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Letter to the Editor

Letter to the Editor—Comments on the Use of LOINC and SNOMED CT for Representing Nursing Data

We are writing in response to Keenan et al.'s article (2017), "A Shovel-Ready Solution to Fill the Nursing Data Gap in the Interdisciplinary Clinical Picture," in which the authors recommend that the American Academy of Nursing (AAN) should update its 2014 recommendations (Clancy et al., 2014) for using the SNOMED CT and Logical Observation Identifiers Names and Codes (LOINC©) terminologies in favor of a tool such as the Hands-on Automated Nursing Data System (HANDS). HANDS is a commercial software module for collecting nursing data that requires custom interfaces to connect with electronic health record systems (EHRs). To start, it is important to distinguish between terminologies and software. Standard terminologies, including the NANDA International (NANDA-I) diagnoses, the Nursing Intervention Classification (NIC) interventions, the Nursing Outcome Classification (NOC) outcomes, SNOMED CT and LOINC, are intended to be technology-neutral. Although HANDS uses standard terminologies (NIC, NOC and NANDA-I), it is proprietary software, and it would be highly inappropriate for organizations such as the AAN to recommend use of a specific commercial product.

We maintain that AAN should continue to support the use of LOINC and SNOMED CT to enable interoperability of nursing data for several reasons: (1) LOINC and SNOMED CT are complementary terminologies that already contain a significant amount of nursing content, including nursing assessments that are not included in nursing-specific terminologies; (2) LOINC is free for use worldwide under the LOINC license, and SNOMED CT is free for use in countries and territories that are members of SNOMED International (such as the United States); (3) Both terminologies use an open development process that provides a straightforward means to request new content if gaps are found; (4) LOINC and SNOMED CT have already been widely adopted in clinical systems on a global scale; and (5) Both LOINC and SNOMED CT are discipline-agnostic so that patient-focused data across the spectrum can be collected and analyzed together rather than in individual silos for each discipline. Clinical care does not occur in discipline-specific silos, and neither should outcomes research using "big data" that is intended to improve clinical outcomes. We discuss each of these points in more detail below, primarily with a focus on LOINC, and starting with a brief clarification on the use of LOINC and SNOMED CT together.

LOINC and SNOMED CT are complementary terminology standards that are both required by the Meaningful Use regulations in the United States as well as eHealth initiatives in other countries. In July 2013, the Regenstrief Institute, Inc., which maintains the LOINC terminology, and SNOMED International (formerly known as IHTSDO) signed a landmark long-term collaboration agreement to align how LOINC and SNOMED CT represent laboratory tests and some types of clinical measurements (Regenstrief Institute and SNOMED International, 2013). In general, LOINC is used to represent the observation being collected (the "question") and SNOMED CT is used for the observation value (the "answer"). For example, LOINC code 80345-2 "Pressure points examined" would be used to record the SNOMED CT values for the anatomical locations, such as occiput, elbow or heel, that were evaluated during a nursing skin assessment. Quantitative observations, such as diastolic blood pressure or the width of a wound, are typically recorded using LOINC codes with numeric results as the observation values. Other parts of the EHR, such as the Problem List, use SNOMED CT codes to record diagnoses, symptoms, and other "problems."

Implementing standard terminologies can consume a significant, but largely invisible, amount of resources at healthcare organizations. With each additional terminology comes a major increase in implementation cost. It is important to recognize that most organizations implement standard vocabularies "behind the scenes." On the user interface, clinicians see the preferred labels for variables that they are used to. Inside the EHR, those variables are linked to the standard codes that are understood by other computer systems made by different vendors. Using standards to represent the variables already capturing nursing data is far more feasible for most institutions compared to purchasing and implementing new terminologies and software tools, such as HANDS, and then building a custom interface to their EHR. The Minnesota eHealth Initiative, the American Nurses Association (ANA), and the Office of the National Coordinator (ONC) all support use of any of the ANA recognized terminologies (Minnesota Department of Health, 2014; American Nurses Association, 2015; Office of the National Coordinator for health Information Technology, 2015), such as NIC, NOC, and NANDA-I, and we are not suggesting that these terminologies should not be used within EHR systems. However, when exchanging data or building a clinical data

warehouse, LOINC and SNOMED CT should be used. If these terminologies had updated mappings to LOINC and SNOMED CT, then implementing both would be feasible without additional costs.

Furthermore, both LOINC and SNOMED CT are already widely adopted. Commercial and open-source EHR systems used around the world already have the capability ofbrk linking local variables to these standards and can readily output them in common data exchange formats such as HL7 messages and the Consolidated CDA standard, as required by the Meaningful Use regulations. LOINC is free to use for both commercial and noncommercial purposes under the LOINC license. Today, it is used by more than 44,000 users from 172 countries and is a national standard in nearly 30 countries. It has been translated into 18 variants of 12 languages and is used by healthcare organizations, reference laboratories, ministries of health and other federal agencies, professional societies, healthcare information exchange networks, insurance companies, healthcare IT vendors, instrument manufacturers, health application developers, and more (Vreeman, Chiaravalloti, Hook, & McDonald, 2012). SNOMED International currently has 29 member countries, in which SNOMED CT is free to use under the SNOMED license, and has also issued affiliate licenses to more than 5,000 individuals and organizations. It is used in over 50 countries and also has translations that are managed by member countries (SNOMED International, 2017).

Keenan et al. assert that "on a policy level, (HANDS) aligns with the nation's interoperability roadmap for health information technology," citing the ONC national interoperability roadmap. Yet, the final version of that roadmap clearly asserts guiding principles such as (a) building upon the existing health IT infrastructure and (b) "One size does not fit all … interoperability …does not require that each stakeholder implement exactly the same technology" (ONC, 2016a). In addition, the roadmap notes LOINC and SNOMED CT (along with RxNorm for medications) as vocabulary standards that are already adopted by the HHS Secretary. The roadmap recommends terminologies rather than a specific technology. Furthermore, the ONC's 2017 Interoperability Standards Advisory lists LOINC as the vocabulary standard for observations (questions) in 22 different domains, including for representing nursing assessments and outcomes. Similarly, SNOMED CT is listed as the vocabulary for observation values (answers) across many domains, including nursing (ONC, 2016b). In addition, all of the electronic Clinical Quality Measures developed for use in Centers for Medicare and Medicaid Services (CMS) programs identify the clinical variables in the measures using the standards adopted by ONC, including LOINC and SNOMED CT (CMS, ONC, & U.S. Department of Health and Human Services, 2017). And finally, like the AAN, the ANA has adopted an official policy, *Inclusion of Recognized Terminologies within EHRs and other Health Information Technology Solutions* that advocates the use of LOINC and SNOMED CT when exchanging nursing data between settings (Monsen, Honey, & Wilson, 2010).

Keenan et al. noted that LOINC has limited coverage of nursing concepts and while it has "expanded to include some nursing assessments …and outcomes," it "focuses on laboratory medicine testing and reporting" (Keenan et al., 2017). It is true that the first release of LOINC in May 1995 contained only terms for laboratory testing, but by December of 1996, LOINC had already added about 1,500 clinical terms. Now, more than 20 years and 58 releases later, LOINC has had significant growth and adoption in other domains, including radiology, standardized survey instruments, clinical documents, nursing management data, and nursing assessments. The LOINC 2.59 release in February 2017, LOINC contains over 700 active terms from recognized nursing data standards (see these LOINC terms here: http://search.loinc.org/search.zul?query=class%3Anurs*), including concepts from the Clinical Care Classification (Saba, 2012) Omaha System (Omaha System, n.d.), and Nursing Management Minimum Data Set (Huber, Schumacher, & Delaney, 1997; Westra et al., 2010). In addition, the LOINC Nursing Physiologic Assessment Panel (direct link: https://loinc.org/80346-0) contains over 300 concepts to record nursing observations. These observations are not included in nursing-specific terminologies.

Keenan and colleagues also claim that there is "no present method to identify which assessments need to be added to best support nurses documentation" in LOINC. Both LOINC and SNOMED CT are managed as openly-developed standards. Indeed, nearly all of the content additions to these standards come from end user requests. We note several published examples of how others have successfully identified gaps in content, requested new concepts be created, and implemented the new concepts in their EHR systems. In 2015, Harris et al. reported a multicenter collaboration in which nursing flowsheets from all of the participating organizations were analyzed in order to come up with a common list of variables that were subsequently mapped to SNOMED CT and LOINC concepts. Where no appropriate codes existed, new concepts were requested from each organization and incorporated into the EHRs. Ultimately, some of the existing and new content was used to collect data for a National Quality Forum eMeasure (Harris et al., 2015). Similarly, Matney et al. gathered 100 common nursing assessment data elements from several institutions' EHRs, mapped them to SNOMED CT and LOINC when possible, and requested new concepts from the respective organizations where gaps existed. Upon completion of this work, they determined that this set of data elements coded with LOINC and SNOMED CT would facilitate interoperable nursing information exchange, research across institutions, and provide a framework for nursing big data analysis (Matney et al., 2016).

We challenge Keenan et al.'s repeated assertion that there is no evidence to suggest that LOINC and SNOMED CT produce interoperable data. A search for "LOINC" in PubMed reveals 205 papers, and Google Scholar returns more than 5,500. Specifically, Keenan et al. fail to mention the 2015 paper "Exemplars for Advancing Standardized Terminology in Nursing to Achieve Sharable, Comparable Quality Data

Based Upon Evidence" by McCormick et al. (2015), which specifically discusses how three large healthcare organizations (Partners HealthCare, Intermountain Healthcare, and Kaiser/VA) use LOINC and SNOMED CT for exactly this purpose, including outlining a 10-step, repeatable process to aggregate and harmonize nursing data using SNOMED CT and LOINC. Like these organizations, we at the Regenstrief Institute have long been reaping the benefits of interoperable data using LOINC and SNOMED CT. For more than 20 years, clinicians, public health professionals, and researchers have been leveraging the integrated information infrastructure of the Indiana Network for Patient Care (McDonald et al., 2005), one of the most comprehensive and longest tenured health information exchanges in the country. Stitching together billions of discrete observations for millions of patients from about 100 institutions, the INPC is a humongous repository and a rich resource for clinical care and research. The secret to integrating all of these data sources from disparate systems is, of course, the hard but often invisible work of committing to exchange standards like HL7 and vocabulary standards like LOINC and SNOMED CT. A recent review (Dixon, Whipple, Lajiness, & Murray, 2016) characterized over 190 studies demonstrating how this infrastructure enables data captured for routine clinical purposes to be utilized for observational studies, health services research, and comparative effectiveness research. Whether enabling a regional infection control network (Kho et al., 2013), a successful primary care-based research network (Kho, Zafar, & Tierney, 2007), or supporting a novel and effective model of primary care for low-income seniors (catalyzed by a nurse practitioner) (Counsell, Callahan, Buttar, Clark, & Frank, 2006; Counsell et al., 2007), or a host of other innovations and discoveries, vocabulary standards like LOINC are key to making data from disparate systems sharable and actionable in the INPC. Making data sharable and comparable is exactly the reason why all of the contemporary large-scale research networks (e.g., PCORnet, OMOP, OHDSI) use LOINC and SNOMED CT in their common data models.

Finally, the multidisciplinary care needed today cannot succeed if data are collected and stored in domain-specific silos. This reality is embodied by the comprehensive shared care plan (CSCP), a multidisciplinary plan for care coordination to address an individual patient's needs across settings and over time. The CSCP was developed based on input from physicians, nurses, policymakers, and patient advocates. (Baker et al., 2016) Dr. Keenan and her colleagues are advocating for nursing-specific tools and terminologies, but such approaches will lead to further domain-specific isolation when we desperately need data integration. Both LOINC and SNOMED CT are domain-agnostic; their scope is all of health, not any one discipline. For example, LOINC has continued to grow across domains and is collaborating with other standards organizations to further interoperability. Some current efforts include work with the Radiological Society of North America (RSNA) to harmonize their radiology procedure codes with LOINC, with IEEE to map medical device codes to LOINC, the American Physical Therapy Association (APTA) to standardize their Outcomes Registry using LOINC. In addition, work with the Centers for Medicare and Medicaid Services (CMS) is underway to update the current LOINC representation of CMS Post-Acute Care (PAC) assessments and create new LOINC representations for CMS PAC assessments not currently represented in LOINC. This collaboration includes the Nursing Home Minimum Data Set (MDS), Long-term Care Hospital CARE Data Set (LCDS), In-Patient Rehabilitation Facility Patient Assessment Instrument (IRF-PAI), and the Home Health Outcome and Assessment Information Set (OASIS). The CMS-required assessment instruments exemplify how broad terminologies can represent and support multidisciplinary care. Whether the pain assessment is captured by the physical therapist, nurse, occupational therapist, or other provider, we all want that data to be represented in a common standard vocabulary.

In conclusion, we strongly support AAN's 2014 call to action and recommendations for using LOINC and SNOMED CT to represent nursing data in EHR systems. And we are not alone. In addition to the examples already given, we note that key national nursing and informatics organizations, healthcare systems, and industry leaders have re-affirmed their support of the AAN recommendations at the yearly Nursing Knowledge: Big Data Conference (University of Minnesota, 2016). Use of these international standard terminologies is already creating interoperable nursing data, and we believe that they hold tremendous promise for research and improved patient outcomes by enabling analysis of big data from across institutions and domains.

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