Common Data Element (CDE) Implementation for CT Paranasal Sinusitis: Improved Disease-Specific Evidence-Based Clinical Reporting, Moving Towards a Community Standard, and Building a Foundation for Research in Artificial Intelligence/Machine Learning

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Introduction

The American Society of Neuroradiology (ASNR), American College of Radiology (ACR), and the Radiological Society of North America (RSNA) have collaboratively developed Common Data Element (CDE) macros for reporting of various diseases, including an introductory implementation manual.[1] These CDE macros allow for comprehensive reporting, moving towards a community standard of reporting best practices. In addition to the clinically relevant findings important to ordering clinicians, these macros help build the foundation for research in artificial intelligence and machine learning with explicit statements and by including more common responses. We highlight the implementation of a CDE macro for reporting of CT paranasal sinuses to demonstrate the utility of incorporating CDE macros into a radiology practice.

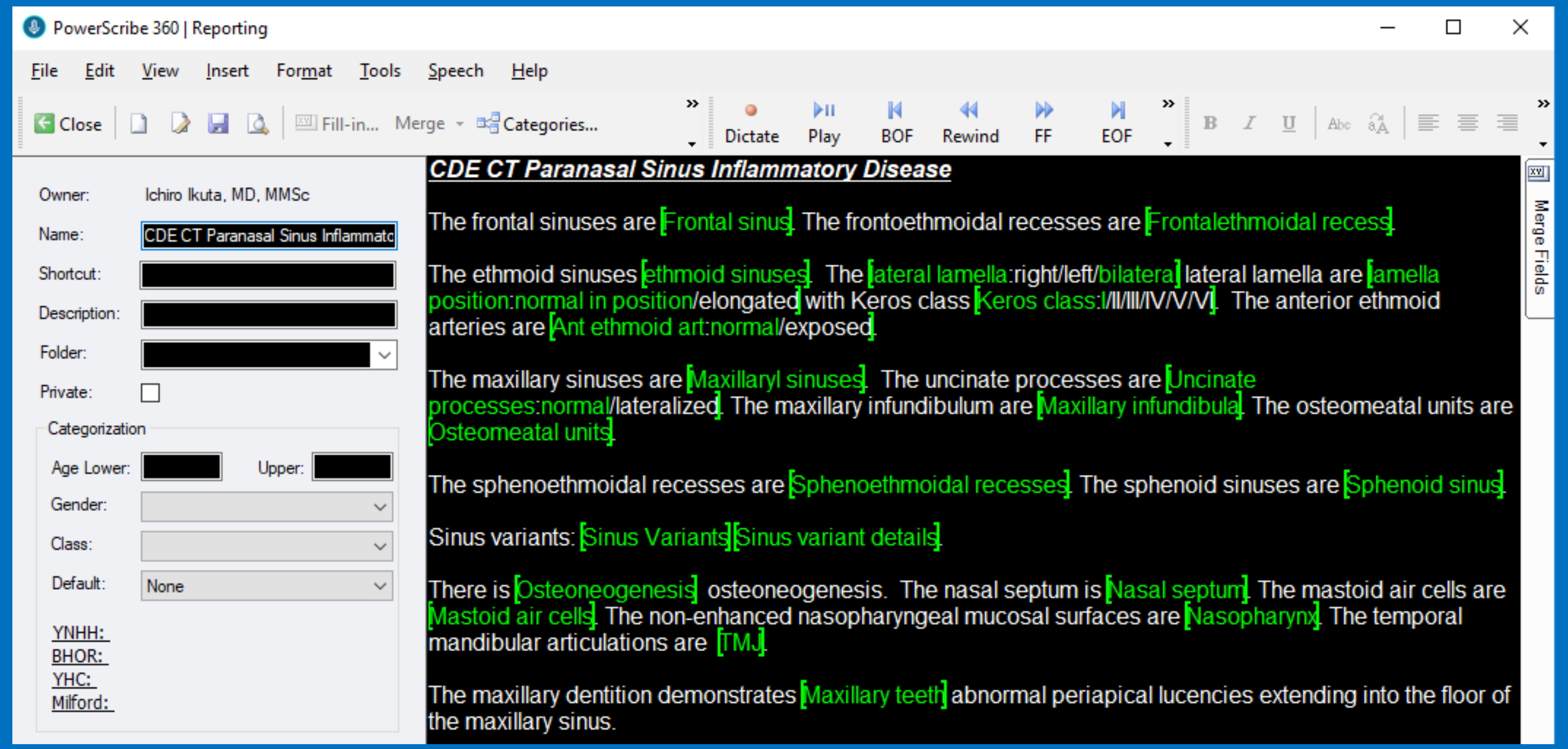
Objectives

1. Planning phase included evaluating our radiology practice group initial baseline practice of CT paranasal sinus reporting, noting any reporting deficiencies in clinically relevant findings (relative to the ASNR-ACR-RSNA CDE macro for CT paranasal sinus inflammatory disease).
2. Perform the implementation of a CDE macro for CT paranasal sinus inflammatory disease customized to our practice, including radiologist training & education regarding new CDE macro implementation.
3. Study the post-implementation effects on any reporting deficiencies.
4. Iteratively improve the CT paranasal sinus CDE macro based upon radiologist feedback and ordering clinician feedback.

Materials & Methods

Institutional review board approved the waiver of informed consent for this project of quality improvement and quality assurance.

As per CDE instructions[1], we used the original ASNR-ACR-RSNA CT paranasal sinus template as a baseline guide **(Figure 1).** We customized the CDE macro to reflect our radiology group's style of reporting, inclusion of more robust Pick Lists in our voice recognition system (PowerScribe 360), and the inclusion of non-CDE findings to make this a complete exam template (for example, discussion of the partially visualized neck soft tissues and partially visualized intracranial compartment).



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CDE CT Paranasal Sinus Inflammatory Disease

The frontal sinuses are [Frontal sinus]. The frontoethmoidal recesses are [Frontalethmoidal recess].

The ethmoid sinuses [ethmoid sinuses]. The [lateral lamella:right/left/bilateral] lateral lamella are [lamella position:normal in position/elongated] with Keros class [Keros class:I/II/III/IV/V/VI]. The anterior ethmoid arteries are [Ant ethmoid art:normal/exposed].

The maxillary sinuses are [Maxillaryl sinuses]. The uncinate processes are [Uncinate processes:normal/lateralized]. The maxillary infundibulum are [Maxillary infundibula]. The osteomeatal units are [Osteomeatal units].

The sphenoethmoidal recesses are [Sphenoethmoidal recesses]. The sphenoid sinuses are [Sphenoid sinus].

Sinus variants: [Sinus Variants][Sinus variant details].

There is [Osteoneogenesis] osteoneogenesis. The nasal septum is [Nasal septum]. The mastoid air cells are [Mastoid air cells]. The non-enhanced nasopharyngeal mucosal surfaces are [Nasopharynx]. The temporal mandibular articulations are [TMJ].

The maxillary dentition demonstrates [Maxillary teeth] abnormal periapical lucencies extending into the floor of the maxillary sinus.

Figure 1. Original ASNR-ACR-RSNA CT Paranasal Sinus Inflammatory CDE Macro. [Text within brackets represent fields for free response and/or selection from Pick Lists].

Materials & Methods (continued)

Osteoneogenesis was not included in the original ASNR-ACR-RSNA CDE macro, but more descriptive terms were preferred by our radiologists.

One notable modification of the original CDE template was the inclusion of more details with regard to the Keros class Pick List. Radiologists and trainees were often looking up the olfactory fossa depth and corresponding Keros classification. To avoid this online search and to avoid posting the Keros class on the walls of the reading room, we implemented the olfactory fossa depth and included the associated Keros class in the same Pick List option (Figure 2).

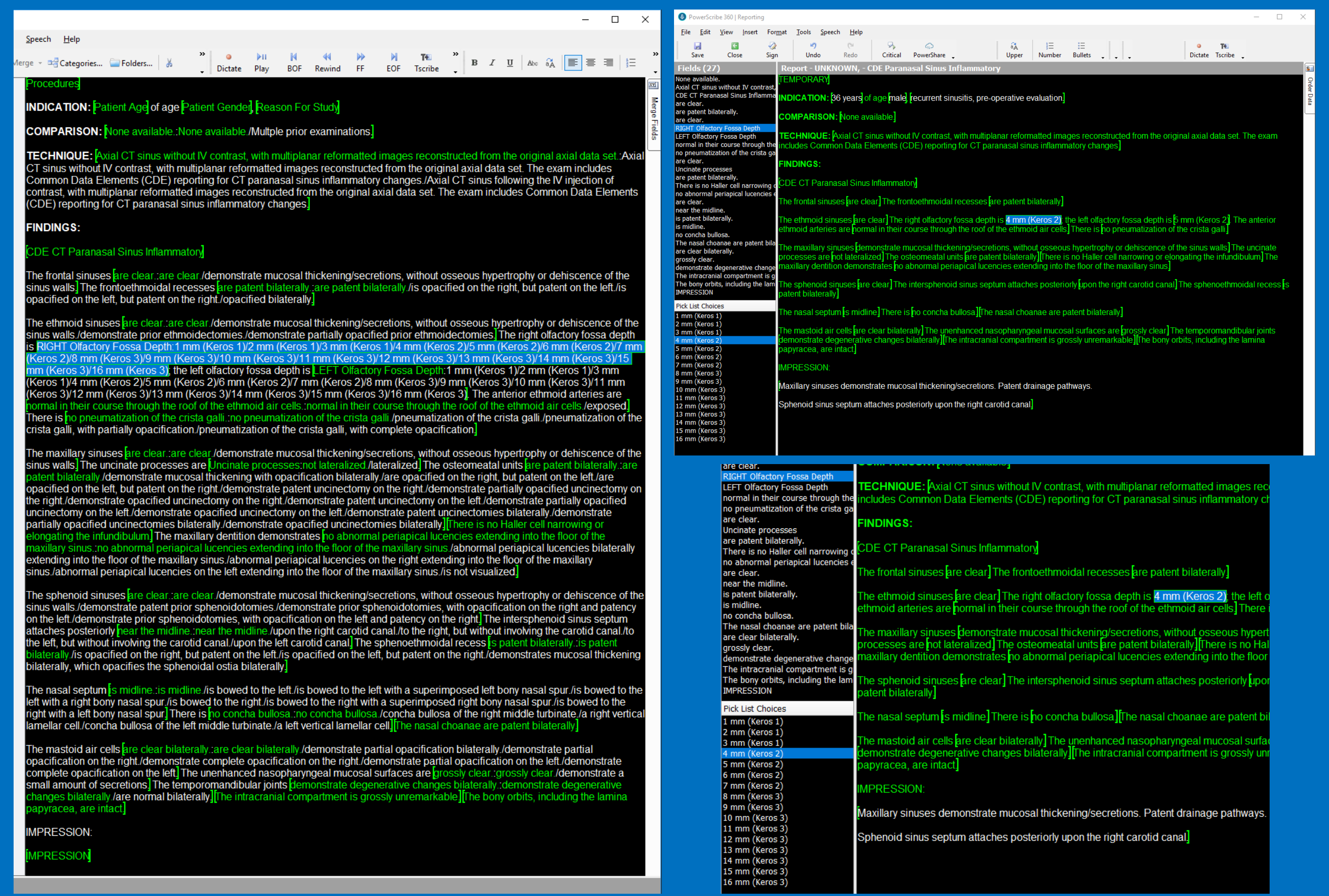

Figure 2. Yale customization of the ASNR-ACR-RSNA CT Paranasal Sinus Inflammatory CDE Macro. On the left is the AutoText editor with the full extent of modifications, which at a glance can appear disorganized. On the top right, a sample report shows what the report looks like in the clinical workflow, and bottom right how the Pick List can be used for the Keros Class (double click the Pick List option on the screen left, dictate "Pick 4," or dictate "4 mm (Keros 2)."

All CT sinus exam reports from 3/1/2018-5/1/2018 (before promotion of CDE macros at ASNR 2018) as well as 12-7-2018-1/31/2019 (after institutional implementation of CDE macros) were reviewed. Exams were excluded if not specifically for paranasal sinus inflammatory disease (for example, paranasal sinus tumor or perineural spread of tumor, trauma, etc). CDE macro implementation occurred on 12/7/2018.

The primary outcome was the CT paranasal sinus inflammatory CDE macro contains 19 fields. The 19 fields include: frontal sinus, frontoethmoidal recess, ethmoid sinus, Keros class, anterior ethmoid arteries, maxillary sinus, uncinate process lateralization, maxillary infundibula, osteomeatal units, sphenoethmoidal recess, sphenoid sinus, sinus variants, sinus variant details, osteoneogenesis, nasal septum, mastoid air cells, nasopharynx, temporomandibular joints (TMJ), maxillary teeth. These fields were marked as either explicitly present or absent from each report, as well as the percentage of all 19 CDE's in each report.

The secondary outcome was the adoption rate of the CT paranasal sinus CDE macro. We also discuss some of the radiologist complaints revolving around the implementation and maintenance of the CDE macro, and clinician feedback.

Results (pre-intervention)

Before CDE macro implementation, 66 reports met inclusion criteria, and 35 met exclusion criteria. Pre-intervention reports most commonly reported CDE fields include: maxillary sinus (97%), frontal sinus (91%), and ethmoid sinus (91%) **(Figure 3).** Pre-intervention least commonly reported CDE include: uncinate process lateralization (2%), nasopharynx (11%), and temporomandibular joint (11%). Completeness of reports for inclusion of all 19 CDE fields was 11-79%.

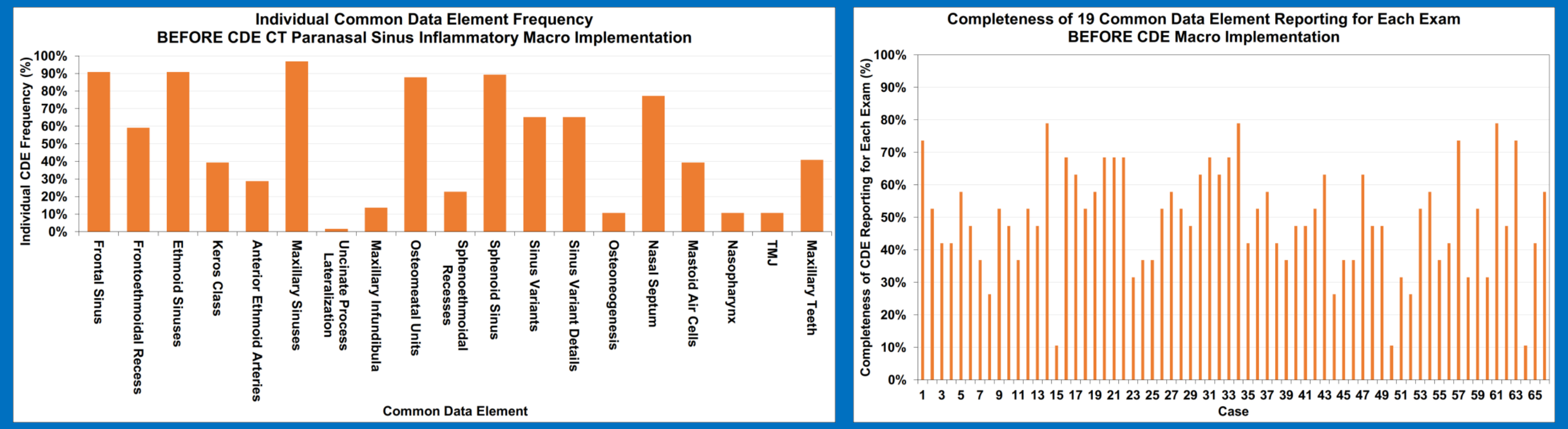

Figure 3. Pre-intervention baseline reporting for CT paranasal sinus inflammatory disease. The left bar graph demonstrates the percentage of reports including each particular CDE field. The right bar graph demonstrates the variable extent of individual report inclusion of all 19 CDE fields.

Results (post-intervention)

After CDE macro implementation, 59 reports met inclusion criteria, and 30 met exclusion criteria. The CDE macro was adopted for 56% of reports. For those adopting the CDE macro, reporting improved for uncinate process lateralization (79%), nasopharynx (79%), and for temporomandibular joint (73%). Those not adopting the CDE macro, reporting remained similar to pre-intervention frequency for uncinate process lateralization (4%), nasopharynx (0%), and temporomandibular joint (8%) (**Figure** 4). Completeness of reports for inclusion of all 19 CDE fields was 84% for those adopting the CDE macro, and 44% for those not adopting the CDE macro.

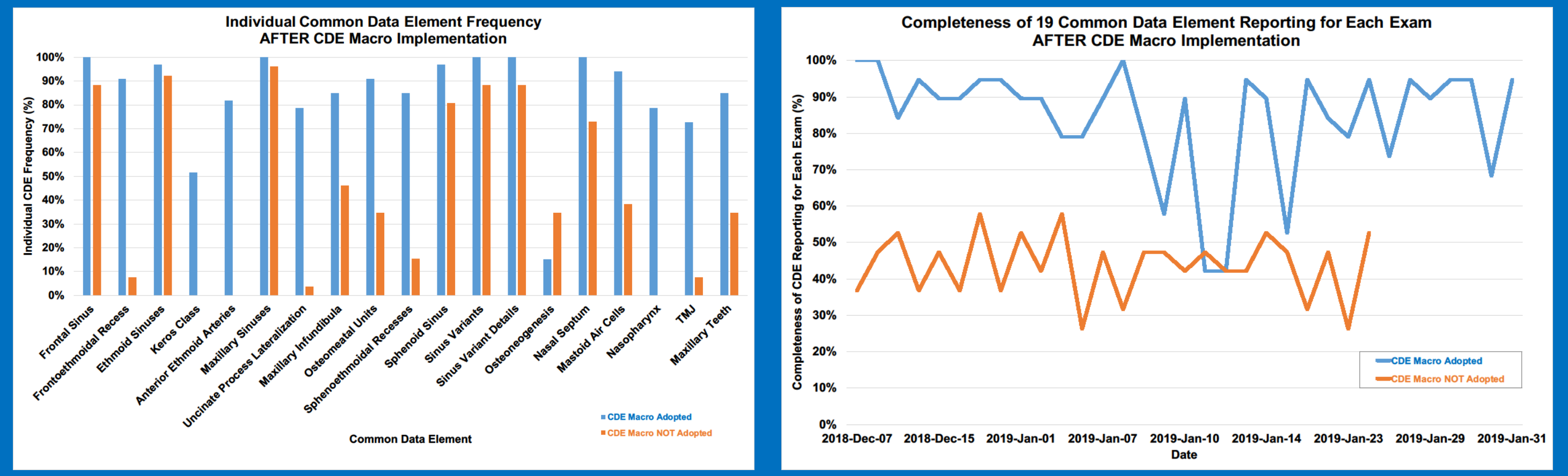

Figure 4. Post-intervention CDE macro reporting for CT paranasal sinus inflammatory disease. The left bar graph demonstrates the percentage of reports including each particular CDE field, including radiologists adopting the CDE macro (blue), and those not adopting the CDE macro (orange). The line graph demonstrates the variable extent of individual report inclusion of all 19 CDE fields after CDE macro implementation.

Many radiologists liked the ease of Keros class reporting with the more robust Pick List options instead of having to look up the Keros class each time or having to commit it to memory. Some radiologists still would have preferred a blanket statement for relatively normal studies such as "No significant paranasal sinus disease or significant anatomic variability," but were fine receiving reports from trainees that used the CDE macro. By including additional paragraphs regarding the rest of the imaged anatomy outside of the paranasal sinuses, minimal additional information had to be dictated. The ordering clinicians have enjoyed the thoroughness of these clinically relevant reports.

Discussion

Implementation of the ASNR-ACR-RSNA CDE macro for CT paranasal sinus inflammatory consistently improved disease-specific reporting when adopted by the radiologist. We hope incorporation of the CDE macros will bring our group towards a community standard of evidence-based clinically relevant reporting, potentially making data more interoperable.[2] The use of Pick List options greatly facilitated reporting and adoption of the CDE macro.

The ASNR-ACR-RSNA CDE macros will hopefully facilitate research into natural language processing, machine learning, and deep learning as artificial intelligence advances imaging.[3] It could potentially be used in meeting potential government inquiries into quality benchmarks,[4] as well as facilitate implementation with current government mandate for clinical decision support (CDS).[5] As part of this Plan-Do-Study-Act type of project for quality improvement, further improvement of CDE adoption is planned via education as to the clinical importance of disease-specific reporting, and demonstrating shortcuts in dictation software to improve turnaround times. While not measured in this project, trainees can explicitly see what is expected of their reporting, and incorporating these macros into trainee education may be beneficial for knowledge acquisition such pertinent positive and pertinent negative findings, clinically relevant findings, and appropriate vocabulary.

With a renewed interest in artificial intelligence (AI) including machine learning (ML) and deep learning (DL), the search for reliable big data has become paramount. While natural language processing (NLP) has been used to find studies supposedly appropriate for AI, it is our hope that explicit discussion of clinically relevant findings will help supply the big data requirement in AI development, AI validation studies, and ontology evolution.[6-7]

Acknowledgements & Contact Information

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