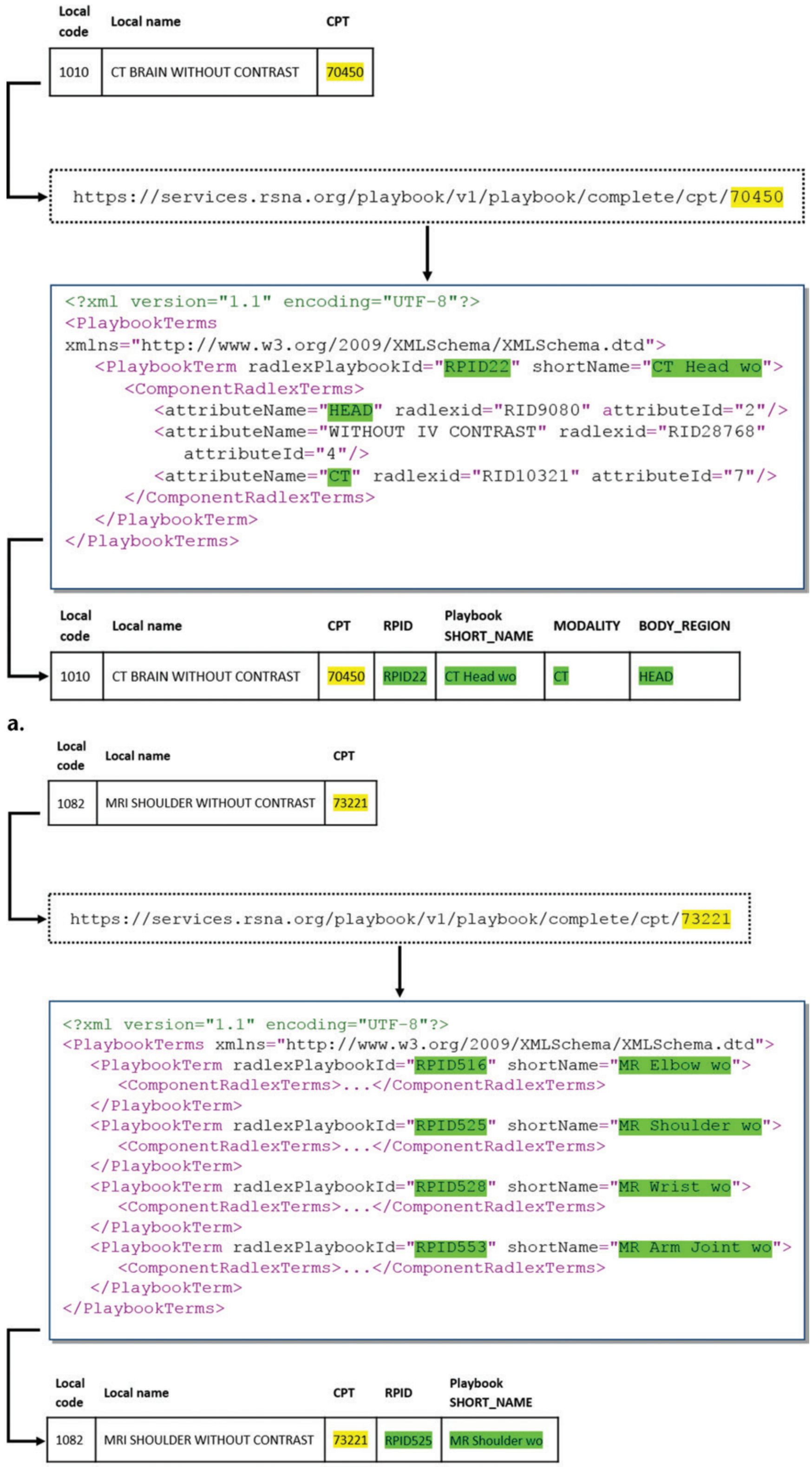

Figure 4. Use of the RadLex Playbook Web service application programming interface to map local procedure codes to standardized codes. CPT codes from a local chargemaster can serve as useful intermediary codes in the mapping of local codes to standardized codes. **(a)** In this example, a single entry from a chargemaster (top) shows the association of local code 1010 ("CT BRAIN WITHOUT CONTRAST") with CPT code 70450 (yellow). Using this CPT code with the RadLex Playbook Web service call (7) (dotted box) yields the (excerpted) XML (*xml*) result shown (shadowed box). This XML result contains any matching RPIDs and associated metadata (selected elements shown in green), which can then be used to populate new fields in the chargemaster to map the local code to the standardized code (bottom). In this case, a single matching RPID is found (RPID22). In general, a given CPT code may map to multiple RPIDs, and multiple local codes may be associated with a single CPT code, so this approach does not facilitate fully automated mapping. Even so, using CPT codes as intermediary codes in this way can narrow the list of possible matches. Note also that the associated attribute values such as modality and body region may be stored and used to facilitate various workflows. **(b)** In this example, the chargemaster entry (top) for local code 1082 ("MRI SHOULDER WITHOUT CONTRAST") is shown with its associated CPT code, 73221 (yellow). In this case, the RadLex Playbook Web service call (dotted box) yields four matching RPIDs (shadowed box); the XML is further excerpted as compared with that in **a**. Manual inspection leads to the correct match, RPID525 (bottom), from these four RPIDs.

representatives from referring clinical services and leaders from the enterprise-level IT organization. For such a project to succeed, those entities that govern the IT systems in question need to be involved. Collaborations among departmental and enterprise-level IT organizations are often already established at large institutions, since the stewardship of radiology data is only one of many types of IT governance across an enterprise. Leveraging or developing such collaborations as part of a project to update imaging procedure codes will serve to expand the potential benefits to be gained from deploying standardized codes. For example, while a department may be able to adopt standardized codes internally—that is, within its own applications for its own purposes—engaging with hospital or enterprise IT systems to extend such codes to electronic medical records will create new opportunities for workflow improvement.

Once the decision to move forward is made and the scope and objectives of the project are clearly defined, the challenges of mapping local procedure codes to standardized codes can be mitigated by using a combination of techniques. First, by separating the master examination list into smaller sections (eg, by modality or subspecialty), one can divide the work into more manageable tasks. Second, making use of CPT as a common coding target can help simplify the mapping task. That is, if the associations between local procedure codes and CPT (ie, from the organization's chargemaster) and between standardized codes and CPT are known, then CPT terms can serve as useful intermediate codes in the mapping process (17). Third, departments and enterprises should make use of the tools provided by the organizations that publish terminologies. The RadLex Playbook may be queried through a Web-based application programming interface (API), which provides programmatic access to RPIDs, the associated code attributes, and any LOINC mappings released as part of the LOINC/RSNA Radiology Playbook project (20). One portion of this API also enables a CPT-based search for RadLex Playbook codes. With this interface, the use of CPT terms as intermediate mapping codes may be partially automated, as shown in Figure 4. The Regenstrief Institute provides two tools for browsing and mapping local codes to LOINC codes: the RELMA (Regenstrief LOINC mapping assistant), which is a desktop mapping program, and the LOINC Web search tool (21). Fourth, by using text searching methods to analyze procedure names, one can partially automate the process of finding specific target codes, as described by Mabotuwana et al (22). Finally, third-party consultants also provide mapping services.

Looking ahead, more widespread adoption of standardized radiology procedure codes may be driven by several factors in the future. The first factor is the trend toward consolidation of physician practices and hospitals. As networks expand, the benefits of cross-enterprise data interchange with use of standardized procedure codes will become greater. The second factor is the growing role of data registries, such as those hosted at the ACR National Radiology Data Registry (23). Such registries depend on interoperability, and registry enrollment will move institutions toward the use of standardized coding systems. A third factor is related to laws and regulations such as the Protecting Access to Medicare Act (24), under which quality improvement activities (eg, clinical decision support) are required. Standardized procedure codes are an important part of such activities.

Conclusion

Procedure codes are a critical part of radiology workflows. Historically, unstructured coding systems have had limited semantic capability; however, new standards for structured coding of imaging procedures enable broader interoperability. The involvement of several key stakeholders is required to adopt these structured codes. The challenges of mapping local procedure codes to standardized codes can be mitigated by using a variety of mapping techniques.

Acknowledgments.—The authors gratefully acknowledge the National Institutes of Health and U.S. Department of Defense for funding support; Clem McDonald, MD, National Library of Medicine, Bethesda, Md, for his efforts in initiating and coordinating this work; and technical support from Katie Allen, Jamalynne Deckard, and John Hook, Regenstrief Institute, Indianapolis, Ind; Katy Holck, JP Systems, Clifton, Va; and Scott Steingall, Siemens Healthineers, Malvern, Pa.

Disclosures of Conflicts of Interest.—**K.C.W.** *Activities related to the present article:* disclosed no relevant relationships. *Activities not related to the present article:* cofounder of DexNote. *Other activities:* disclosed no relevant relationships. **D.J.V.** *Activities related to the present article:* disclosed no relevant relationships. *Activities not related to the present article:* personal fees from Icahn School of Medicine at Mt. Sinai for consulting on U.S. National Library of Medicine grant, and grant from U.S. National Library of Medicine for development, maintenance, and distribution of LOINC. **C.P.L.** *Activities related to the present article:* disclosed no relevant relationships. *Activities not related to the present article:* personal and consulting fees, and travel reimbursement from Montage Healthcare Solutions for founder, shareholder, and board member activities; compensation from the RSNA as Informatics advisor. *Other activities:* disclosed no relevant relationships.

References

1. American Medical Association. About CPT. American Medical Association website. https://www.ama-assn.org/practice-management/cpt. Accessed January 16, 2017.
2. Wang KC, Kohli M, Carrino JA. Technology standards in imaging: a practical overview. J Am Coll Radiol 2014;11(12 pt B):1251–1259.
3. Benson T. Principles of health interoperability HL7 and SNOMED. 2nd ed. London, England: Springer, 2012; 201–206.
4. World Health Organization. Classification of diseases (ICD). World Health Organization website. http://www.who.int/classifications/icd/en/. Published November 29, 2016. Accessed January 16, 2017.
5. National Electrical Manufacturers Association. DICOM PS3.3 2017a: information object definitions. http://dicom.nema.org/medical/dicom/current/output/pdf/part03.pdf. Accessed January 16, 2017.
6. Radiological Society of North America. RSNA Informatics RadLex Playbook. http://playbook.radlex.org. Published December 2016. Accessed January 16, 2017.
7. Radiological Society of North America. RSNA Informatics RadLex Playbook 2.3 user guide. http://playbook.radlex.org/playbook-v2_3-user-guide.pdf. Published December 2016. Accessed January 16, 2017.

8. Langlotz CP. RadLex: a new method for indexing online educational materials. RadioGraphics 2006;26(6):1595–1597.
9. Rubin DL. Creating and curating a terminology for radiology: ontology modeling and analysis. J Digit Imaging 2008;21(4):355–362.
10. Dose Index Registry. American College of Radiology website. http://www.acr.org/Quality-Safety/National-Radiology-Data-Registry/Dose-Index-Registry. Accessed January 16, 2017.
11. The universal standard for identifying health measurements, observations, and documents. LOINC from Regenstrief website. https://loinc.org. Published December 2016. Accessed January 16, 2017.
12. Centers for Medicare & Medicaid Services (CMS), HHS. Medicare and Medicaid programs; electronic health record incentive program: stage 2—final rule. Fed Regist 2012;77(171):53967–54162.
13. Office of the National Coordinator for Health Information Technology (ONC), Department of Health and Human Services. Health information technology: standards, implementation specifications, and certification criteria for electronic health record technology, 2014 edition; revisions to the permanent certification program for health information technology—final rule. Fed Regist 2012;77(171):54163–54292.
14. Vreeman DJ, Chiaravalloti MT, Hook J, McDonald CJ. Enabling international adoption of LOINC through translation. J Biomed Inform 2012;45(4):667–673.
15. 2016 ICD-10 PCS and GEMs. Centers for Medicare & Medicaid Services website. https://www.cms.gov/Medicare/Coding/ICD10/2016-ICD-10-PCS-and-GEMs.html. Published October 8, 2015. Accessed January 16, 2017.
16. ACR Common. American College of Radiology Informatics website. http://acrinformatics.org/ACR-Common. Accessed January 16, 2017.
17. Vreeman DJ, McDonald CJ. Automated mapping of local radiology terms to LOINC. AMIA Annu Symp Proc 2005:769–773.
18. Fidahussein M, Vreeman DJ. A corpus-based approach for automated LOINC mapping. J Am Med Inform Assoc 2014;21(1):64–72.
19. Vreeman DJ, Stark M, Tomashefski GL, Phillips DR, Dexter PR. Embracing change in a health information exchange. AMIA Annu Symp Proc 2008:768–772.
20. Vyas B, Siegel E, Wang K. Automated RadLex Playbook identifier mapping utilizing web services and Microsoft Excel. Leesburg, Va: Society for Imaging Informatics in Medicine, 2016.
21. LOINC from Regenstrief. http://search.loinc.org. Published December 2016. Accessed January 16, 2017.
22. Mabotuwana T, Lee MC, Cohen-Solal EV, Chang P. Mapping institution-specific study descriptions to RadLex Playbook entries. J Digit Imaging 2014;27(3):321–330.
23. American College of Radiology. National Radiology Data Registry. American College of Radiology NRDR National Radiology Data Registry website. https://nrdr.acr.org/Portal/Nrdr/Main/page.aspx. Accessed January 16, 2017.
24. Centers for Medicare & Medicaid Services. Appropriate use criteria program. Centers for Medicare & Medicaid Services website. https://www.cms.gov/Medicare/Quality-Initiatives-Patient-Assessment-Instruments/Appropriate-Use-Criteria-Program/index.html. Published December 9, 2016. Accessed January 16, 2017.