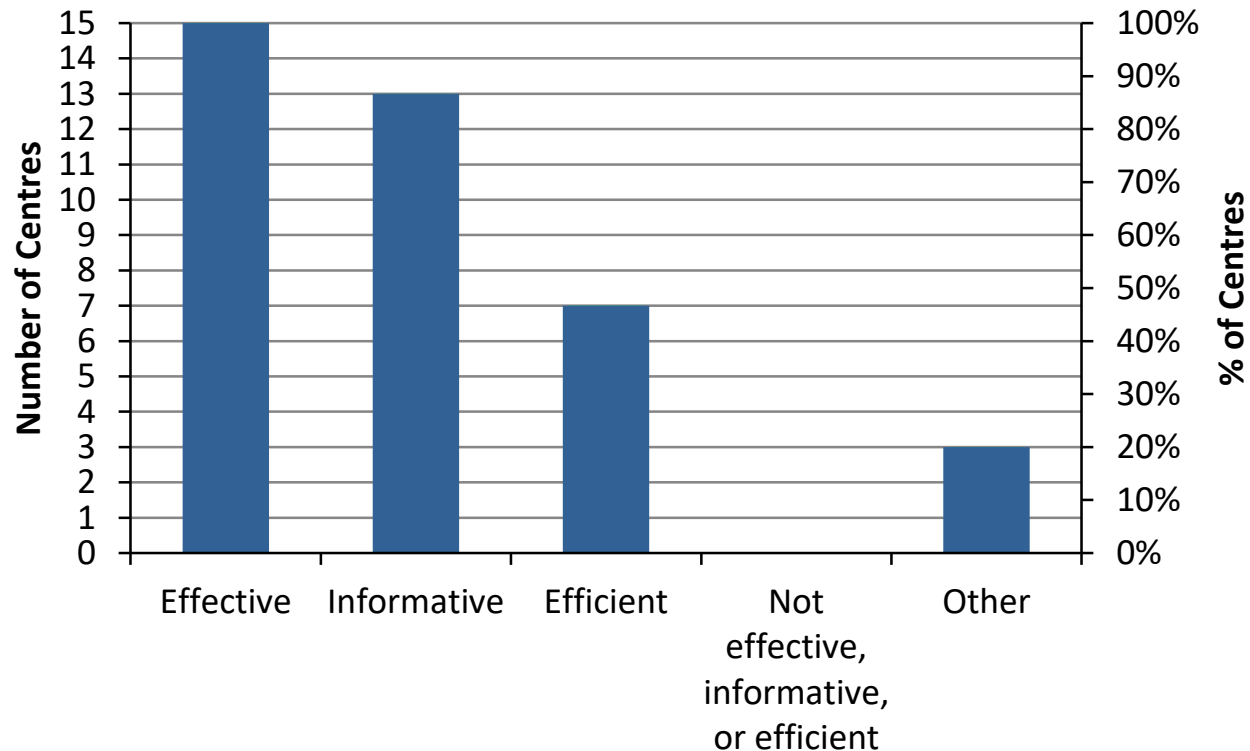
Question 4: Has your centre participated in an independent credentialing process for IMRT and/or VMAT (IROC for example)?

<i>Response</i>	<i>Number of Centres (%)</i>
Yes	15 (100%)
No	0

Summary: All centres participated in an independent credentialing process for IMRT and/or VMAT.

Comment: All responded using IROC (formerly RPC). Most listed CCO CQA audit as well.

Question 5: We would like to know your opinion regarding your centre’s current IMRT/VMAT PSQA program, whether it is effective (such as the ability to catch a serious error), informative (e.g. to gain enough information to improve the planning and delivery), and efficient (please choose all that apply).

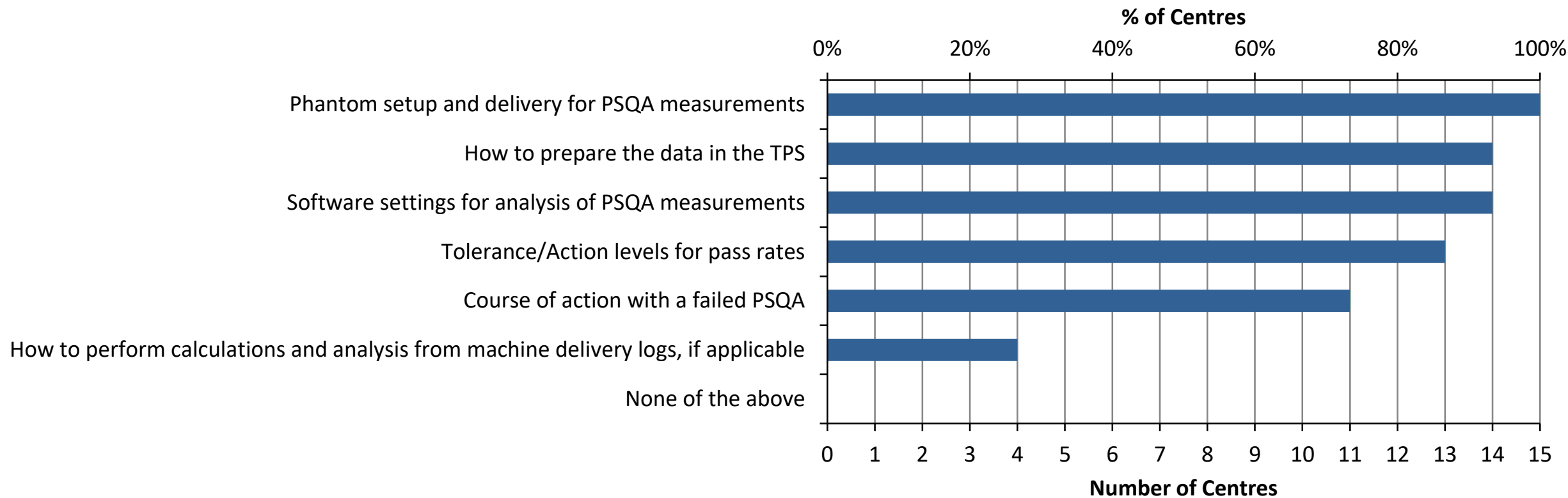


Summary: All centres considered that their current IMRT/VMAT PSQA programs were “Effective”. 13 (87%) selected “Informative” and seven (47%) selected “Efficient”.

Comment:

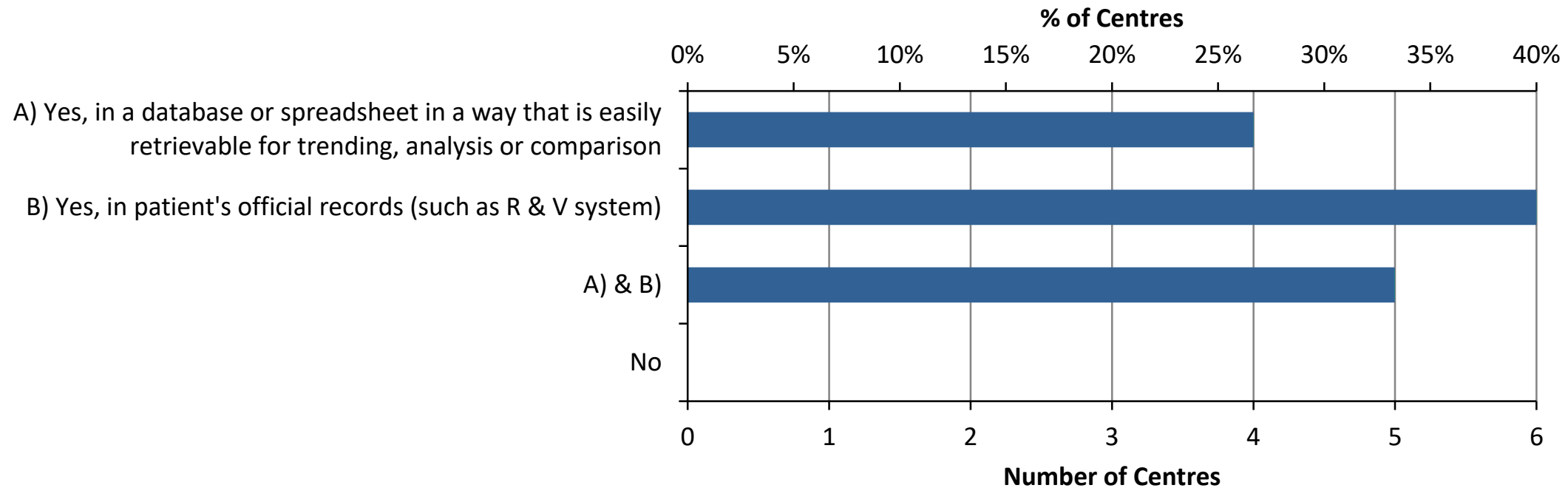
- “Effective and informative for serious problems. Low sensitivity and specificity on small issues...”
- “Using PSQA to improve planning is easily the most difficult of these options”
- One centre commented for effectiveness that some serious errors such as gantry speed-dose rate interplay errors were not caught by PSQA based on delivery log, but by regular VMAT QA or PSQA measurements.
- Another centre commented their PSQA in part established a governor in the timelines that limited last minute handoffs from plan approval to treat.

Question 6: Has your centre created documents detailing the procedures for the following (choose all that apply)? *[KQI: E1]*



Summary: The vast majority of centres had created documents for measurement setup and delivery (100%), data preparation in the TPS (93%), measurement analysis (93%), and tolerance/action levels for pass rates (87%); however, four (27%) responded not having a course of action procedure for failed PSQA.

Question 7: Does your centre keep recent records of PSQA (measurements + delivery log calculations) results? *[KQI: E2]*



Summary: All sites kept a record. Nine (60%) kept record in a retrievable fashion. 11 (73%) kept record in official record such as Record and Verify (R & V).

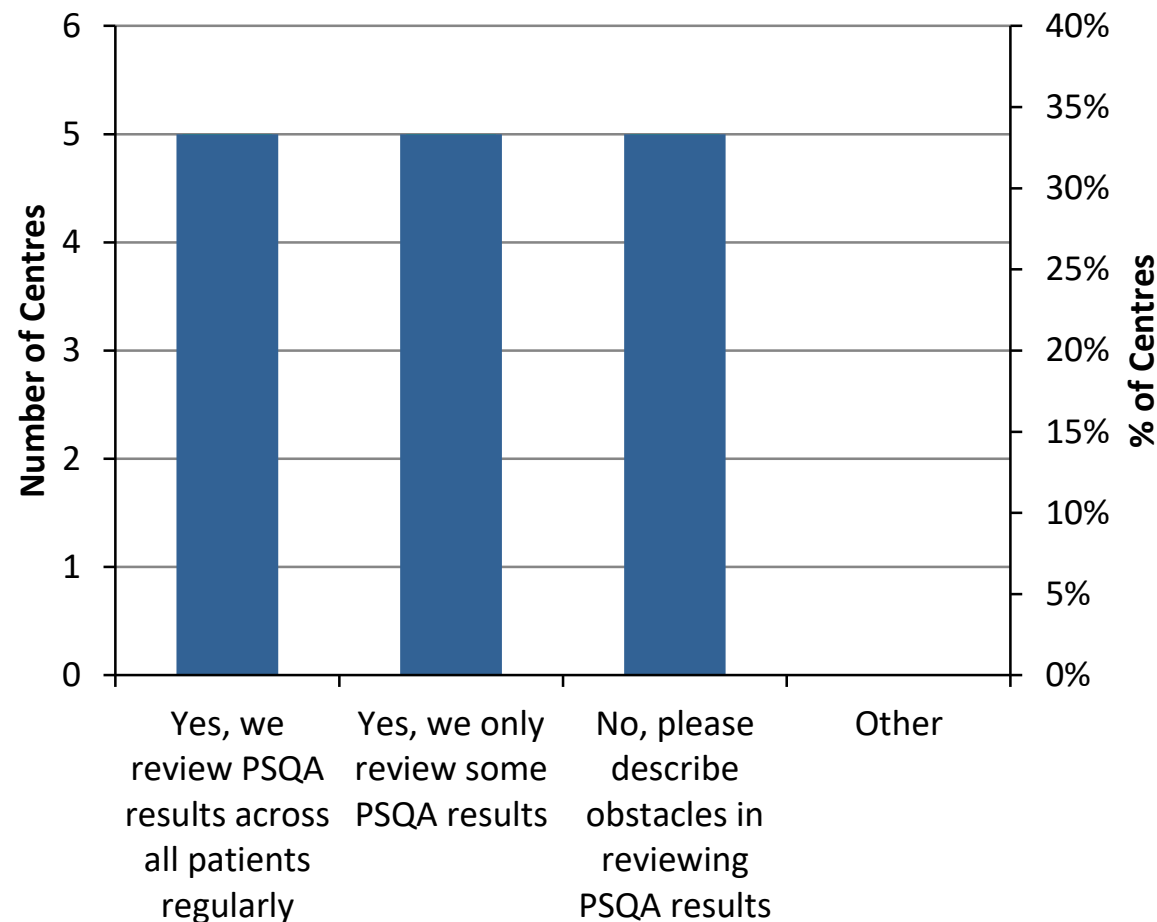
Comment: One site mentioned that the only official record kept is that PSQA was performed and whether it passed.

Question 8: Does your centre review PSQA results across patients, especially for the same disease sites, or class solutions, regularly to look for systematic errors in the system? *[KQI: E4]*

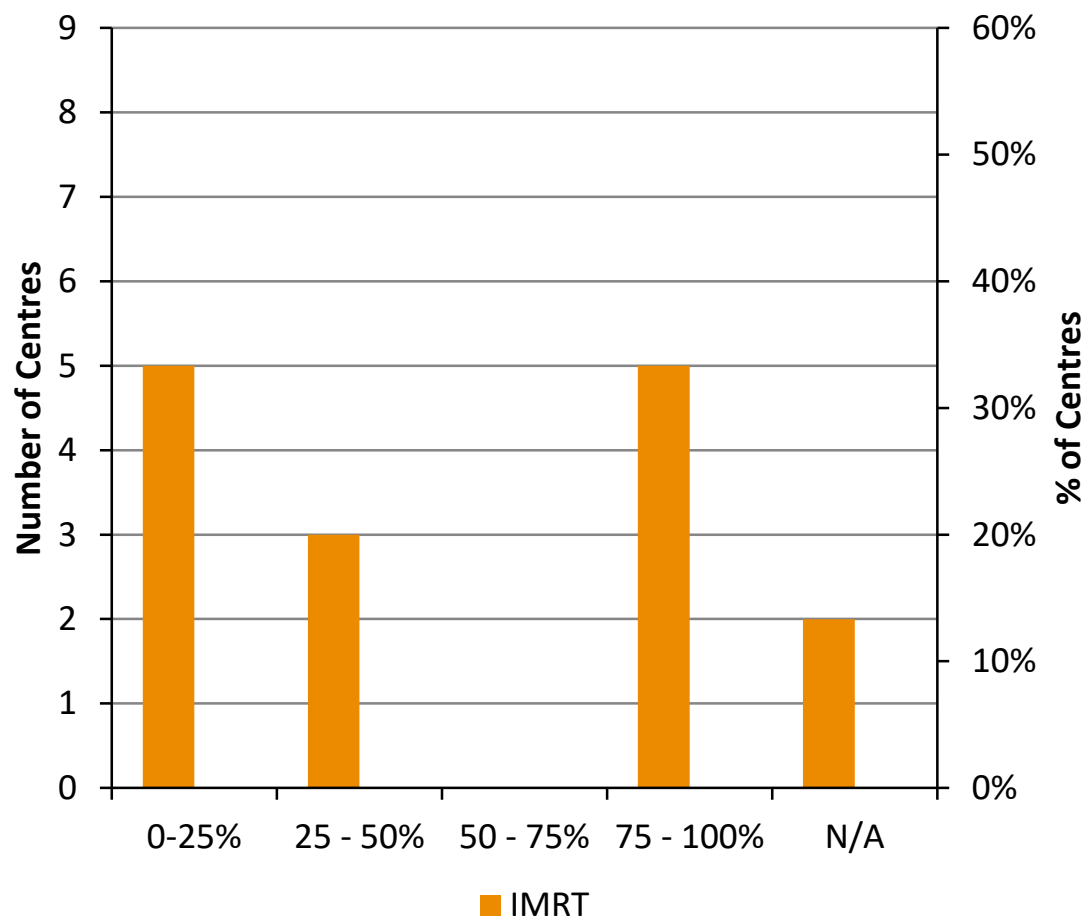
Summary: Two-thirds (10) of centres reviewed all or some PSQA results regularly.

Comment:

- The centres that did not review regularly cited obstacles such as lack of automated extraction tools, lack of urgency due to historically high pass rates, and lack of benefits of regular review.
- One centre commented they did control chart analysis for their recently implemented portal dosimetry PSQA program
- One centre reviewed PSQA results for 10 test patients before rollout of technique for a disease site/fractionation



Question 9: What percent (approximate) of IMRT plans (normalized to total number of IMRT plans) use standardized protocols (same beam geometry, objectives, planning avoidance, etc) based on developed or commissioned class solutions?



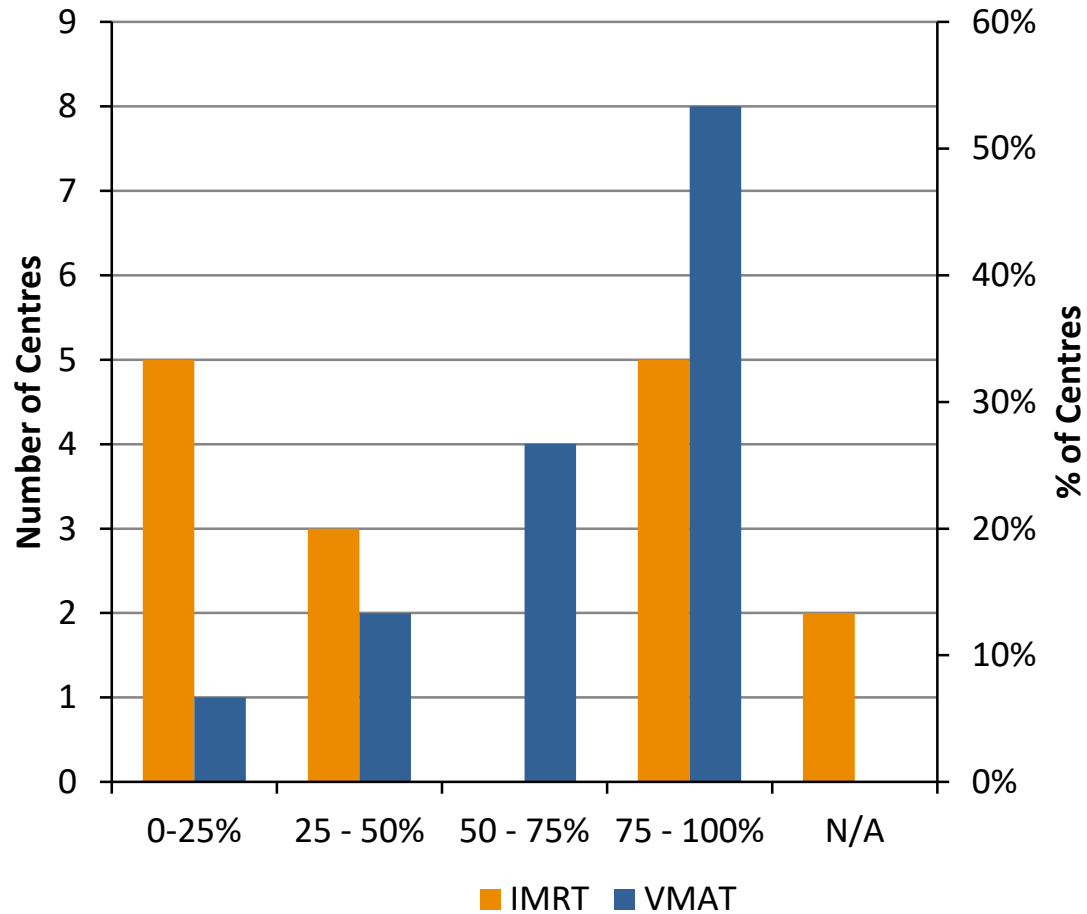
Summary: One-third (5) of centres responded using standard protocols for 0 - 25% and another one-third (5) for 75% - 100% of IMRT cases.

Comment:

- Three centres using standard protocols for 0 - 25% of IMRT cases commented that they used IMRT for non-standard or very complex cases. Therefore, standardization was not applicable.

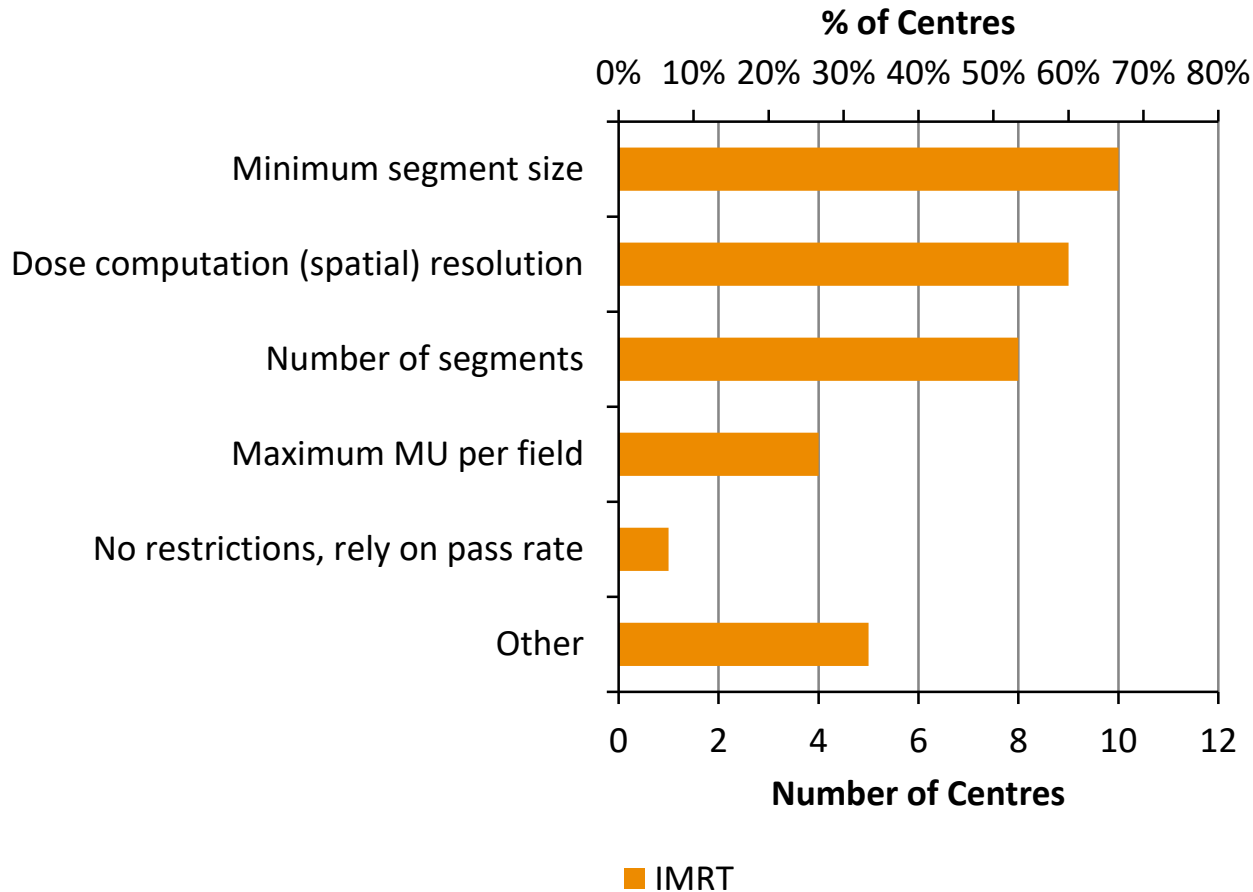
Note: Three centres commented that they either did not or rarely treat IMRT.

Question 10: What percent (approximate) of VMAT plans (normalized to total number of VMAT plans) use standardized protocols (same beam geometry, objectives, planning avoidance, etc) based on developed or commissioned class solutions?



Summary: 12 (80%) centres responded using standard protocols on most of their VMAT plans. This is in contrast to IMRT (see question 9), where only five (33%) used standard protocols on most of their IMRT plans.

Question 11: Have you defined restrictions or recommendations on the use of the following features in your planning system based on the impact these have on your IMRT PSQA pass rates (choose all that apply)? [KQI: A4]

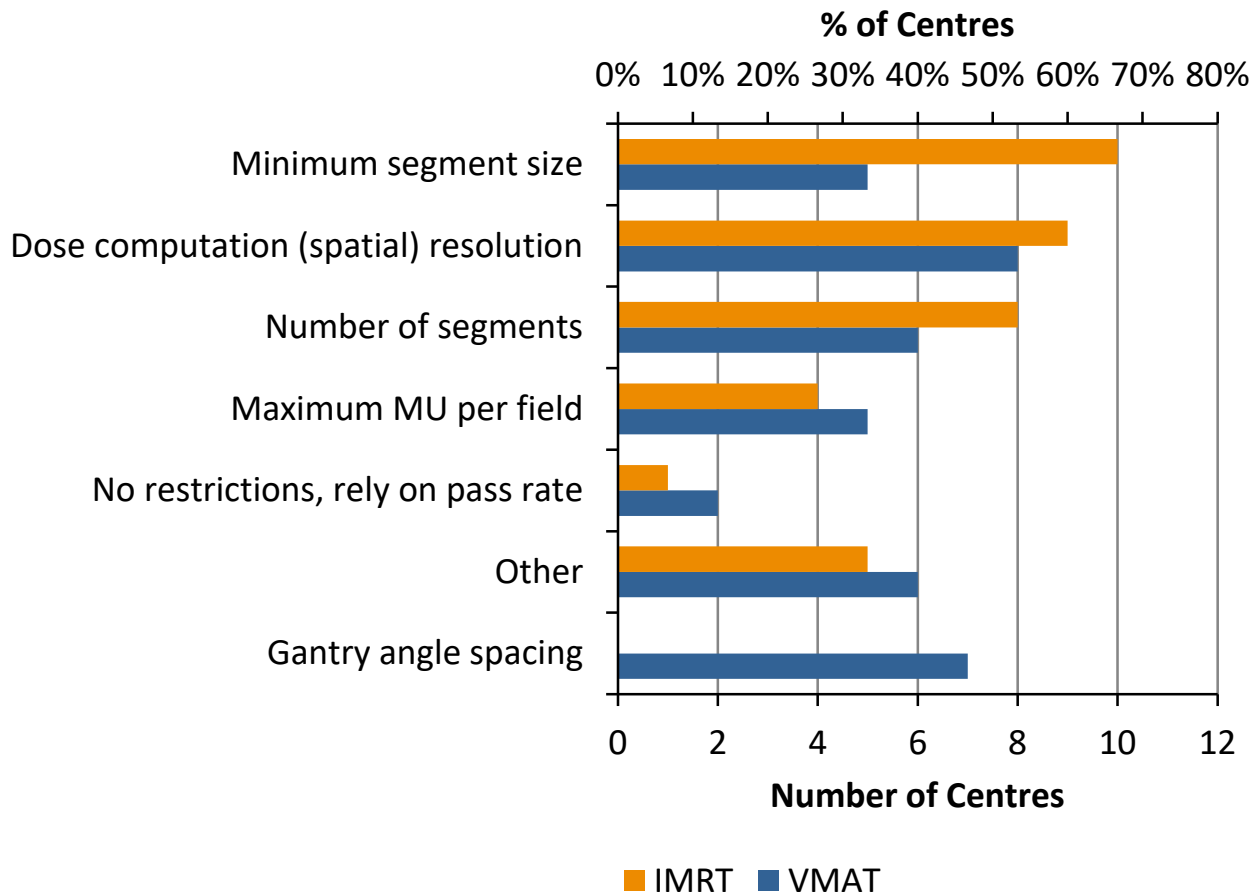


Summary: The most common restriction or recommendation defined was “Minimum segment size” (10 centres or 67%). Eight (53%) centres had three or more restrictions/recommendations on their IMRT treatment planning.

Comment:

- One centre that did not have any restrictions commented, “We use different dose grid settings for different sites but not because of PSQA pass rates”
- Two centres commented that they restricted MU/cGy.
- Three centres commented they did not or rarely treat IMRT.

Question 12: Have you defined restrictions or recommendations on the use of the following features in your planning system based on the impact these have on your VMAT PSQA pass rates (choose all that apply)? [KQI: A4]



Summary: Several centres selected the same restrictions or recommendations for both IMRT (see question 11) and VMAT. Eight centres selected “Dose computation (spatial) resolution” and six selected “Number of segments” for both IMRT and VMAT. However, only four selected “Minimum segment size” and three selected “Maximum MU per field” for both IMRT and VMAT. The comments indicated that it was difficult to control the segment size directly for VMAT in certain TPS. Six (40%) centres had three or more restrictions or recommendations on their VMAT treatment planning.

Comment:

- One centre that did not have any restrictions commented, “We use different dose grid settings for different sites but not because of PSQA pass rates”.
- Four centres commented using MU/cGy and only one of these also selected “maximum MU per field” as a restriction.
- Two centres commented they did not have a direct way to control the minimum field aperture. They did it indirectly using optPTV structures and MLC motion per arc degree.
- One wrote that for Lung VMAT plans, they had “an average leaf pair opening criteria to try to meet by forcing the optimizer to reduce MU if necessary”.

Question 13: Do you have procedures to ensure consistency of the transfer of plan delivery parameters from the TPS to the R & V and/or linac? [\[KQI: A1\]](#)

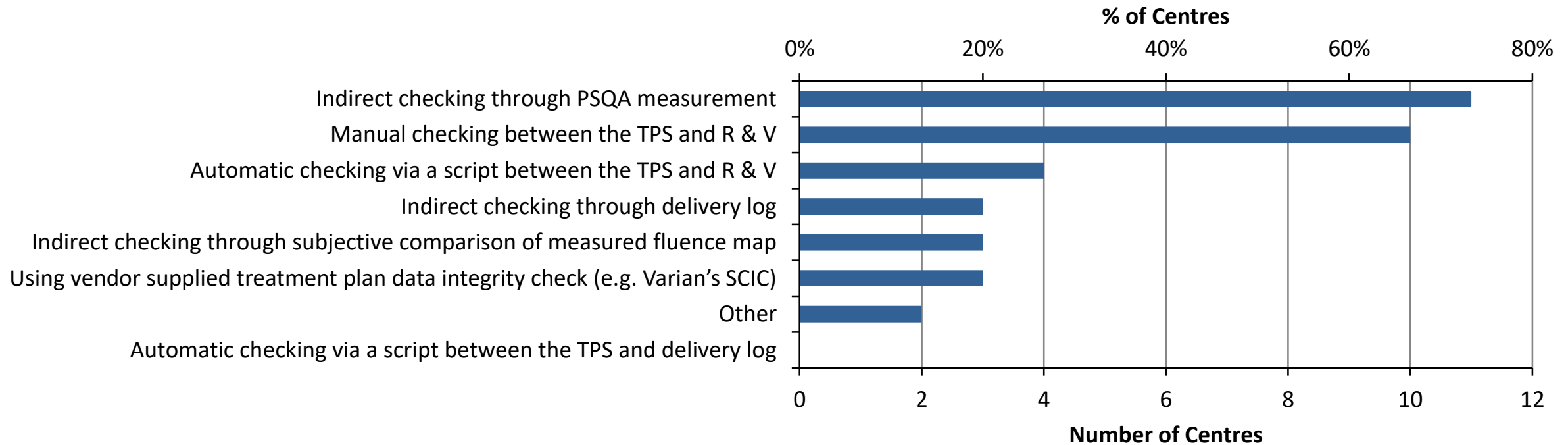
<i>Response</i>	<i>Number of Centres (%)</i>
Yes, for all plans including 3D Conformal	12 (80%)
Yes, just for IMRT/VMAT plans	0
No	3 (20%)

Summary: Large majority of centres had procedures to check plan transfer parameters for all plans.

Comment: Two centres commented that they had “integrated” systems.

Note: Based on the comments in this question and the responses from question 14, there are probably five (33%) centres in Ontario that had “integrated” systems such as Varian Eclipse – Aria system. Two of those centres responded “No” to this question and the other three responded “Yes for all plans...”.

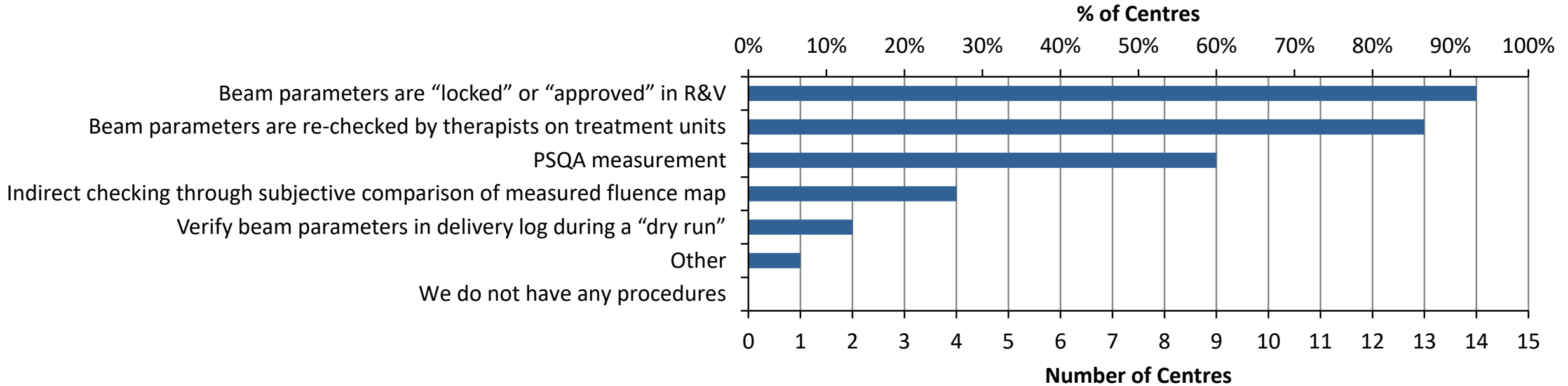
Question 14: How do you ensure the IMRT/VMAT beam transfer from the Treatment Planning System (TPS) to the Record & Verify (R & V) system or linac is correct (choose all that apply)? *[KQI: A1]*



Summary: The most common method of beam transfer check was “Indirect checking through PSQA measurement” (11 centres or 73%). Although 10 (67%) selected “Manual checking between the TPS and R & V”, only one of five centres that had “integrated” systems performed this check. All but three centres performed at least two checks of data transfer. Two of these three centres used vendor supplied treatment plan data integrity check and the remaining one used only PSQA measurements. In addition, two of these three centres also responded not having procedures for beam transfer check in question 13.

Note: Based on the comments and responses of some centres in this and in question 13, it is possible that some centres might interpret that performing a check on one of the listed items is the same as a check on the beam transfer.

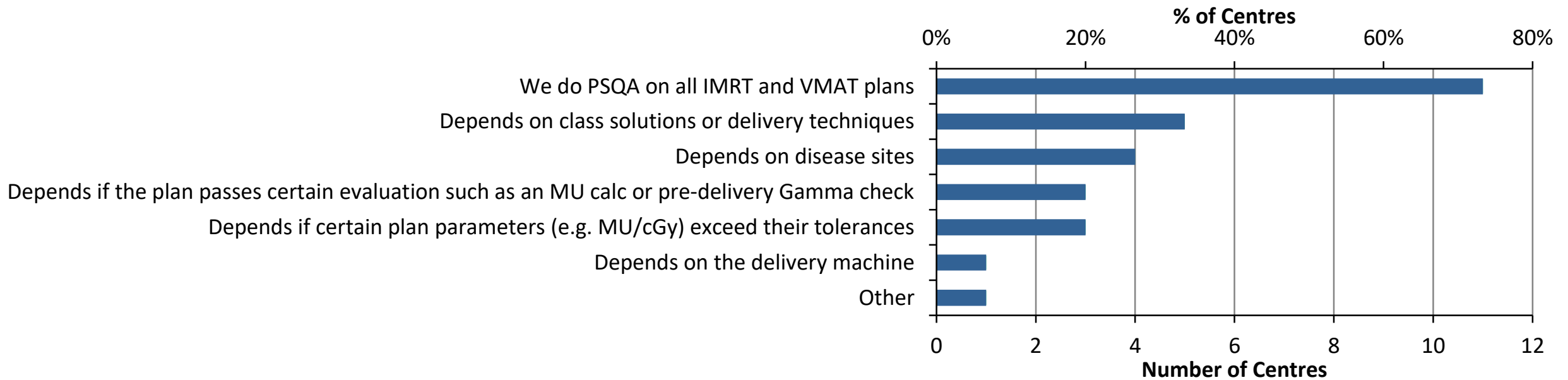
Question 15: After ensuring beam transfer from the TPS to R & V and/or linac is correct, what are your steps or procedures to ensure no alterations are accidentally made to the plan delivery parameters prior to treatment (choose all that apply)? *[KQI: A3]*



Summary: All but one centre "locked" or "approved" beam parameters in R & V. For all but one of these centres, treatment unit therapists re-checked beam parameters. In addition, all but two centres had two or more steps/procedures.

Comment: One centre that selected only "Other" commented that "A gap in procedures has been identified and a review is underway to address the deficiency."

Question 16: How does your centre determine which IMRT or VMAT plan needs to get PSQA (choose all that apply)? [KQI: A2]



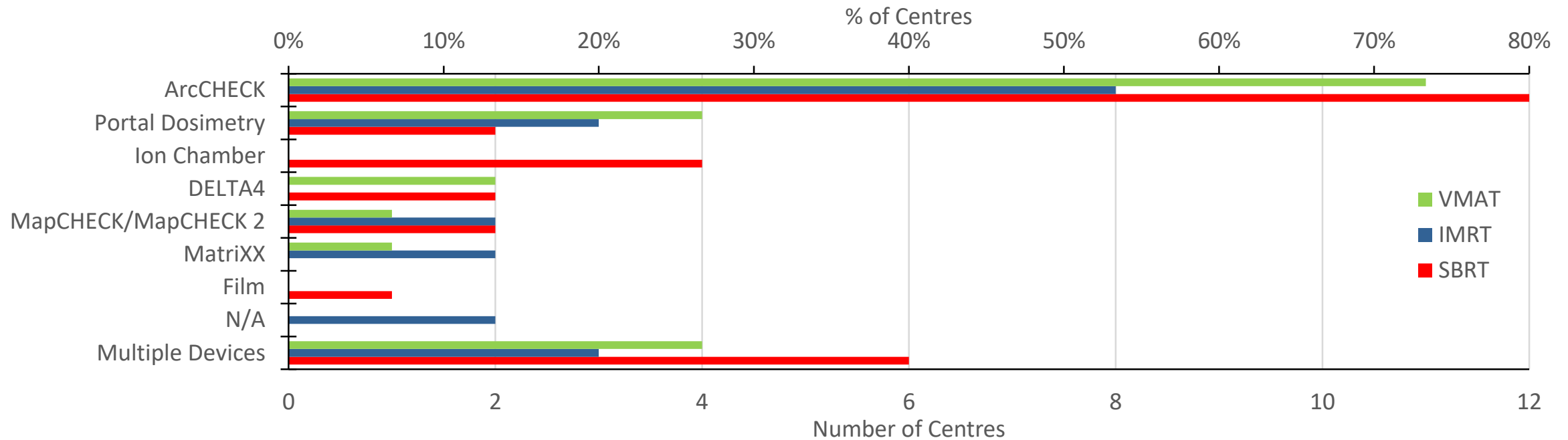
Summary: 11 (73%) centres performed PSQA on all IMRT and VMAT plans. In nine of these centres, this was their only selection. One centre selected “Other” only.

Comment:

- The centre that selected “Other” commented they relied on MU calc, pre-delivery dose and Gamma check if MU calc failed, and measurements if pre-delivery check failed for their IMRT plans, and delivery log calculations for their VMAT plans.
- One centre commented that they measured most plans because they found no real correlations between any parameters pass rates.

Note: The selection “We do PSQA on all IMRT and VMAT plans” might not have been not very clear, possibly leading to a difference in interpretation. The intention was to find out if centres performed PSQA measurements and/or delivery log calculations for all IMRT and VMAT plans, or if centres relied on other ways to reduce the amount of PSQA. However, some might have included patient-specific plan check such as MU calc or independent dose verification as a part of the PSQA.

Question 17: Which measurement device(s) and its measuring and analyzing software, if applicable, do you use for routine IMRT and VMAT PSQA? [KQI: B2]



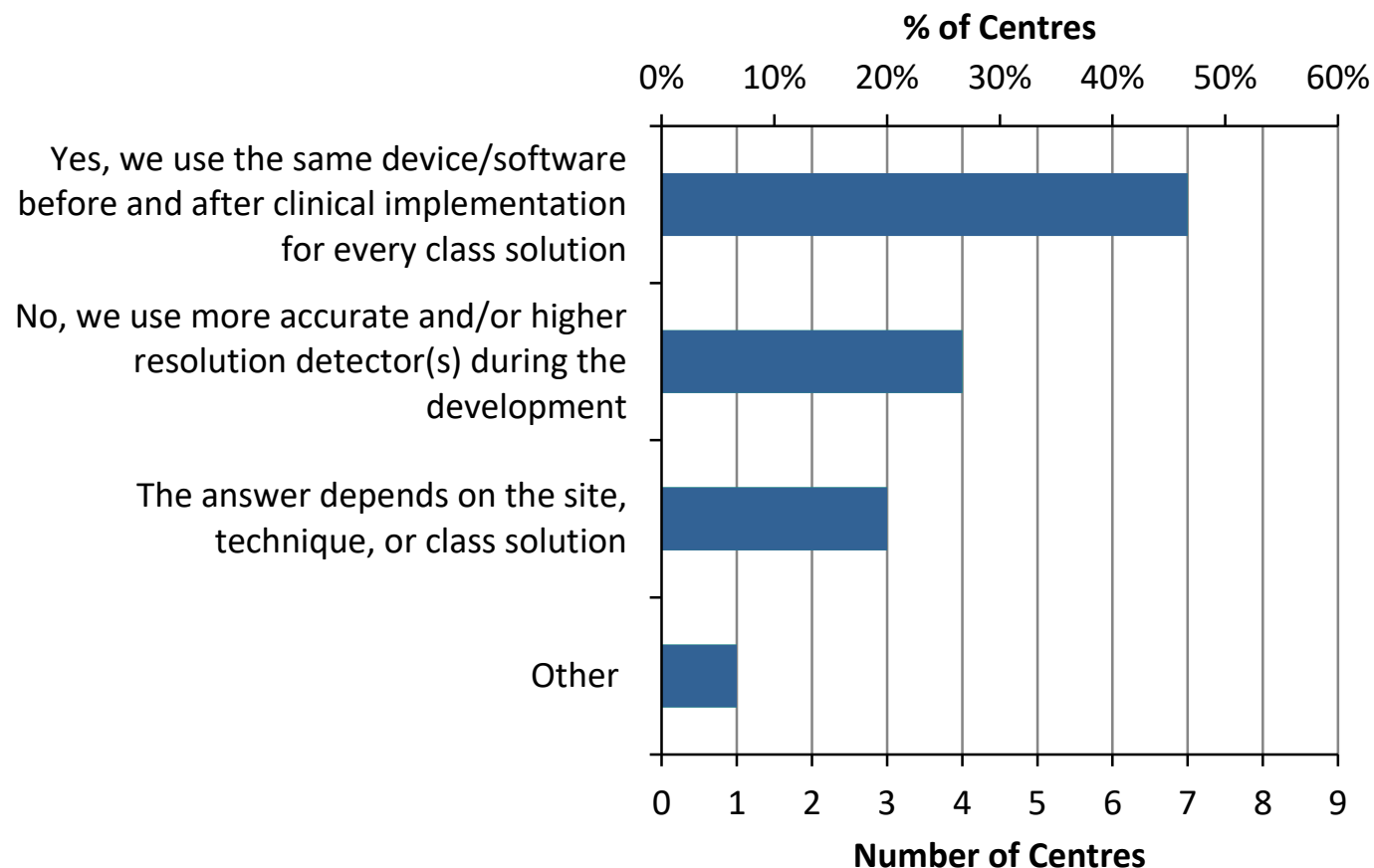
Summary: ArcCHECK was the most commonly used device for VMAT, IMRT and SBRT. Portal dosimetry was the second most commonly used device for VMAT and IMRT, and ion chamber for SBRT. One centre reported using a 2D array detector (MatriXX) for VMAT.

Comment: One centre commented that they occasionally used film for secondary verification for high resolution techniques. Another centre used film for CyberKnife SBRT treatments.



Note: Two centres did not treat IMRT.

Question 18: Do you use the same measurement device(s) and its measuring and analyzing software, if applicable, during the development and testing of a new IMRT/VMAT class solution as those in the routine PSQA after the same new class solution is clinically implemented? [KQI: B1, B2]

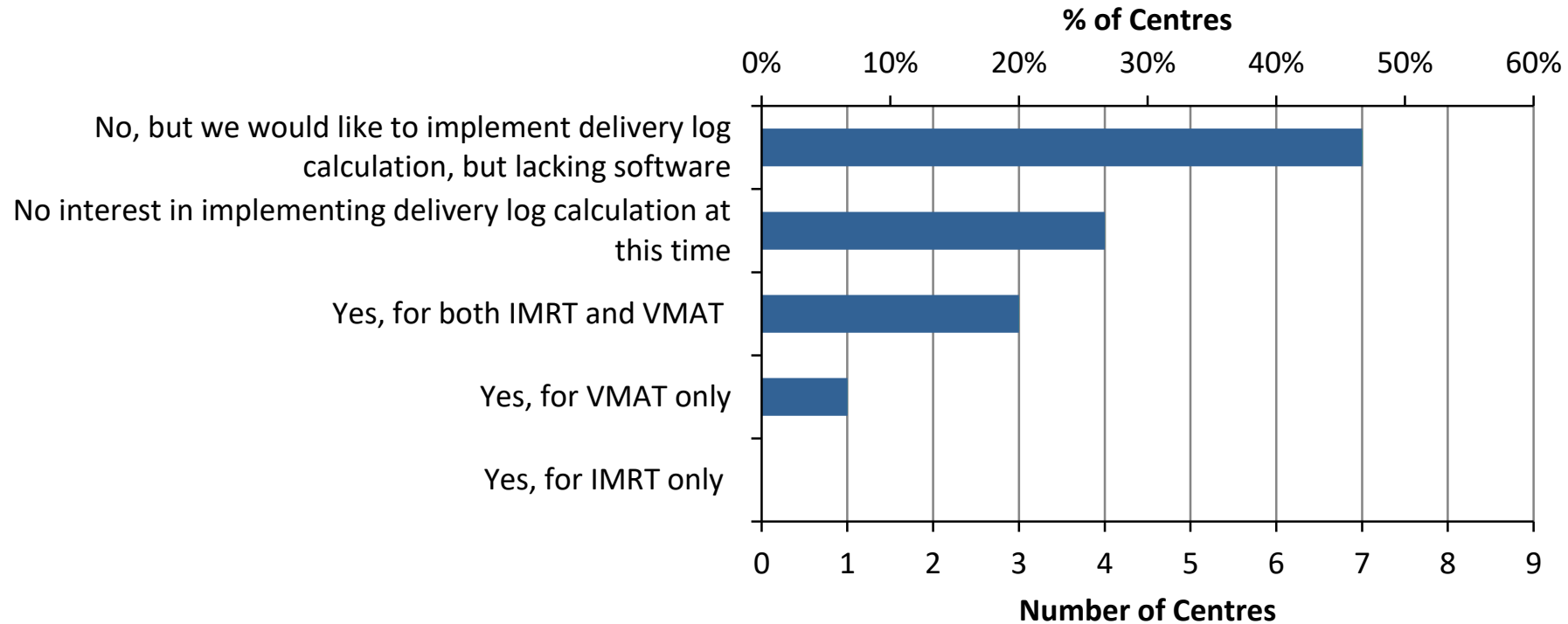


Summary: Seven (47%) centres used the same device/software in routine PSQA after clinical implementation, whereas four (27%) used more accurate and/or higher resolution detectors during the development of a new class solution.

Comment: One centre commented they might use log based calculation only after enough measured and log based data had been collected to allow meaningful analysis.

Question 19: Do you use a delivery log calculation software for routine IMRT and VMAT PSQA?

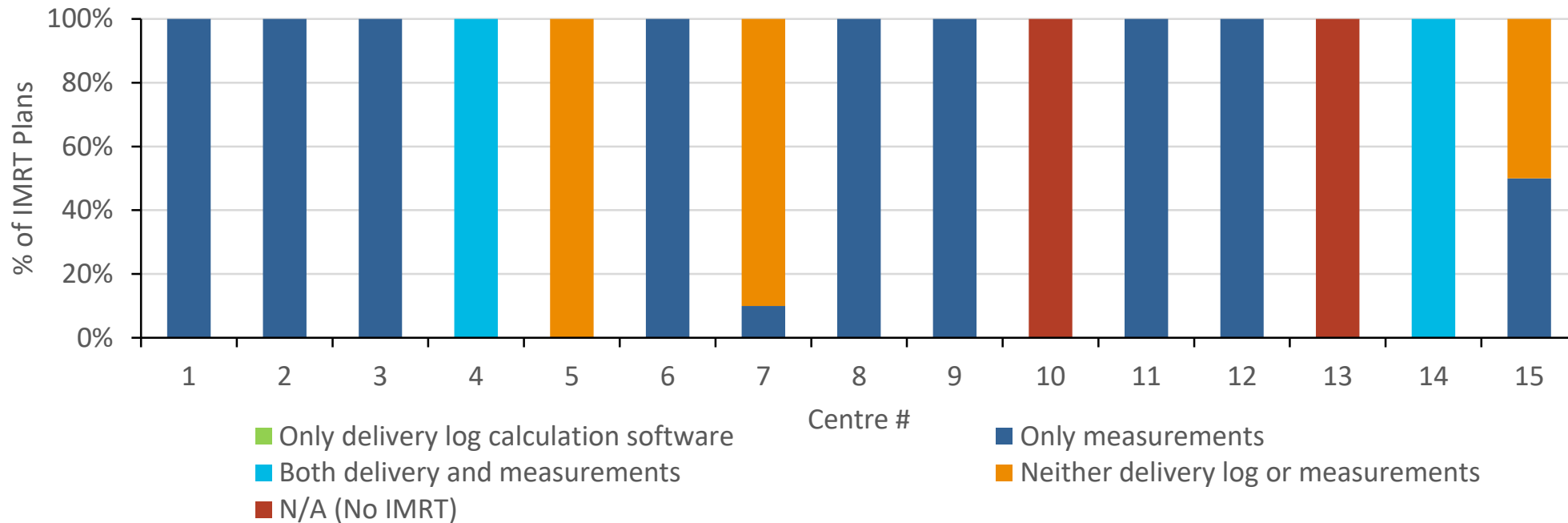
[KQI: A2]



Summary: A good majority (11 centres or 73%) did not use delivery log calculation for routine IMRT and VMAT PSQA. However, seven (47%) would like to implement it. Only three (20%) used delivery log calculation for both IMRT and VMAT.

Comment: Three centres commented they were developing/commissioning delivery log calculation software, while one stated it would be in use in future.

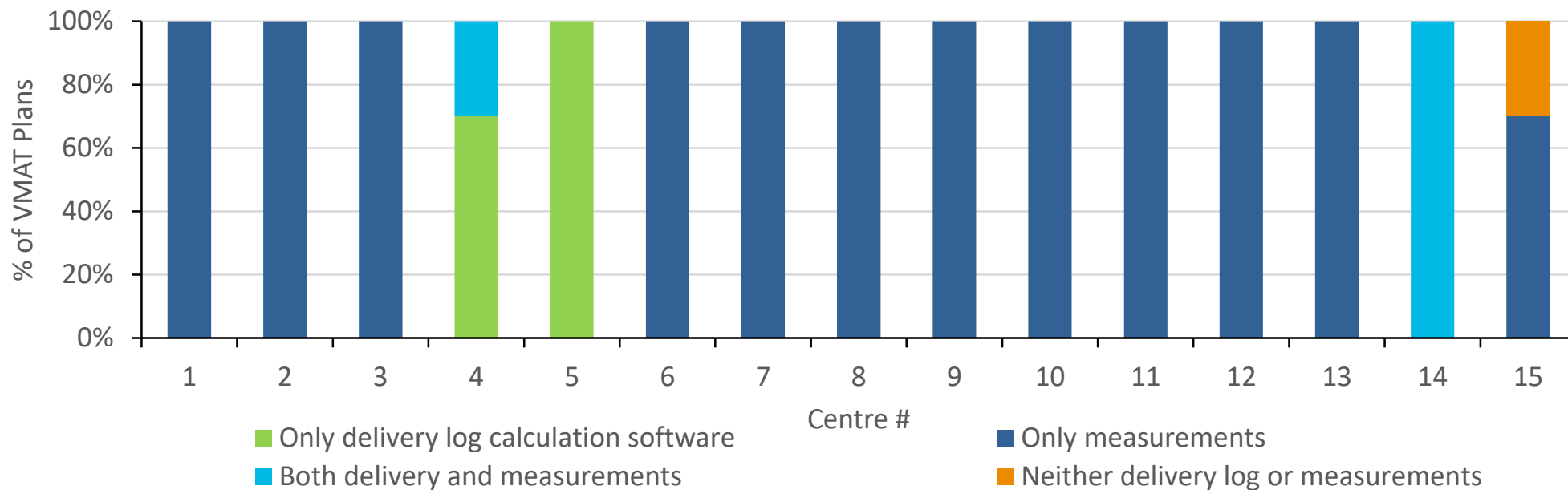
Question 20: Indicate what percent (approximate) of your IMRT plans undergoing PSQA uses the following. Note: the percentages should add up to 100%. [KQI: A2]



Summary: A slim majority (8 centres or 53%) performed measurements for 100% of IMRT plans undergoing PSQA. Only one centre did not perform measurements or delivery log calculation for any IMRT. No centre selected “Only delivery log calculation software”.

Note: This question was not very clear in the phrase “plans undergoing PSQA”. The intention of this question was to find out what centres did for their PSQA, typically a measurement, delivery log calculation, and/or some other methods, after plan checking, if required. Based on the comments, some might have interpreted that certain plan check, such as MU or secondary dose calculation, was considered as a part of the PSQA.

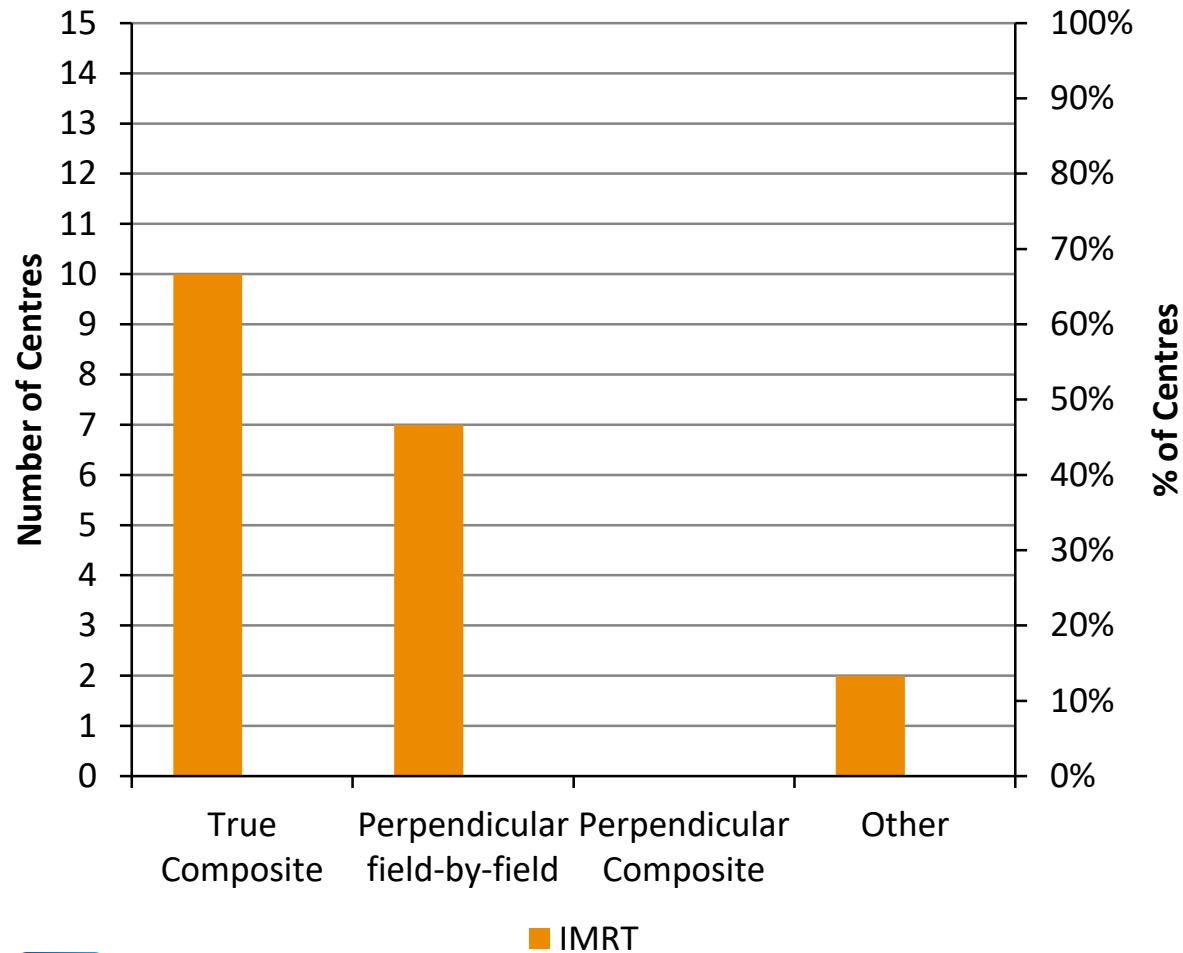
Question 21: Indicate what percent (approximate) of your VMAT plans undergoing PSQA uses the following. Note: the percentages should add up to 100%. [KQI: A2]



Summary: 11 (73%) centres performed measurements for 100% of VMAT plans undergoing PSQA. This is three more than reported for IMRT (see question 20). One centre performed only delivery log calculations. All centres performed measurements or delivery log calculation for VMAT cases.

Note: This question was not very clear in the phrase “plans undergoing PSQA”. The intention of this question was to find out what centres did for their PSQA, typically a measurement, delivery log calculation, and/or some other methods, after plan checking, if required. Based on the comments, some might have interpreted that certain plan check, such as MU or secondary dose calculation, was considered as a part of the PSQA.

Question 22: How do you set up your phantom for IMRT measurements (if different setups are used, choose all that apply)? [KQI: C3]

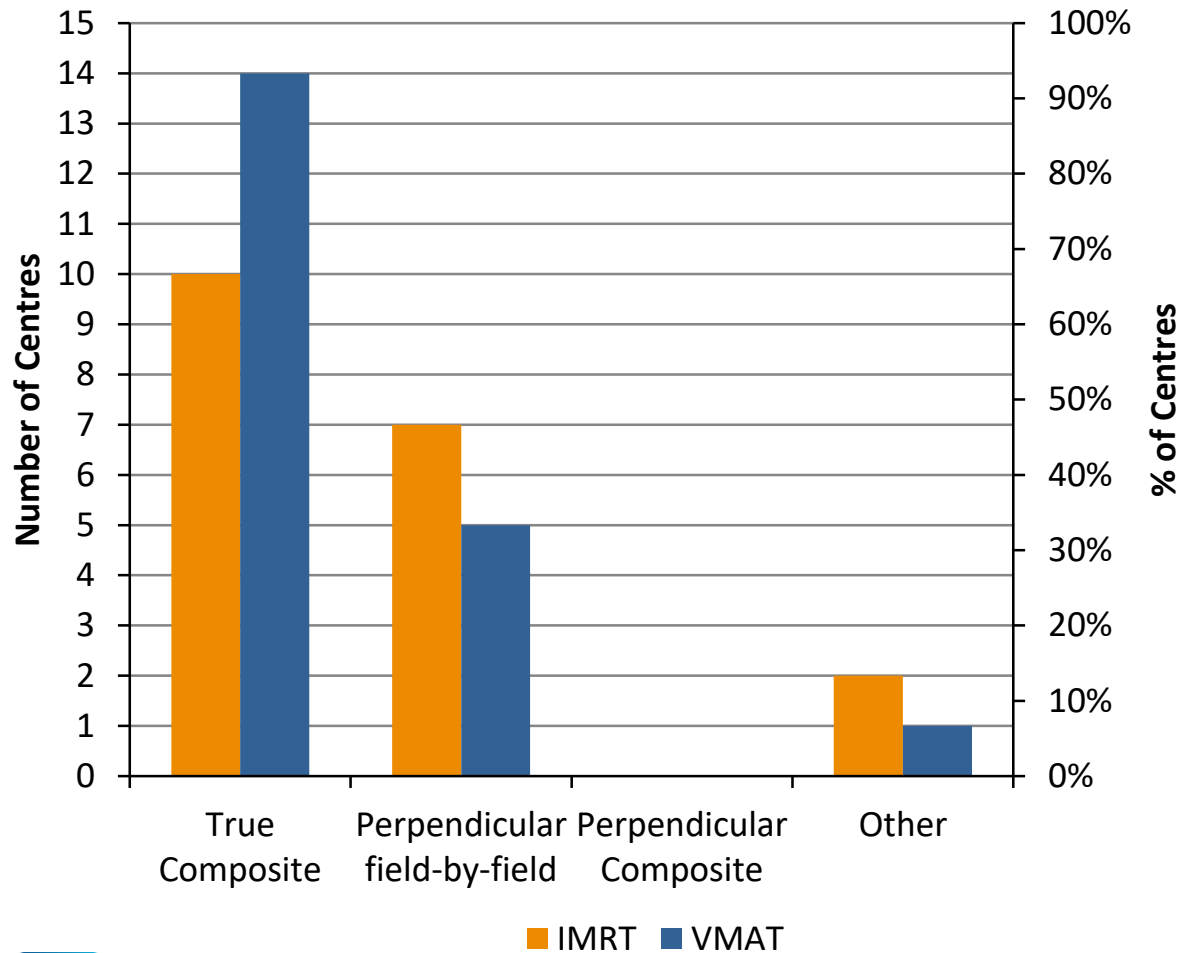


Summary: Two-thirds of centres (10) responded using True Composite (TC) as their setup for IMRT. Note: two centres did not treat IMRT. Four (27%) used both TC and Perpendicular Field-by-field (PFF). No centre used Perpendicular Composite (PC). The three centres that used portal dosimetry (question 17) for IMRT all selected or commented using PFF.

Comment:

- One centre commented that PFF was used for troubleshooting or technique development.
- Two centres wrote they used different set up methods for different devices.

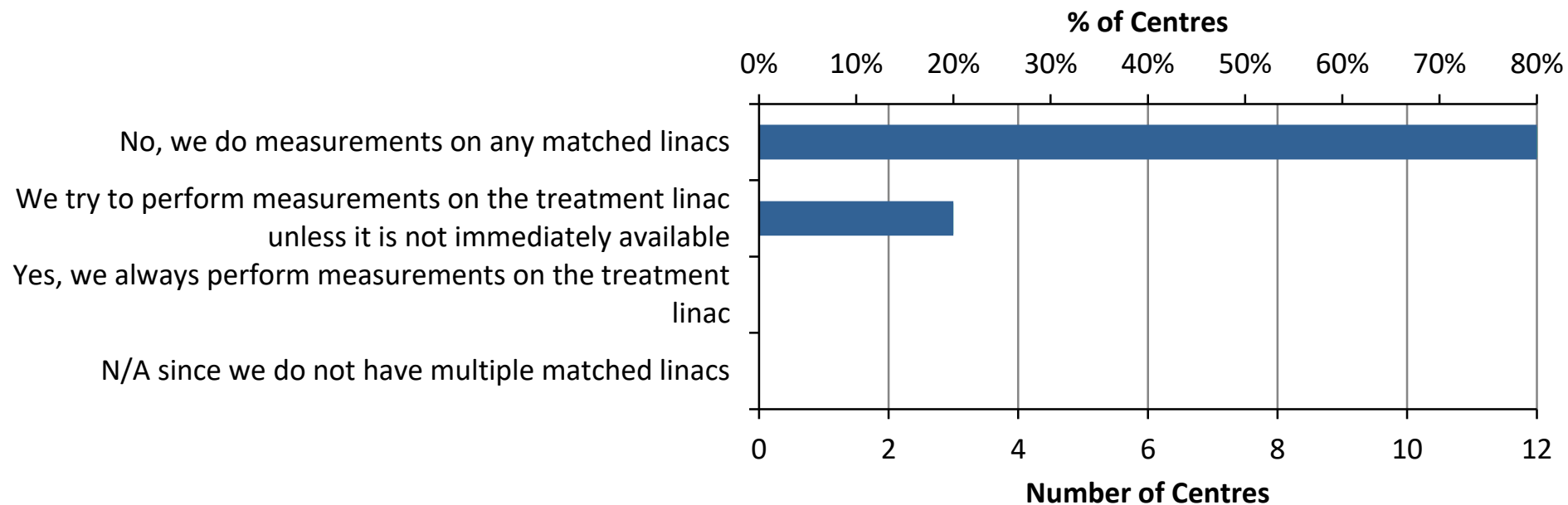
Question 23: How do you set up your phantom for VMAT measurements (if different setups are used, choose all that apply)? [KQI: C3]



Summary: Almost all (14 centres or 93%) responded using TC as their setup for VMAT, four more than for IMRT (see question 22). Four (27%) used both TC and PFF. No centre used PC. The four centres that used portal dosimetry (question 17) for VMAT all selected or commented using PFF.

Comment: One centre commented that TC was used for all coplanar beams, whereas PFF was used for non-coplanar beams due to potential irradiation of electronics.

Question 24: If you have matched linacs, do you always perform PSQA measurements on the same linac as the treatment linac and what is the rationale for your choice? [KQI: C4]

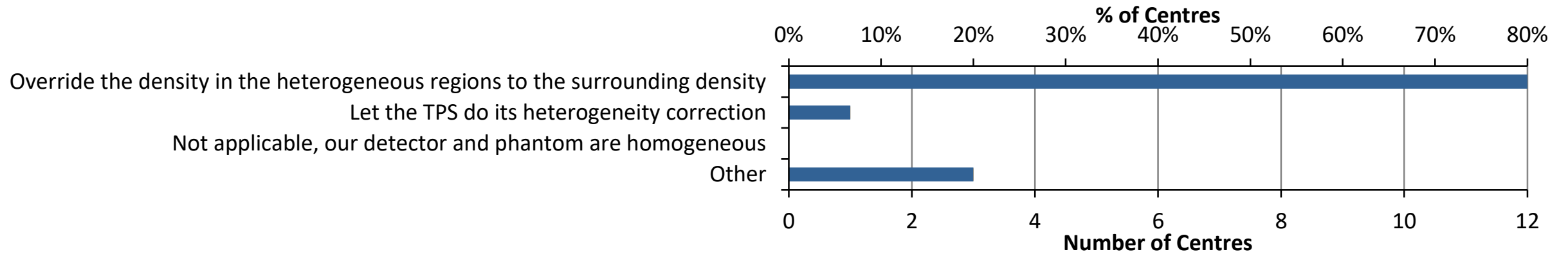


Summary: No centre always performed PSQA measurements on the treatment linac. 12 (80%) centres performed PSQA measurements on any beam-matched linacs, while three (20%) performed on the treatment linac unless it was not immediately available.

Comment:

- Practicality and efficiency were cited by five centres as the reasons for measurements on matched linacs.
- “For SBRT, always on the treatment Linac”.

Question 25: How do you handle inhomogeneity in the detector on the CT scan for your PSQA plan calculations? For example, air in a chamber or electronics for the detectors. [KQI: C5]

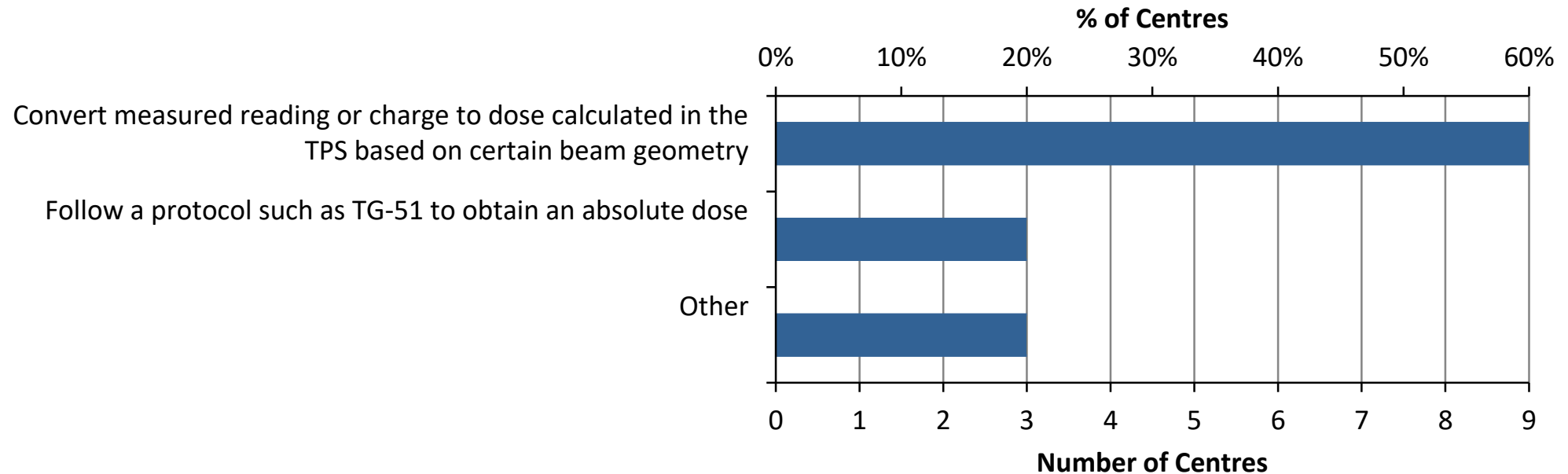


Summary: A large majority (12 centres or 80%) handled detector heterogeneity by performing a density override in the TPS on the CT scan.

Note:

- When this question was created, we did not anticipate that many centres using ArcCHECK were provided a virtual homogeneous CT phantom by the vendor. It appears that many of them obtained the phantom density directly from the CT set and they selected “Override the density...” In addition, one of them selected “Let the TPS do its heterogeneity correction” and another one selected “Other”. Based on the follow up responses from these two centres, we changed their responses to “Override the density...”.
- Of the four centres that used portal dosimetry (question 17), three answered “Other”. The remaining one selected “Override the density...”. But this centre also used ArcCHECK. It is likely their response was intended only for ArcCHECK.
- One centre commented they used ArcCHECK and portal dosimetry. They selected “Other” in their response. But we added “Override the density...” to their response based on their comment on the ArcCHECK.

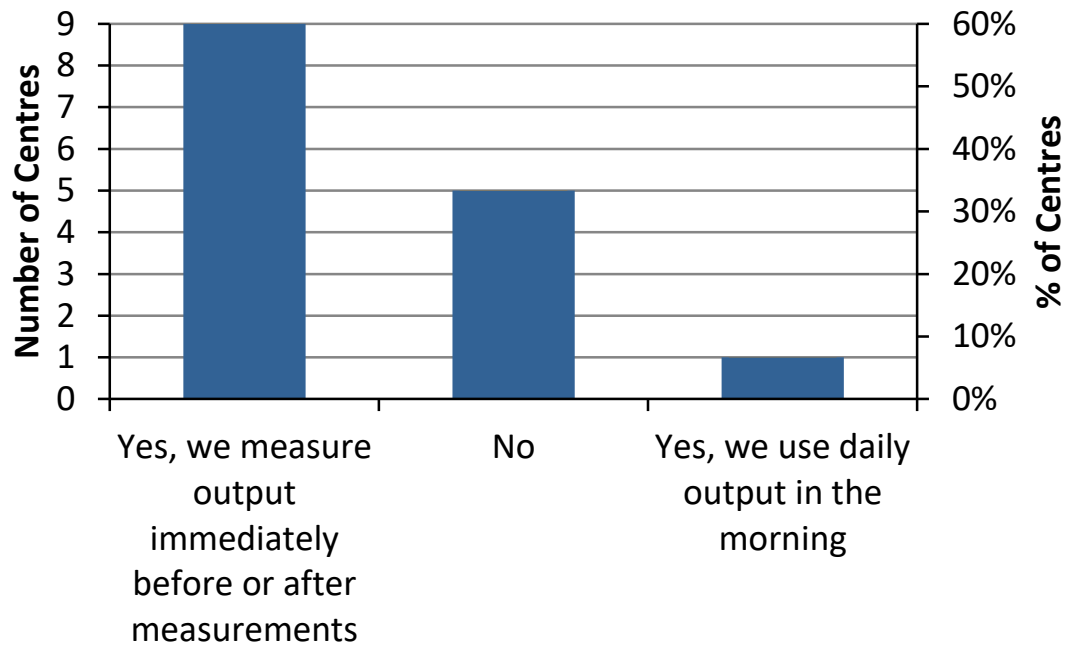
Question 26: How is the detector calibration done (converting reading or charge into dose) for your PSQA device? [KQI: B5]



Summary: Most (9 centres or 60%) performed PSQA detector calibration by converting measured reading to dose calculated in the TPS. Only three (20%) followed a protocol for this calibration.

Comment: Five centres commented they followed the vendor’s recommended procedures. Of those, four centres used ArcCHECK (from question 17), but selected their responses differently (one selected “Following a protocol...”, one selected “Convert measured reading...”, and two selected “Other”). This suggests either the vendor’s procedures were not followed exactly, or different centres interpreted parts of the procedures differently.

Question 27: Do you perform a dose calibration measurement compared against a standard dose to factor the variation of the detector response and linac output into the PSQA measurements? [KQI: C6]



Summary: Two-thirds of all centres (10) corrected their PSQA measurement dose to factor out detector response and linac output variation.

Comment:

- Of the five centres that responded “No”, three of them used portal dosimetry (from question 17), and the other two wrote that the measured dose (without factoring out the variation) would be more representative of the actual dose the patients would receive.
- One centre selected daily output, but commented the response was for their portal dosimetry. For their ArcCHECK device, they would incorporate the output measured immediately before or after PSQA measurement if a pass rate was low.

Question 28: Do you do PSQA (delivery log calculations or measurements using detectors such as an EPID or a transmission detector) and review the results for every fraction?

<i>Response</i>	<i>Number of Centres (%)</i>
No	14 (93%)
Yes, the results are based on delivery logs	1 (7%)
Yes, the results are based on measurements	0

Summary: Only one centre reviewed the PSQA results for every fraction (using delivery logs).

Comment: For the centres that responded “No”,

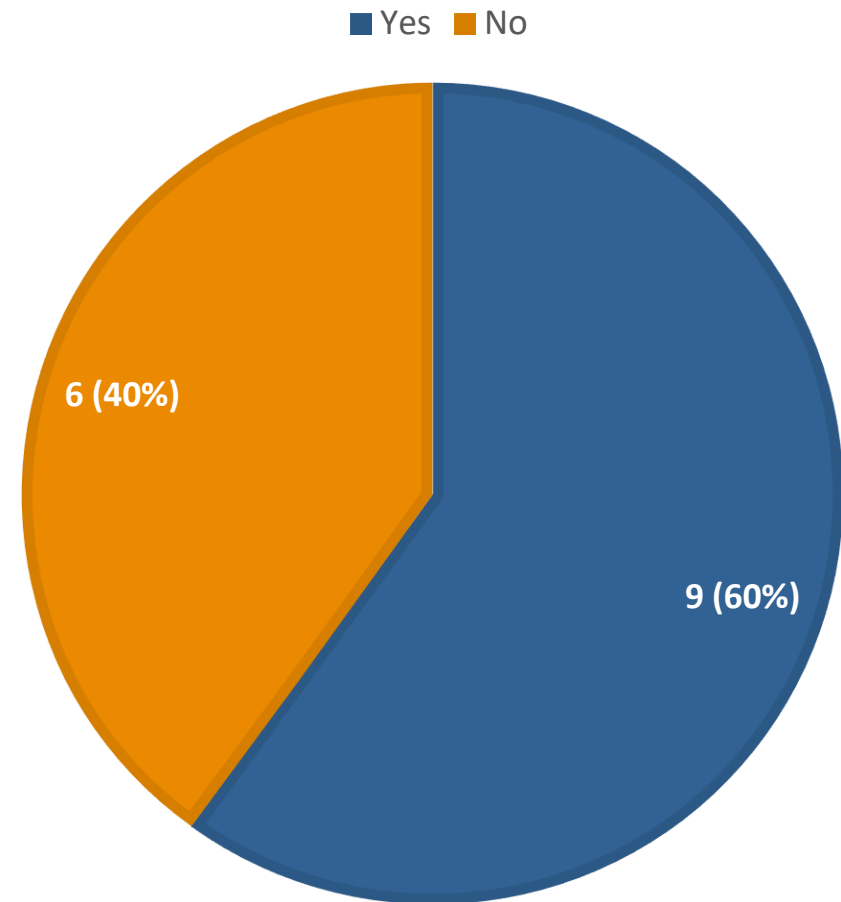
- Five centres indicated a lack of resources or infrastructures
- Three commented no intention or evidence of value
- One stated they performed other QA that “catches unit performance”
- One might consider it once delivery log software was commissioned, and
- One wrote, “Not necessary for all cases”

Question 29: Do you perform regular QA on your PSQA device or software? [KQI: B4]

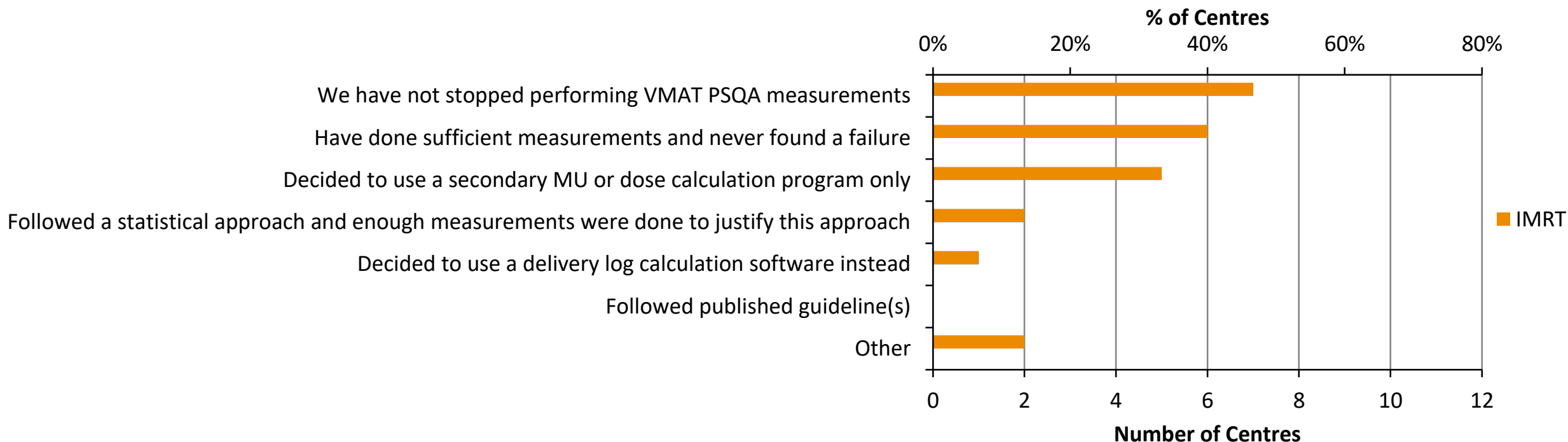
Summary: Most (9 centres or 60%) performed regular QA on the PSQA device or software.

Comment:

- Comments regarding the type and frequency of regular QA performed involved reproducibility or stability check of simple fields/arcs or base plans, and detector re-calibration ranging from weekly to 18 months.
- Two centres commented ad hoc QA or as needed.
- One stopped their regular QA “as we never discovered any problems” and performed only array calibration every 18 months.



Question 30: If your centre has generally stopped doing IMRT PSQA measurements for a specific site, class solution, or technique, how was this decision made (choose all that apply)? [KQI: A2]



Summary: Almost half (7 centres or 47%) responded they had not stopped performing IMRT PSQA measurements. Of the remaining eight centres, two did not treat IMRT and six responded they had done sufficient measurements and never found a failure. Out of these six centres, five decided to use a secondary MU or dose calculation program only.

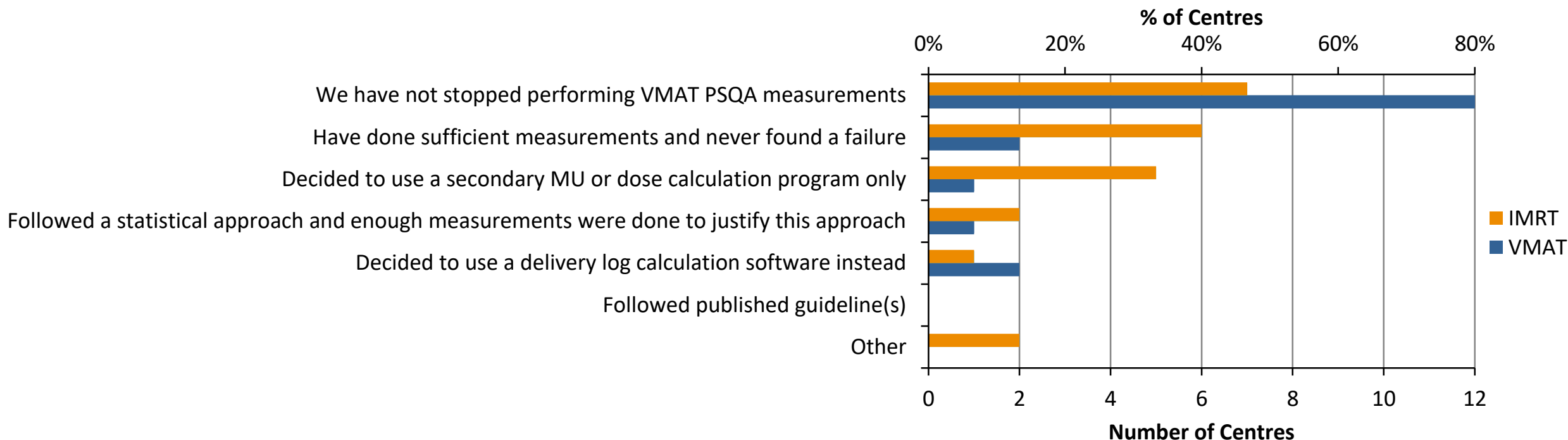
Comment:

- “... currently looking at statistical approaches (including control charts) to stop measuring more sites / plan types”.
- “...we used to perform a quantitative ion chamber measurement. This was replaced by EPID fluence with visual assessment”.



Car

Question 31: If your centre has generally stopped doing VMAT PSQA measurements for a specific site, class solution, or technique, how was this decision made (choose all that apply)? [KQI: A2]



Summary: Vast majority (12 centres or 80%) had not stopped performing VMAT PSQA measurements. Comparing with IMRT (see question 30) where only seven selected this option, many centres were not ready to stop measurement or utilize a surrogate. Of the remaining 3 centres that have stopped PSQA measurements, two responded they had done sufficient measurements and never found a failure, and one followed a statistical approach and enough measurements were done to justify that approach.

Question 32: What are your typical criteria in analyzing and evaluating PSQA results using Gamma or Composite analysis? Enter typical values, or N/A if not applicable. [\[KQI: D7\]](#)

		# of Centres (% of Centres)			
		<i>Head & Neck</i>	<i>Intact Prostate</i>	<i>SBRT Lung</i>	<i>Palliative (non-SBRT)</i>
Dose Difference	2%	0 (0%)	1 (7%)	1 (7%)	1 (7%)
	3%	11 (73%)	14 (93%)	13 (87%)	12 (80%)
	5%	0 (0%)	0 (0%)	0 (0%)	1 (7%)
Distance to Agreement	2mm	4 (27%)	5 (33%)	7 (47%)	5 (33%)
	3mm	7 (47%)	10 (67%)	7 (47%)	9 (60%)
Low Dose Threshold	0%	1 (7%)	1 (7%)	1 (7%)	1 (7%)
	5%	1 (7%)	2 (13%)	2 (13%)	2 (13%)
	10%	9 (60%)	12 (80%)	11 (73%)	11 (73%)
N/A	Not measured or not treated	4 (27%)	0 (0%)	1 (7%)	1 (7%)

Question 32: What are your typical criteria in analyzing and evaluating PSQA results using Gamma or Composite analysis? Enter typical values, or N/A if not applicable. [\[KQI: D7\]](#)

		# of Centres (% of Centres)			
		<i>Head & Neck</i>	<i>Intact Prostate</i>	<i>SBRT Lung</i>	<i>Palliative (non-SBRT)</i>
Tolerance Level	80%	1 (7%)	0 (0%)	1 (7%)	1 (7%)
	88%	0 (0%)	1 (7%)	0 (0%)	0 (0%)
	90%	3 (20%)	3 (20%)	3 (20%)	3 (20%)
	95%	5 (33%)	8 (53%)	7 (47%)	8 (53%)
	97%	1 (7%)	2 (13%)	2 (13%)	1 (7%)
	N/A	5 (33%)	1 (7%)	2 (13%)	2 (13%)
Action Level	80%	1 (7%)	1 (7%)	1 (7%)	1 (7%)
	90%	1 (7%)	3 (20%)	2 (13%)	3 (20%)
	95%	5 (33%)	6 (40%)	6 (40%)	5 (33%)
	Other (physicist's discretion)	1 (7%)	1 (7%)	1 (7%)	1 (7%)
	N/A	7 (47%)	4 (27%)	5 (33%)	5 (33%)

Question 32: What are your typical criteria in analyzing and evaluating PSQA results using Gamma or Composite analysis? Enter typical values, or N/A if not applicable. [\[KQI: D7\]](#)

Summary: For all sites (H&N, GU, SBRT Lung, and Palliative), the most common analysis criteria are:

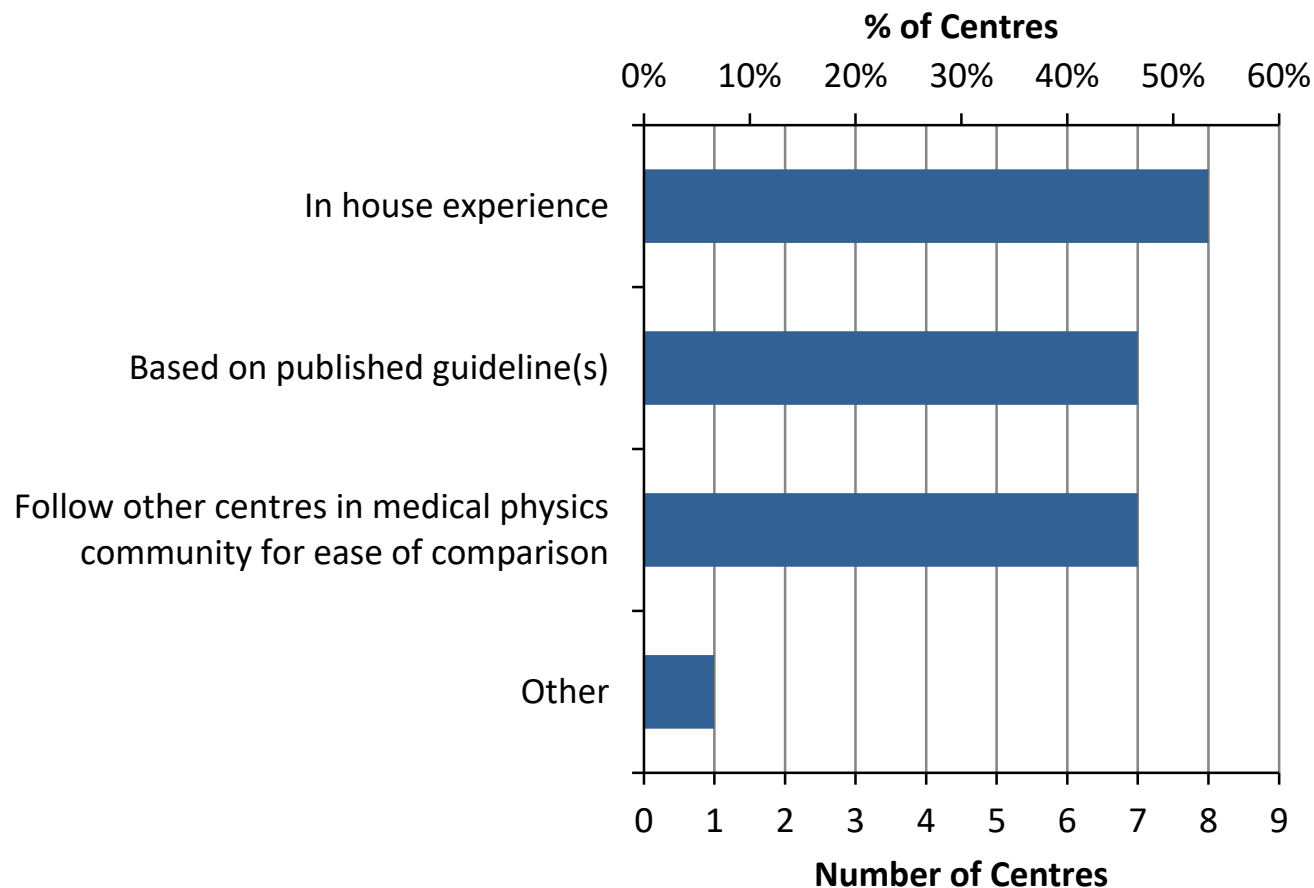
- Dose difference: 3%
- Distance to agreement: 3 mm
- Low dose threshold: 10%
- Pass rate (tolerance level): 95%
- Pass rate (action level): 95%

The survey also asked respondents to enter the number of failed pixels/voxels for tolerance and action levels. All centres entered 0 for both.

Note:

- One centre commented they always applied a vendor specific “measurement uncertainty” option which effectively added an additional 1 mm to the DTA criterion. In question 36, six centres commented they applied “measurement uncertainty”.
- There are four to seven centres that selected “N/A” for the pass rate for action level.

Question 33: In gamma or composite analysis, how does your centre determine the evaluation criteria (dose difference/DTA/dose threshold)? [KQI: D7, D8]

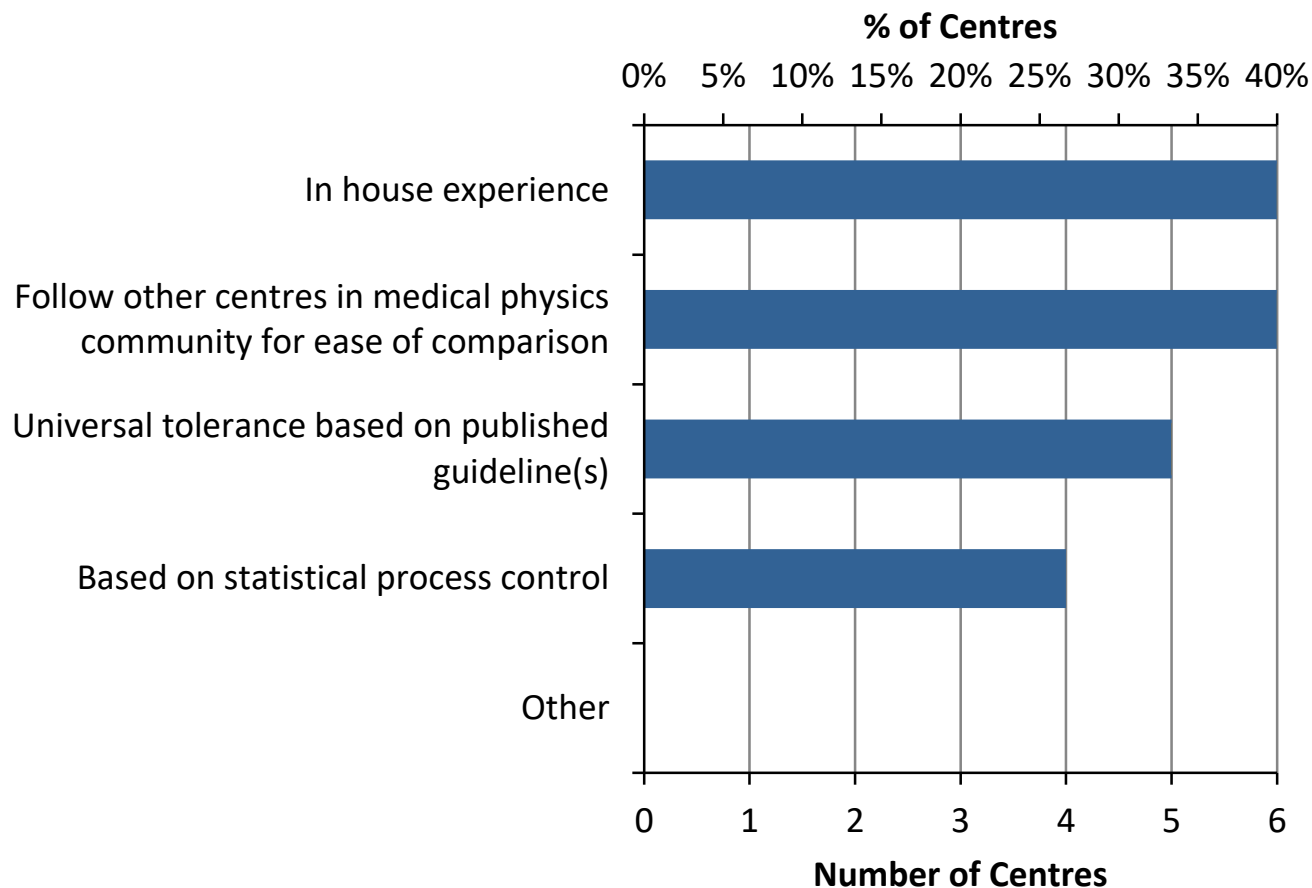


Summary: Most (8 centres or 53%) selected “In house experience”, though the first three responses are almost evenly split, suggesting no universal approach. One-third (5) selected more than one criterion.

Comment: “During commissioning, we chose evaluation criteria that would give a reasonable sensitivity. For example, we searched for the criteria that allowed us to see differences between plans/sites/techniques and would not result in 100% pass rates most of the time.”

Note: This question originally allowed only one selection. However, in many comments, centre wrote in additional answers. They were subsequently added to the graph and analysis.

Question 34: In gamma or composite analysis, how does your centre determine the pass tolerance and action levels? [KQI: D7, D8]



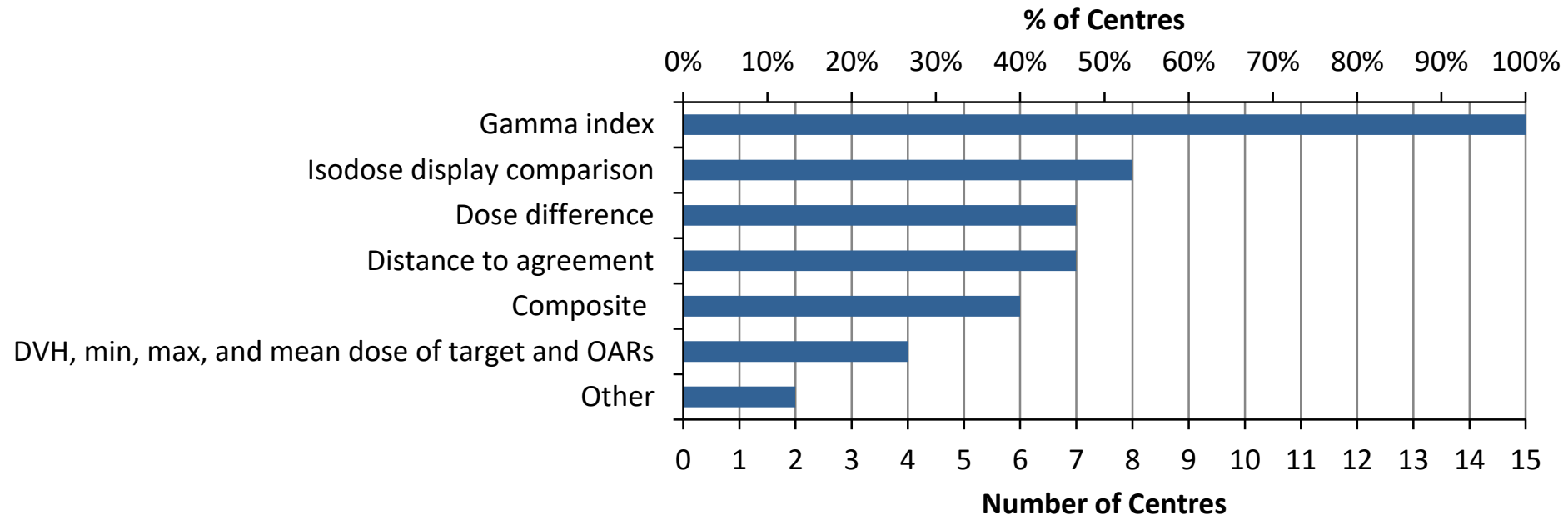
Summary: Six (40%) centres selected “In house experience” and “Follow other centres in medical community for ease of comparison”, though the first four responses are almost evenly split, suggesting no universal approach. Four (27%) selected more than one criterion.

Comment:

- “started with in house experience and have used SPC to confirm and monitor”
- “we are looking into stratifying tolerances / action levels by site based on clinical implications of %dose or DTA inaccuracies [sic]”

Note: This question originally allowed only one selection. However, in many comments, centre wrote in additional answers. They were subsequently added to the graph and analysis.

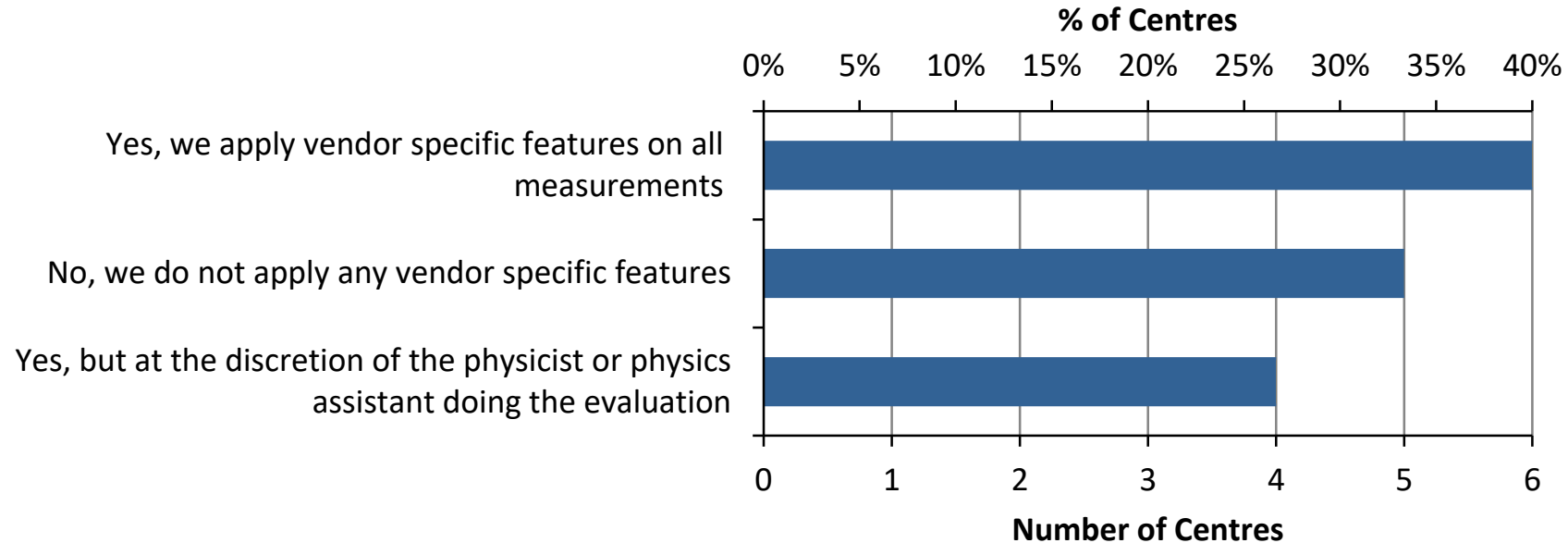
Question 35: How do you evaluate PSQA results (choose all that apply)? [KQI: D1, D9]



Summary: Gamma Index was the most commonly used metric to evaluate PSQA and was being used by all Ontario centres. The vast majority (13 centres or 87%) used at least one additional metric in addition to or in conjunction with Gamma Index when evaluating their PQSA results.

Comment: One commented they also evaluated dose difference histogram, while another commented they also evaluated “location of failing points, and distribution of failing points”, whether they were centered and not skewed.

Question 36: Do you apply optional vendor specific features (such as autoshift, measurement uncertainty) that can affect plan comparison results? *[KQI: D6]*



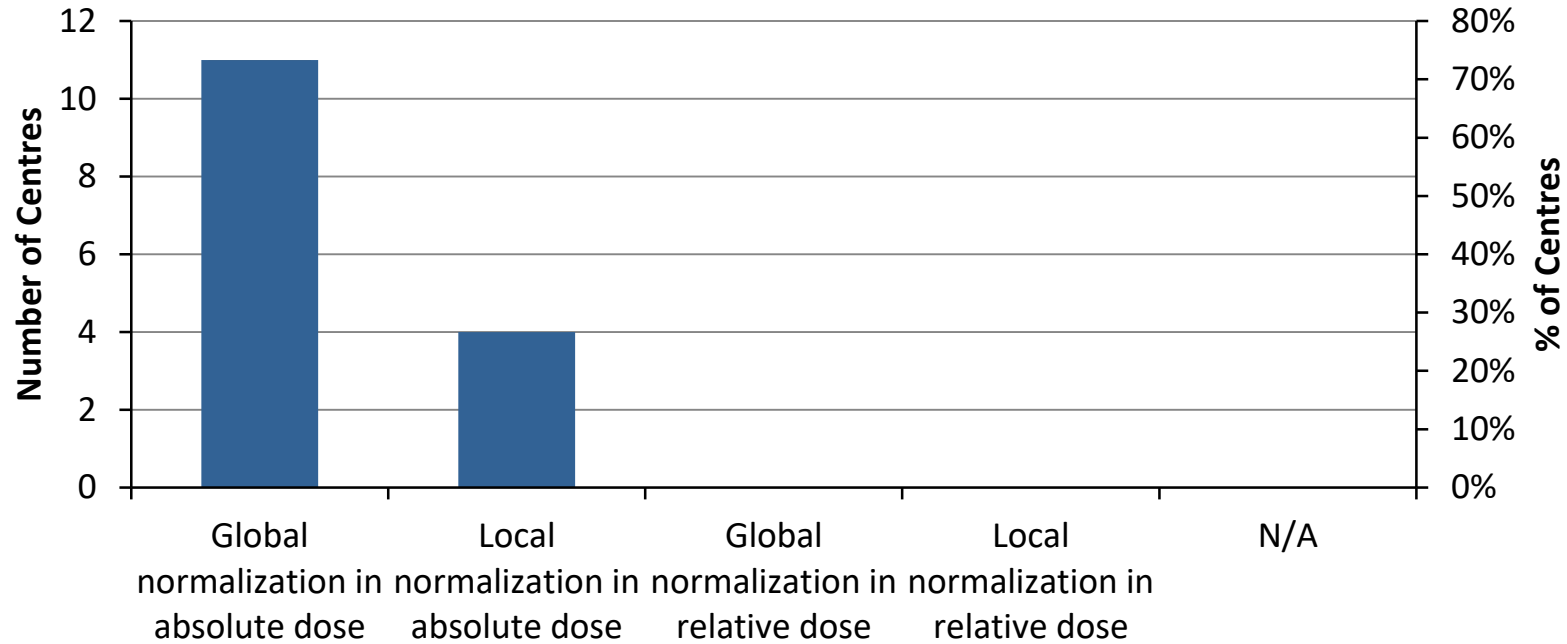
Summary: 10 (67%) centres used vendor specific features on all measurements or at the discretion of the physicist or physics assistant.

Comment:

- Six centres stated they applied “measurement uncertainty”, which added 1 mm to the DTA criterion.
- Five centres commented they applied or sometimes applied “auto shift”, which shifted the measured dose distribution automatically until the highest Gamma or Composite pass rate was obtained.

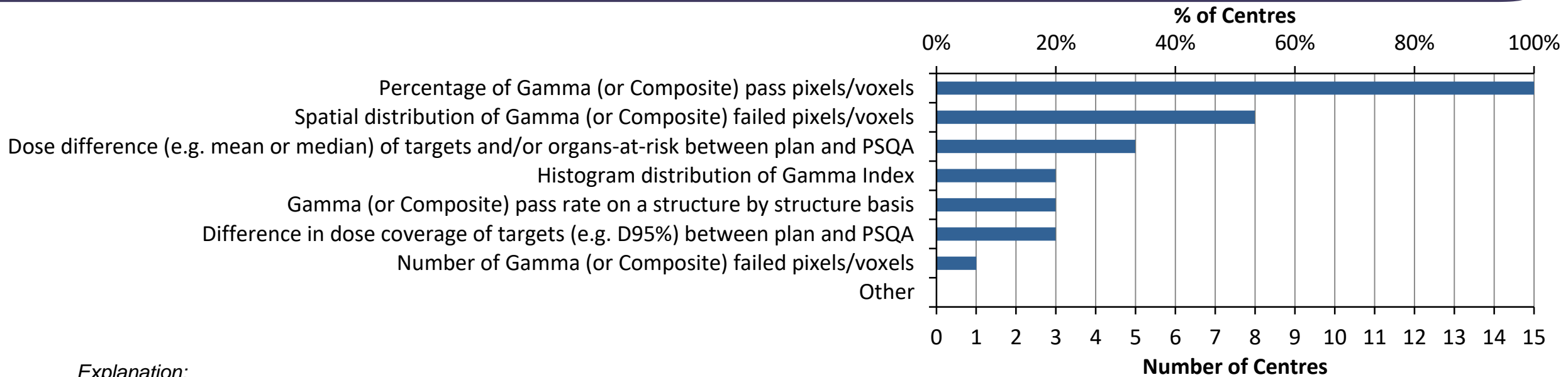
Question 37: How do you perform normalization in dose difference (or Gamma) analysis?

[KQI: D3, D4]



Summary: All centres performed normalization in absolute dose. 11 (73%) used Global and four (27%) used Local type.

Question 38: How do you determine if a PSQA passes (choose all that apply)? [KQI: D1, D9]



Explanation:

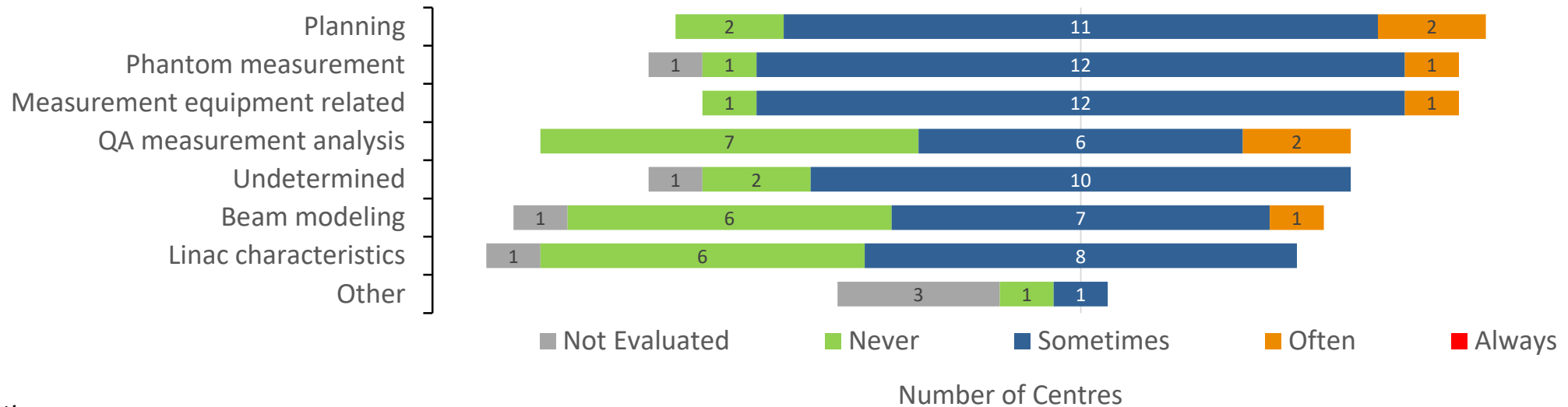
- *Spatial distribution of Gamma (or Composite) failed pixels/voxels: e.g. determine if they are clinically significant in target.*
- *Histogram distribution of Gamma Index: e.g. max, mean, median, min, and number of percentage of pixels/voxels > 1.5.*

Summary: All centres considered percentage of Gamma (or Composite) pass rate when determining whether PSQA passes. Five (33%) centres used it as their sole criteria. Eight (53%) of the remaining centres also reviewed spatial distribution of Gamma (or Composite) failed pixels/voxels.

Comment:

- One centre that did not select “Dose difference of targets and/or organs-at-risk...” commented they reviewed “Median dose deviation in detector geometry and gamma pass rate”
- Another wrote, “... spacial [sic] distribution (and impact of failed points based on ArcCheck measurement) often difficult to judge”.

Question 39: The following factors have been shown to affect pass rates of PSQA. Please indicate how often these factors, if evaluated/investigated, have been found to be a reason for PSQA failures or low pass rates at your centre. [KQI: E4]



Explanation:

Planning: e.g. large beam modulation, minimum segment size, numerous small segments, inadequate optimization

Phantom measurement: e.g. phantom setup, wrong shift, wrong array calibration, wrong plan

Measurement equipment related: e.g. detector response changes over time, non-uniform response not properly corrected

QA measurement analysis: e.g. incorrect analysis parameters, poor registration of measured and calculated dose distributions

Beam modeling: e.g. Beam profiles, PDD, especially at large depths and field sizes, output factors, MLC modelling

Linac characteristics: e.g. MLC positioning inaccuracy, dose rate and dose nonlinearity, profile inconsistency

Summary: Most of the responses were either “Sometimes” or “Never”. 10 centres (67%) responded “Sometimes” the reason for PSQA failures was undetermined. Weighted average responses were distributed approximately uniformly for all factors, suggesting they were all relevant causes of PSQA failures or low pass rates.



Ca

Comment: “We have very few failures, so it’s difficult to assign a frequency”.

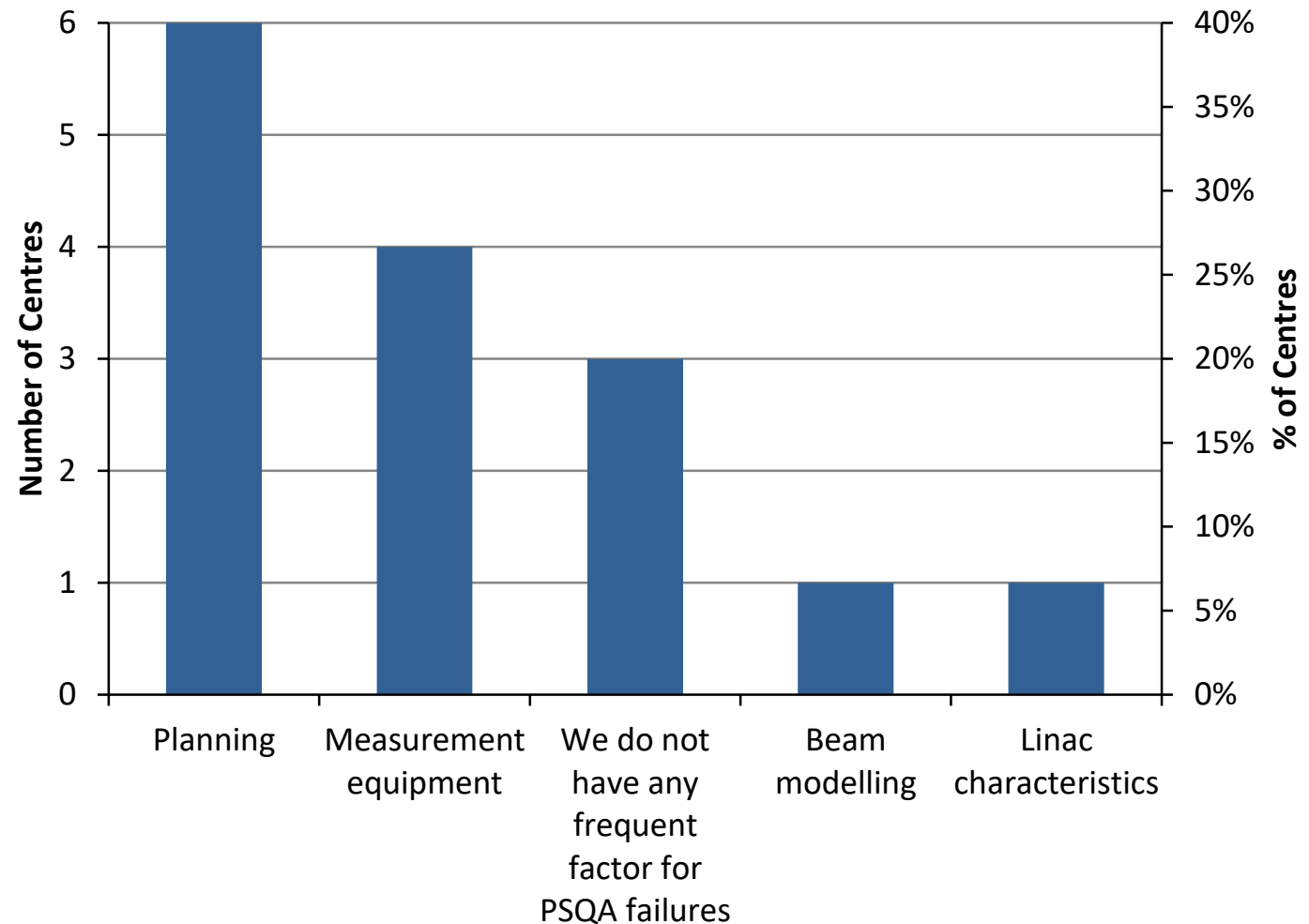
Question 40: Of the following 4 factors, a) beam modelling, b) planning, c) linac characteristics, and d) measurement equipment listed in the previous question, please indicate the most frequent factor for PSQA failures or low pass rates, and the steps taken to remove it. Alternatively, if no action is taken, please indicate reasoning.

[KQI: E4]

Summary: Six (40%) centres selected “Planning” as the most frequent factor for PSQA failures, followed by “Measurement equipment” (4 centres or 27%). Three (20%) centres indicated they did not have any frequent factor for PSQA failures.

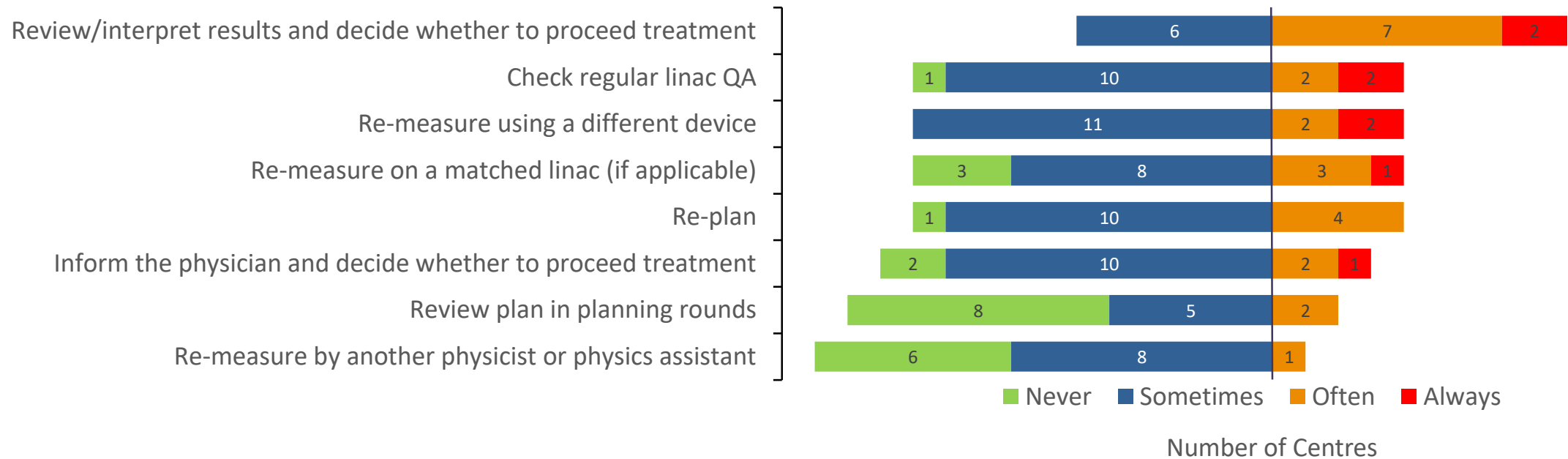
Comment:

- Comments did not show a consistent pattern in actions taken to improve pass rates, suggesting that causes were centre-specific and varied with equipment, software and clinical practices.
- Among the comments, re-planning (3) and few or no failures (3) were most cited.
- One centre commented they were not sure of reasons for SBRT/SRT issues, but “Low pass rates seem to occur when small lesions are far off-axis, and possibly when FFF.”
- One centre that used a delivery log software which calculated dose in patient geometry wrote, “Failure often seen in large patients with 6 MV VMAT. Modelling of PDD at large depths a major factor. Re-plan with IMRT with beams avoiding large depths with perhaps higher energy and fewer segments.”



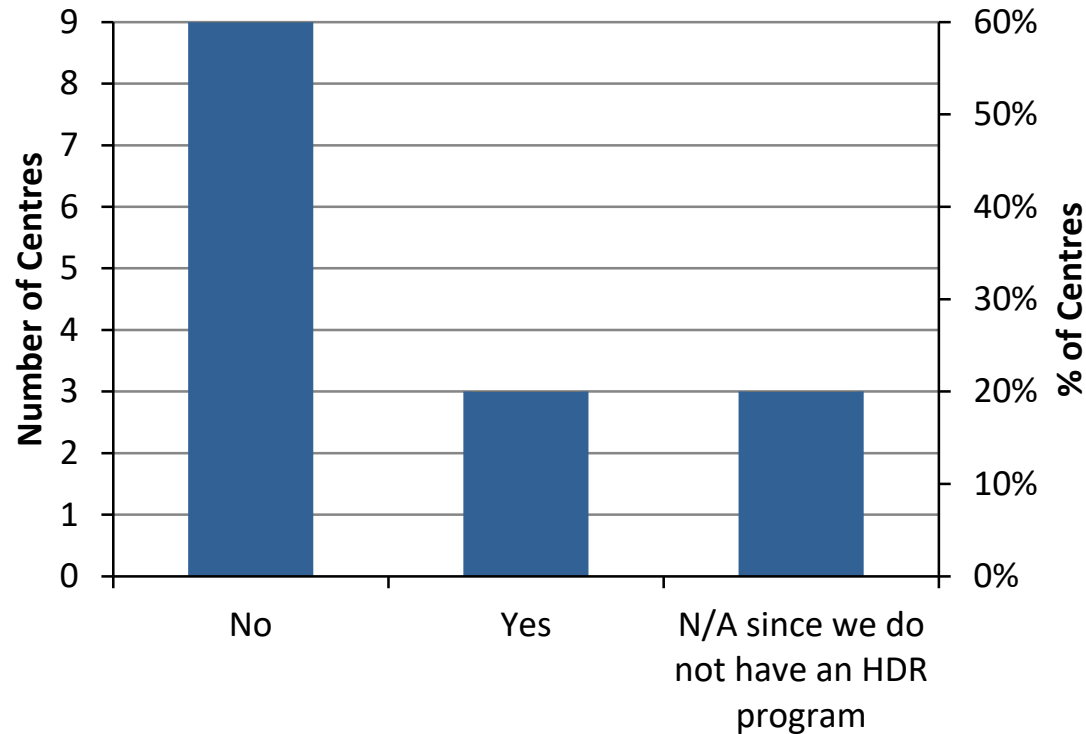
Question 41: To which degree does your centre follow the course of action below when a plan fails PSQA?

[KQI: E2]



Summary: All courses of action were followed “Often” or “Sometimes” by at least one centre. The weighted average of responses suggests that “Review/interpret results and decide whether to proceed to treatment” was the most frequent course of action, and “Review plan in planning rounds” was the least frequent.

Question 42: Does your centre perform PSQA measurements for HDR brachytherapy procedures?



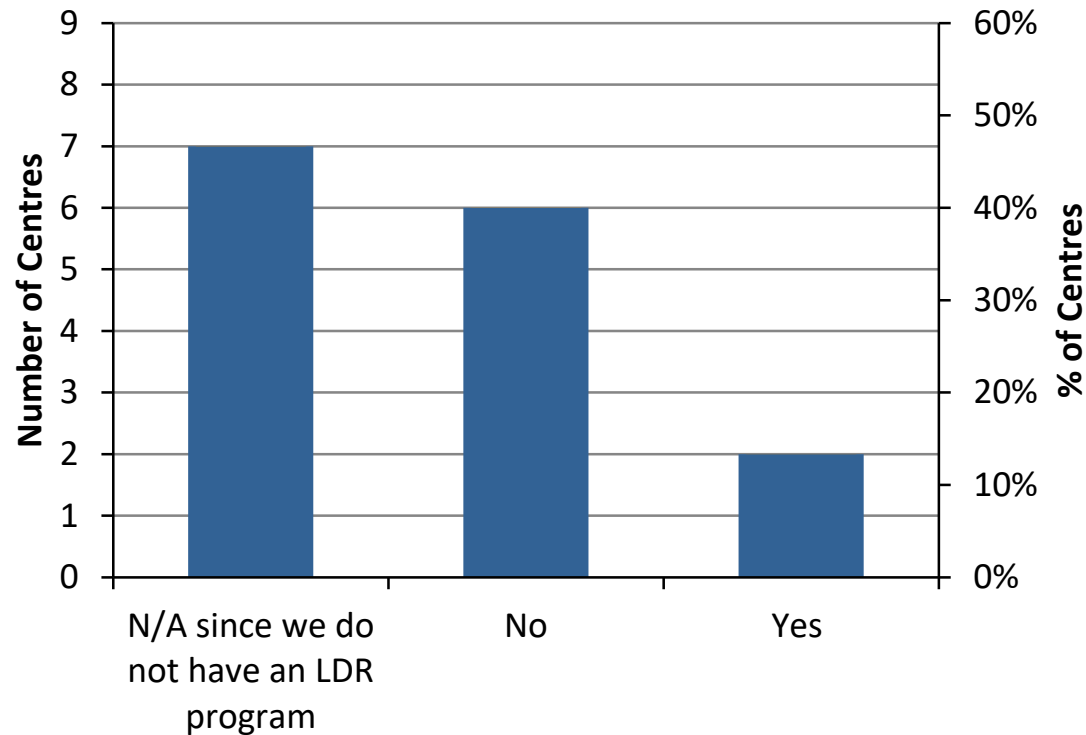
Summary: Only three (20%) centres indicated they performed PSQA measurements for HDR brachytherapy procedures.

Comment:

- Two centres that responded “Yes” used Mobius for PSQA, though technically this is not considered a measurement
- One wrote they did the following measurements, “1. Length measurements of catheters; 2. visual check of x-ray images of catheters and anatomy; 3. secondary point dose verification; 4. confirmation of plan details (time, activity, dose etc); 5. pre and post treatment survey of patients; and 6. visual verification of catheter connection to the afterloader channel.”

Note: It is possible this question was interpreted differently by different centres. Items such as secondary dose checks might not be considered to be PSQA measurements by some centres.

Question 43: Does your centre perform PSQA measurements for LDR brachytherapy procedures?



Summary: Eight (53%) centres performed LDR brachytherapy, and only two (13%) indicated they performed PSQA measurements.

Comment:

- Two centres wrote that their PSQA measurements included seed/needle position verification on images and seed activity/source strength
- One centre wrote when they still performed LDR, they did the following measurements, “1. verification of correct isotope, activity, number of seeds and number of needles ordered; 2. verification of seed positions on radiographs; and 3. source strength assay.”

Note: Two centres stated they checked seed activity/source strength, but did not consider them to be patient-specific measurements.

General Comments: Please share any additional comments below (as required).

Select comments:

- “This survey was quite long. If there is another round, perhaps consideration could be given to a more targeted, reduced questions set and not attempting to collect all in a single survey.”
- “This is a very timely initiative and we look forward to the results. The TG218 approach to arriving at a tolerance/action limit with universal limits as a reference seems very reasonable and offers a possible path to greater uniformity across centres in Ontario.”
- “Gamma analysis is often not very useful in deciding if a plan is ok to treat. DVH derived from measurements or delivery log provides more relevant information. Evaluation in CT set (3D) rather than on a plane is more helpful. We found that the following factors often have a significant on the gamma: large modulation factor (MU/cGy), dose at very large depths, off axis dose for large field profiles.”
- “We are transitioning as many sites as possible to log file based calculation, but fall back on measurement if needed. Using in house statistical data to establish criteria.”

Appendix A: Policy and Procedure

KQI	
A1	A procedure must be implemented to verify the consistency of plan delivery parameters prior to first fraction for all IMRT and VMAT treatments.
A2	A procedure should be in place to verify plan deliverability and dose accuracy prior to first fraction for all IMRT and VMAT treatments.
A3	A procedure must be implemented to prevent or catch accidental alterations to the plan delivery parameters prior to each treatment.
A4	Restrictions or recommendations on certain IMRT/VMAT treatment planning system (TPS) optimization and calculation parameters that impact PSQA pass rates should be implemented.

Appendix B: PSQA Instrumentation

KQI	
B1	PSQA of new IMRT/VMAT techniques or class solutions should be evaluated using measurement devices with high dosimetric accuracy and high spatial resolution.
B2	Following validation of new IMRT/VMAT techniques or class solutions, routine PSQA may employ devices with slightly lower dosimetric accuracy or spatial resolution.
B3	Detectors must be commissioned prior to clinical use.
B4	A QA program must be in place to ensure continued and consistent performance of the PSQA tools at the level at which they were commissioned.
B5	Detector calibration (single or array) must be performed at a frequency dependent on its usage or if it fails regular quality control (QC) tolerance.

Appendix C: PSQA Measurement Setup and Methodology

KQI	
C1	The PSQA detector should be set up to maximize the measurement of relevant clinical region.
C2	Detector and phantom should reach equilibrium temperature with the environment before use or a temperature correction factor is applied.
C3	True composite is the preferred detector setup and delivery method.
C4	Patient-specific measurements can be done on any beam-matched linacs provided consistent inter-machine performance as demonstrated by compliance to appropriate regular linac QC guidelines.
C5	Density heterogeneity on CT must be considered in relevant software and phantoms in all PSQA measurements.
C6	Variation of machine output should be accounted for before every measurement session.

Appendix D: PSQA Evaluation Methodology

KQI	
D1	If available, reconstructed 3D dose distribution in patient anatomy from measured dose or fluence should be used to provide clinically relevant comparison with the clinical plan. Otherwise, 2D or 3D phantom-based Gamma evaluation may be used for plan comparison.
D2	The evaluated dose distribution should have at least the same or higher spatial resolution and dimensionality than the reference dose distribution.
D3	Global normalization in absolute dose should be used.
D4	Normalization dose should be chosen in a consistent manner for each class solution, in a low gradient, high dose region.
D5	Dose interpolation should be done for the evaluated dose distribution prior to Gamma analysis if the spatial resolution is greater than 1/3 the DTA criterion.
D6	Optional vendor specific features should be carefully evaluated for their impact on the measurement results before use, and should be enabled in a consistent manner for each class solution.
D7	Gamma passing rate tolerance and action levels of 95% and 90%, respectively, using 3%/2mm and 10% low dose threshold in Gamma analysis are recommended.
D8	PSQA program evaluation and passing rate criteria should be validated to ensure the chosen parameters adequately catch known errors.
D9	If available, clinically relevant parameters in patient anatomy should be evaluated. Otherwise, Gamma passing rate, histogram and spatial distribution of Gamma index should be evaluated.

Appendix E: Documentation, Process and Feedback

KQI	
E1	Documentation on PSQA program tolerance levels, action levels, and acceptance criteria should be developed and followed, along with formal procedures on PSQA measurements and analysis.
E2	A formalized process should be in place to record PSQA results. PSQA results, including failures and the result of any subsequent investigations/decisions, should be clearly documented and approved by a qualified medical physicist for each treatment plan prior to the onset of treatment.
E3	A feedback mechanism should be in place that allows for discussion and shared learning of issues related to PSQA.
E4	Periodic programmatic reviews of PSQA results in a database record and overall process should be conducted to identify systematic issues and/or opportunities for process improvement.