Quality Metric for the First One-Year Term of Operations of a Radiology Department Based 3D Printing Section

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Background and Purpose

- Radiology quality is most often measured using data collected among imaging professionals alone.
- Medical Quality Improvement (QI) can be greatly facilitated by structured feedback from the most responsible physician. This is often not a radiologist.
- Data coordinated among both the 3DP team and the referring provider can fill a large, unmet need for radiology QI.
- Most 3D Printing (3DP) QI focus on technical factors, with fewer reports that focus on the professional (e.g. referring provider) use of the 3D printed parts.
- Anecdotal evidence supports 3DP as value-added for specific clinical scenarios. However, it is challenging to quantify added value.

Background and Purpose

- On September 28 2018, 3DP was recognized by the American Medical Association as a clinical service, defined by four Category III CPT™ codes (effective July 1, 2019). This was followed by the launch (June 22, 2020) of the ACR-RSNA 3DP Registry ("the Registry") to collect further data.
- The Registry includes Likert questions amenable for quality metrics focused on the clinical service of 3DP in hospitals.
- The purpose of this project is to define and tally a 3DP quality metric based on the Registry Likert questions completed over the 1st one-year of operation for a hospital based 3DP section within an academic radiology department.

Methods

- All patients (Feb 2020 - Jan 2021) were prospectively identified via request from an ordering physician for the clinical service of medical 3DP at the University of Cincinnati (UC) Department of Radiology.
- The following data was collected pre-3DP: requesting (most-responsible) physician and hospital service-line, clinical indication, type of surgery and date.
- All Registry technical parameters were captured for all patients.
- Post-procedure, each provider answered the Registry Likert questionnaire. Those answers were quantified by author consensus and scaled to a maximum of 500 3DP quality points.
  - As detailed on the next slide, the confidence in the treatment plan before using the 3D printed model was defined to only contribute negatively in the total quality points; the rationale was that the highest points would correspond to the greatest Likert change in confidence after versus before the 3D printed model was incorporated into patient care.

3DP Likert Question	Response and Conversion to 3DP Quality Points				
	Strongly disagree	Disagree	Neutral	Agree	Strongly Agree
The 3D printed model or guide was easy for me to use.	0	0	0	25	50
Use of the 3D printed model or guide was compatible with other aspects of my approach to this case.	0	0	0	25	50
As a result of using the 3D printed model, the treatment plan was altered or refined.	0	0	0	50	100
Use of the 3D printed model or guide was important in this case.	0	0	0	50	100
The quality of the 3D printed model or guide was adequate.	0	0	0	50	100
Before using the 3D printed model, I was confident in the treatment plan.	**0**	**0**	**0**	**-50**	**-100**
After using the 3D printed model, I was confident in the treatment plan.	0	0	0	50	100
Maximum Total 3DP Quality Points					**500**

Results

- 78 patients underwent 3DP in the 1-year study period.
- Demographics: 47 Men, Age 62.7 ± 16.5 years
- There were 8 requesting clinical services: Cardiac Surgery and Interventional Cardiology accounted for 73% of patients
- Overall 3DP quality points had mean of 316 ± 30

# Pts	Ordering Service	Clinical Indication(s)	3DP Quality Points (mean ± SD)
23	Cardiac Surgery	Coronary Artery Disease	322 ± 64
34	Interventional Cardiology	Atrial Fibrillation	304 ± 50
2	Interventional Radiology	Malfunction of IVC Filter (1 case), Post-Liver Transplant Ascites (1 case)	363 ± 18
5	Neurotology	Skull Base Tumor	280 ± 78
4	Orthopedic Surgery	Complex Joint Fracture	344 ± 43
6	Otolaryngology	Mandible Fracture (5 cases), Orbit Tumor (1 case)	313 ± 44
1	Urology	Renal Cell Carcinoma	275
3	Vascular Surgery	Dysphagia	325 ± 43

Results (case example)

- Clinical indication: planning minimally invasive coronary artery bypass graft
- Selected Registry Inputs: Mimics Imprint, 3-Matic, (Inverted) vat polymerization, rigid
- 4 anatomic parts: bone, myocardium, left anterior descending coronary artery, left internal mammary artery and a marker for the nipple (male patients).
- Model was used to determine feasibility for less invasive surgery and to determine surgical access
- Surgery time: 7 hours 4 minutes
- Quality Points tallied for this patient = 400 (next slide shows point breakdown for this patient)

3DP Likert Question	Response and Conversion to 3DP Quality Points				
Results (Case Example)	Strongly disagree	Disagree	Neutral	Agree	Strongly Agree
The 3D printed model or guide was easy for me to use.	-	-	-	-	50
Use of the 3D printed model or guide was compatible with other aspects of my approach to this case.	-	-	-	-	50
As a result of using the 3D printed model, the treatment plan was altered or refined.	-	-	-	-	100
Use of the 3D printed model or guide was important in this case.	-	-	-	50	-
The quality of the 3D printed model or guide was adequate.	-	-	-	-	100
Before using the 3D printed model, I was confident in the treatment plan.	-	-	-	-50	-
After using the 3D printed model, I was confident in the treatment plan.	-	-	-	-	100
Case Example Total 3DP Quality Points					400

Conclusions

- 3DP quality metrics can be derived from the data that focuses on the patient-specific clinical impact of the model.
- Likert questions can be used to generate quality metrics for 3DP.
- While the proposed metric (3DP quality points) was determined by local consensus, the assignment of points is flexible and can be adjudicated and adjusted as needed.
- The proposed metric was designed to scale to different time periods and any number of patients, clinical indications, and clinical laboratories.

Conclusions

- 3D printing is defined as a clinical service in the United States by the American Medical Association, and thus quality maintenance and improvement should be incorporated into standard operating procedures.
- The overall mean quality points (316 among a maximum of 500) provides a quantitative level of quality as determined by the referring provider for this study. This approach expands the role of QI / QA beyond metrics gathered by radiology personnel.
- The dispersion of quality points among clinical indications for the first one-year of operations in the 3D Printing Section at the University of Cincinnati Department of Radiology 3D printing section was modest.
- While expansion of the proposed methods should include meticulous vetting and testing, the 3D printing quality metric provides an important benchmark for quality of a new and promising service in healthcare.