

SNOMED CT: ELECTRONIC HEALTH RECORD ENHANCES ANESTHESIA PATIENT SAFETY

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This article discusses the importance of electronic health records (EHRs) in anesthesiology, emphasizing the critical role of standardized clinical terminology in the EHR's structure. SNOMED Clinical Terms (SNOMED CT), developed by SNOMED International, a division of the College of American Pathologists, in collaboration with the United Kingdom's National Health Service, offers a controlled healthcare terminology with comprehensive coverage of diseases, clinical findings, etiologies, therapies, procedures, and outcomes. Recommended as the core general terminology for electronic patient medical record information in the United States, it offers flexibility in expressing clinical concepts, enabling clinicians to say things in multiple ways and still be understood.

SNOMED CT's comprehensive, scientifically validated

clinical terminology enables a consistent way of capturing, sharing, and aggregating health data across specialties and sites of care. Its benefits range from facilitating system interoperability to allowing greater shared access to patient health information where and when it is needed.

The article concludes by informing readers of access to English and Spanish language editions of SNOMED CT's core content, which recently was licensed through the National Library of Medicine, a part of the National Institutes of Health within Department of Health and Human Services.

Key words: Anesthesia record, electronic health information, health record, patient information system, standardized clinical terminology.

Clinicians and information technology experts have made steady progress toward developing fully electronic health information systems, particularly in anesthesia. However, because third-generation electronic health record (EHR) systems emerged on the market in 2004, a standard clinical terminology or reference set of clinical concepts is needed to support clinical documentation, decision support, and workflow.¹

Standardized terminology is not used uniformly in medicine. Clinicians often use different terms to mean the same thing or the same term to mean different things. Standardization using a concept-based clinical terminology resolves this situation by creating a common platform for anesthesia providers and other practitioners to provide care while allowing a basis for comparison and communication.

Standardized clinical terminology offers anesthesia providers clarity and precision in conveying what they mean. For example, cholecystectomy may be performed as an open procedure or with a laparoscope. Using a comprehensive standard terminology to describe these procedures allows anesthesia providers to explicitly and accurately express the intraoperative care needed for both open cholecystectomy and laparoscopic cholecystectomy. It helps define and, thus, identify patients at risk, such as those who might be susceptible to malignant hyperthermia

because of family or individual history, and allows for the retrieval and aggregation of more complete and useful data for analysis of patients, disease states, treatments, and outcomes—something conventional paper records make difficult at best.

Consider this scenario: Research indicates that patients taking medications that contain nitric oxide, such as the popular impotence treatment, sildenafil citrate (Viagra), are at risk of dangerously low blood pressure levels during surgery. The combination of the nitric oxide with the use of anesthesia and other drugs used or administered intraoperatively can mitigate the effectiveness of drugs used to raise low blood pressure and produce a host of short- and long-term side effects ranging from poor circulation to kidneys and heart failure. By using an information system that incorporates standardized clinical terminology, anesthesia providers or other clinicians could more readily review the medical records of patients scheduled for surgery and taking medications containing nitric oxide, such as Viagra, and advise them to discontinue use of the medication for at least 24 hours before surgery. Of course, the electronic format of the record does not obviate the need for the clinician to authenticate, confirm, and update vital patient information in the patient record. Nevertheless, as this example attempts to illustrate, the electronic format helps to improve patient safety by enabling anesthesia providers with the capability to search for and act on risk factors that could influence the outcome of surgery.

Coordination and continuity of care typically necessitate that relevant information about a patient be integrated from several different clinicians and settings of care. The divergent health information technologies used within and across settings, however, presents an added hurdle that must be leaped before accurate and reliable electronic communication of medical information can occur.

The Health Information Portability and Accountability Act also presents significant legal and regulatory hurdles that, for the foreseeable future, add substantial privacy, electronic security, and cost challenges to the use of electronic records. However, as organizations develop technical solutions to deal with these issues, they will still need a technical solution for enabling the exchange and integration of health information from divergent information technologies across settings. A standardized clinical terminology, such as SNOMED Clinical Terms (SNOMED CT), makes leaping this hurdle possible by enabling system interoperability, that is, the ability for data to be exchanged between systems, regardless of the technology used. Without standardization, custom interfaces and other workarounds become necessary, which make sharing, comparing, and retrieving patient or population-based data within and among different settings and information systems difficult at best, error prone at worst.

The importance of an EHR in anesthesiology

Digitized data in an EHR is fast becoming one of the most fundamental components of modern medicine. For anesthesia providers and other practitioners, it offers access to critical patient-specific information. Drug allergies, comorbid conditions, and pertinent historical information, such as abnormal reactions to previous anesthesia, can be accessed where and when needed for complete and consistent documentation.

An EHR facilitates effective communication within and across healthcare settings and organizations. For example, identifying patients who are at risk for malignant hyperthermia remains extremely difficult when medical records are in a paper format. Part of the problem stems from inconsistent and incomplete documentation of the relevant patient information. An EHR enables data to be entered in a consistent and more complete manner, which, in turn, enables it to be retrieved in a consistent manner and used over and over again. For example, EHR systems are often typically designed with built-in prompts to remind users to enter required information. Moreover, these systems typically will not allow users to proceed unless the required information is provided.

An EHR also allows for more efficient and effica-

cious care delivery among the team of primary care providers, specialists, nurses, pharmacists, and others involved in a patient's care. Having a digitized record at your fingertips helps avoid duplicate tests and procedures, saving time and healthcare expense. Other advantages include the following:

- More rapid information retrieval—depending, of course, on timely, complete, and accurate data entry;
- Enhanced readability;
- Reduced record-keeping costs;
- Reduced or eliminated duplicate records;
- Reduced storage costs; and
- Continuity of record-keeping.

An EHR also helps create and support much needed research databases within a healthcare enterprise. Researchers in anesthesiology can draw on de-identified patient data from such a database for a wide range of healthcare quality and safety-related efforts, including the following:

- Quality management, such as preventing complications through more complete and more accurate presurgical patient histories;
- Outcomes studies, for example, analyzing cases in which fever occurred during or after anesthesia administration;
- Quality improvement projects, such as further refining the ASA physical status classifications by drawing on an entire population of patients who have undergone anesthesia, rather than a smaller study population;
- Benchmarking and identifying best practices, like identifying more appropriate doses of medications and other anesthetic agents;
- Public health initiatives; and
- Patient safety efforts, for example, reducing complications due to the use of certain anesthetic agents.

Anesthesia providers acknowledge that contemporary healthcare practice has grown increasingly complex, is highly information-dependent, and requires effective communication among all caregivers who treat a patient at any point in the patient's life, not only during a single episode of surgical anesthesia. However, in the United States alone, current estimates put the use of electronic anesthesia records at less than 3%.

Electronic health information in anesthesiology, starting with an electronic anesthesia health record, has the potential to provide the right information to anesthesia providers when and where they need it, thereby reducing errors, improving the quality of anesthesia care, helping to identify opportunities to increase the efficiency of care, and bringing about changes in anesthesia practice through shared knowledge and evidence-based data.

Standardized clinical terminology: The backbone of an EHR

Standardized clinical terminology is the content backbone of the EHR, reducing the variability in the way data are captured, encoded, and used for the clinical care of patients and medical research. The Institute of Medicine Committee on Data Standards for Patient Safety noted in its report that “[h]aving clinical data represented with standardized terminology and in a machine readable format would reduce the significant (population health management) data collection burden at the provider level, as well as associated costs, and would likely increase the accuracy of data reported.”²

Many clinicians involved in implementing EHRs consider SNOMED CT to have distinct advantages that make it more clinically useful than other clinical terminology code sets. Developed by SNOMED International, a division of the College of American Pathologists (CAP), in collaboration with the United Kingdom’s National Health Service, SNOMED CT’s controlled healthcare terminology includes comprehensive coverage of diseases, clinical findings, therapies, procedures, and outcomes. It provides the core general terminology for an EHR, containing more than 366,000 concepts with unique meanings and formal logic-based definitions organized into hierarchies.

SNOMED CT’s more than 993,000 English-language descriptions or synonyms offer flexibility in expressing clinical concepts, enabling clinicians to say things in multiple ways and still be understood. The digital repository of coded text and images within the EHR create a searchable, virtual filing system. With greater than 1.46 million relationships among clinical concepts, the core terminology makes retrieval easier and more reliable and consistent than plodding through paper records. And searches can be executed by any of the defining relationships within the terminology.

Consider this example: An anesthesia provider decides to conduct a research study on blood vessel procedures and searches the SNOMED CT-driven EHRs using the phrase “blood vessels.” The search results will include specialized procedures, such as epidural venographies, as well as more common procedures conducted on blood vessels, such as intravenous injection. Part of SNOMED CT’s power lies in the relationships built into its core clinical concepts.

Industry recognition and use

A number of prominent standards development organizations recognize SNOMED CT’s sustainable, scientifically validated terminology and infrastructure, including the American National Standards

Institute, Health Level 7, and Digital Imaging and Communications in Medicine.

SNOMED CT also is gaining broader recognition by those working to establish core standards and terminologies for use in a US national health information network. As part of its efforts toward recommending patient medical record information standards, the National Committee on Vital and Health Statistics recently recommended SNOMED CT as the general terminology for the US core set for patient medical record information because of its breadth of content, sound terminology model, and widely recognized value.³

SNOMED CT is used in a wide variety of venues and healthcare organizations, so information can be shared. These include individual clinician offices; nationwide provider organizations; government entities, such as the US Department of Veterans Affairs, the Centers for Disease Control and Prevention, and the National Aeronautics and Space Administration; medical research organizations; and major pharmaceutical organizations. Industry software leaders are integrating SNOMED CT into their healthcare applications to secure system interoperability, to enhance the sharing of electronic health information, and to improve patient safety.

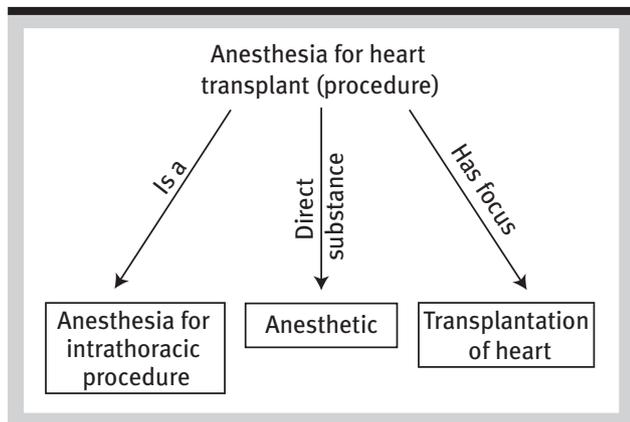
SNOMED’s work with anesthesia organizations

Four basic principles provide the foundation for SNOMED CT and guide development activities related to the core table structure and clinical content:

1. Development efforts must encompass broad, inclusive involvement of diverse clinical groups and medical informatics experts.
2. The clinical content must be quality-focused and adhere to strict editorial policies to ensure scientific and clinical validity.
3. The quality improvement process must be open to public scrutiny and vendor input to ensure that the terminology is truly useful within healthcare applications.
4. There must be minimal barriers to adoption and use.

SNOMED CT is continuously evolving and expanding its content to incorporate clinical terminology from an increasing number of specialties. Currently, SNOMED CT includes hundreds of anesthesia-specific terms, such as “anesthesia for heart transplant” (Figure 1). It also offers anesthesia providers access to more general concepts, such as those for patient history, as well as more than 52,000 procedure concepts, many of which would be useful in documenting information in an anesthesia patient record, such as “cardiomyopathy”

Figure 1. Sample anesthesia terminology in SNOMED CT



CT indicates Clinical Terms.

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(Table 1). SNOMED CT's July 2003 release included more than 300 new anesthesia concepts, and another 200 concepts have been added in 2004 and 2005. SNOMED is updating the terminology continually to keep current with the advances of healthcare. Efforts are made to achieve comprehensiveness in most domain areas. For example, SNOMED has an extensive list of anesthetic drugs and monitoring device concepts at various levels of granularity. Involvement by CRNAs will help to expand the overall content.

SNOMED works collaboratively with The Royal College of Anaesthetists, the Anesthesia Patient Safety Foundation (APSF), the National Health Service Information Authority in the United Kingdom, and the Association of periOperative Registered Nurses (AORN), to broaden and improve the anesthesia content.

The CAP's collaborative agreement with AORN has integrated and mapped the Perioperative Nursing Data Set (PNDS) content to SNOMED CT. This extends the functionality of the PNDS for consistent and complete case retrieval and fosters more coordinated care (Figure 2). The PNDS is recognized throughout nursing as the principal standardized nursing vocabulary used at the point of care to document diagnoses, interventions, and outcomes specific to the perioperative patient experience.

This perioperative content is now enhanced with expanded patient-specific intraoperative content. In October 2003, the CAP signed a 5-year collaboration agreement with the APSF to continue to enhance the anesthesia content currently available in SNOMED CT's core content. The collaboration will help support documentation in the operating room, improving data collection and analysis to reduce anesthetic errors and increase patient safety.

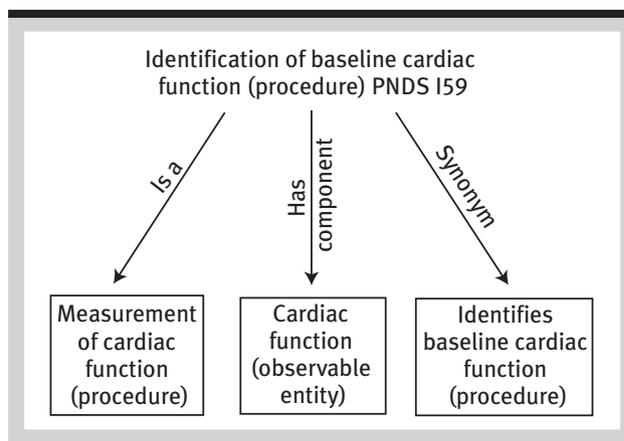
Table 1. SNOMED CT's application for documenting anesthesia care in the patient record

Preoperative diagnosis	Cardiomyopathy (disorder)
Procedure	Transplantation of heart (procedure)
Intraoperative findings and measurements	Measure of urine output (observable entity) Total fluid output (observable entity) Blood pressure (observable entity)
Intraoperative procedures	Administration of IV fluids Transfusion (procedure)

CT indicates Clinical Terms; and IV, intravenous.

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Figure 2. AORN's PNDS content is integrated in and mapped to SNOMED CT content.



CT indicates Clinical Terms; AORN, Association of periOperative Registered Nurses; and PNDS, Perioperative Nursing Data Set.

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The APSF Data Dictionary Task Force will work with SNOMED to evaluate the current anesthesia content in SNOMED CT and provide recommendations for additional concepts. Combined with the surgical procedures in SNOMED CT core and the PNDS content, this will increase the ease of electronic sharing of data and improve patient safety for anesthesia care, an important goal for both the CAP and SNOMED International.

The benefits of using SNOMED CT

SNOMED CT's comprehensive, scientifically validated clinical terminology makes healthcare knowledge more usable and accessible. Its core terminology enables a consistent way of capturing, sharing, and aggregating

health data across specialties and sites of care. Conditions can be tagged for later retrieval. Ultimately, SNOMED CT offers the ability to easily access comprehensive information pertaining to the entire electronic health record, from medical history to chronic or acute illnesses to recent surgical procedures and treatments.

Multiple practitioners, no matter how diverse, can share important patient information, trigger effective treatment guidelines, and improve patient outcomes with the assurance that descriptions of diagnoses and treatments are represented consistently across all healthcare providers. And because SNOMED CT enables primary and specialty care providers and patients to share comparable data at any time, from any place, it can help to greatly reduce medical errors associated with traditional paper records.

To trigger decision support rules, different types of concepts must be linked to each other, such as allergies to drugs, procedures to devices, and diseases to contraindications. Many of the common rules draw on data that may be recorded at different times and places along the continuum of care, by different clinicians, and at varying levels of specificity. For example, clinical alerts can be created based on disease and allergy coding in relation to specific medication codes. Decision support rules built on SNOMED CT enable the development of a more sensitive and sophisticated decision support system (Table 2).

Because SNOMED CT facilitates interoperability between systems, its use can simplify data integration and reduce costs. Clinical care, decision support, and research, in addition to patient safety initiatives, rely on the same information; diseases, treatments, etiologies, clinical findings, therapies, procedures, and outcomes all become digitized. To foster efficiency, users can record data just once, at the level of specificity they choose, then mine it repeatedly for decision support, statistical reporting, outcomes measurement, evidence-based medicine, and cost analysis.

SNOMED CT is highly scalable and flexible and can be used for electronic ordering of medications and laboratory tests, genomic databases, telemedicine, public health reporting, clinical research, disease surveillance, and consumer health information services. Moreover, the kind of data sharing enabled by SNOMED CT only increases the accuracy of clinical documentation and communication.

The breadth and depth of the terminology, as well as its computer-readable hierarchies, enable faster, reliable, and consistent retrieval of clinical information based on flexible queries. This depth allows healthcare organizations to unlock the true power of healthcare information. Cases can be retrieved based on numerous criteria, including clinical and labora-

Table 2. Decision support rules built on SNOMED CT enable the development of a more sensitive and sophisticated decision support system.

- Blood transfusion reaction (disorder)
- Hypovolemia (disorder)
- Bradycardia (disorder)
- General anesthetic drug adverse reaction (disorder)

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tory findings, causative agents, anatomical structure, and therapeutic procedures.

In addition, many organizations have evaluated and selected SNOMED CT as a key component of their system infrastructure. This further ensures system interoperability and enhances the ability to share electronic health information and improve patient safety.

While SNOMED CT is comprehensive on its own, it maps to other medical classifications and terminologies already in use, such as the *International Classification of Diseases, Ninth Revision, Clinical Modification*. This avoids duplicate data capture, while facilitating enhanced health reporting, billing, and statistical analysis. SNOMED CT provides a framework to manage language dialects, clinically relevant subsets, and extensions composed of concepts and terms unique to particular organizations or localities.

The EHR comes of age

The beginning of the end to barriers for an electronic health information network is underway. The HHS announced in July 2003 that it commissioned the Institute of Medicine to design a standardized model of an EHR. The Office of the National Coordinator for Health Information Technology was established in 2004 to facilitate widespread deployment of health information technology and to implement the US Government's vision for widespread adoption of interoperable EHRs within 10 years. David J. Brailer, MD, PhD, was appointed the first National Health Information Technology Coordinator.

Also in 2004, HHS published a Request for Information, seeking input on the development of a nationwide health information network. In its report on responses to the Request for Information, HHS identified SNOMED CT along with 7 other medical coding and terminology systems that respondents recommended for a master list of standards that would provide a national baseline for electronic data exchange. The report notes that standards on the mas-

ter list could function as “the bridge between custom implementations of other standards, where translations to/from the master set would facilitate health information exchange among health applications.”⁴

In June 2005, HHS Secretary Mike Leavitt announced the formation of a public-private collaboration called the American Health Information Community and 4 requests for proposals that will advance efforts to establish common standards and pave the way for interoperability. Momentum surrounding these and other efforts to bring the promise of information technology to healthcare—specifically, enhanced safety, efficiency, and effectiveness—continues to grow.

Clearly, the availability of a standardized EHR model will help speed its more widespread implementation. For this to happen as HHS and private sector stakeholders envision, a common clinical terminology must be embedded within the EHR's structure, and the HHS took a bold step in 2003 to facilitate that objective. The National Library of Medicine, part of the National Institutes of Health within HHS, signed a 5-year contract with the CAP to license English and Spanish language editions of SNOMED CT core content.

The National Library of Medicine agreement to license SNOMED CT core content puts the consistent

and reliable sharing of healthcare information within easy reach. The promise of the electronic future has always involved making healthcare knowledge more usable and accessible wherever and whenever it is needed to enhance quality and reduce errors and risks. Now, healthcare providers will be able to realize this promise by using SNOMED CT to advance excellence in patient care and safety.

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More information about SNOMED International and how to obtain SNOMED CT can be obtained online at <http://www.snomed.org>. For additional information about the AORN and APSF, see each organization's Web site, respectively, at <http://aorn.org> and <http://www.apsf.org>.