Use of SNOMED CT in a Clinical Decision Support System for Critical Care

Maria Hendrickson, RN-BC, MSN, MSCS

Steve Kelleher, RN, BSCS

SNOMED CT Expo 2017
Bratislava | October 19-20

Objectives

Describe how SNOMED CT can be used to normalize clinical data from disparate systems for a clinical decision support system (CDSS).

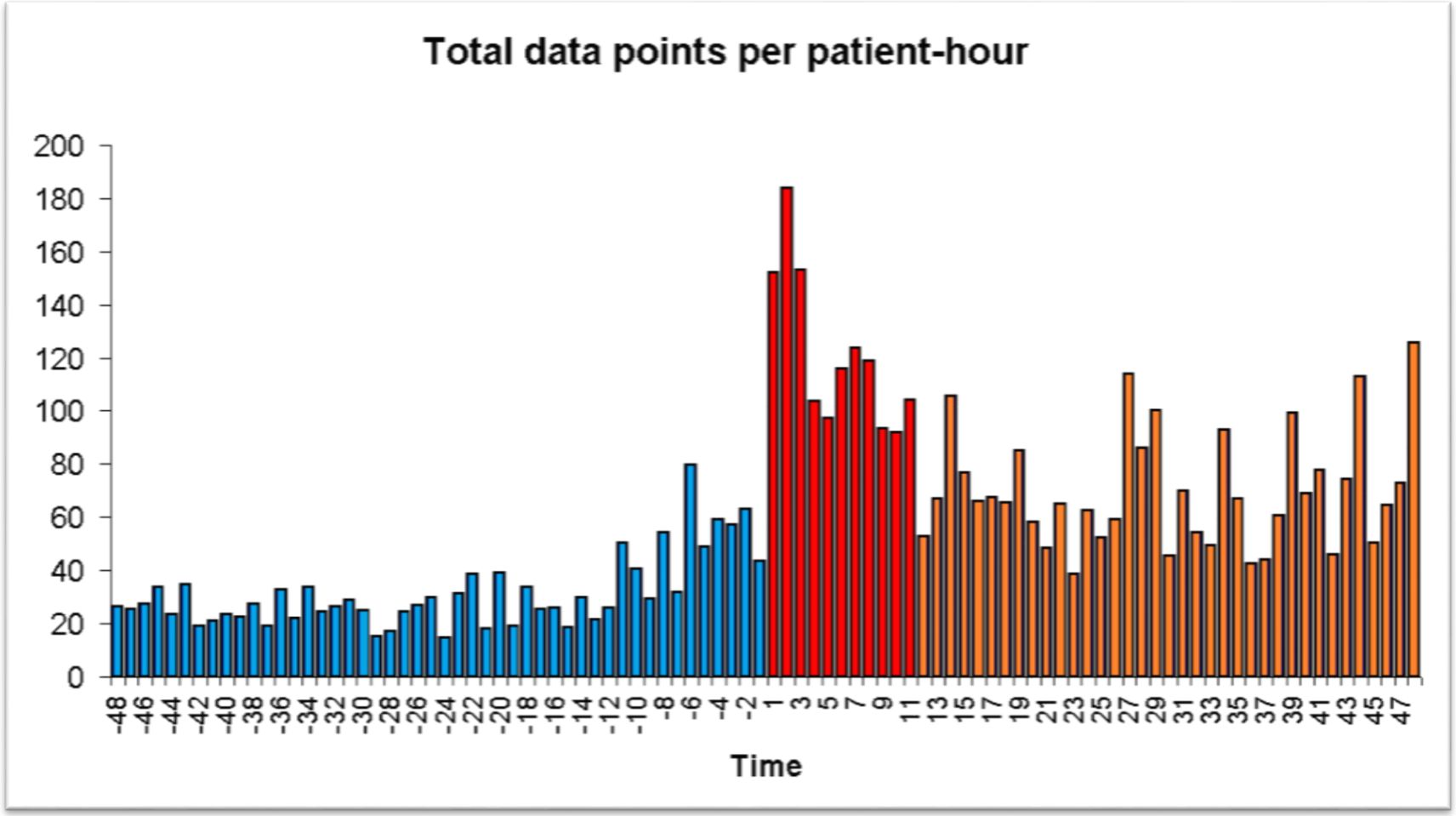
Describe how SNOMED CT can be used for intra-system communication in a CDSS.

What is Clinical Decision Support?

Clinical decision support (CDS) provides clinicians, staff, patients or other individuals with knowledge and person-specific information, intelligently filtered or presented at appropriate times, to enhance health and health care. The Office of the National Coordinator for Health Information Technology (ONC) . Clinical Decision Support (CDS). Retrieved September 28, 2017, from URL https://www.healthit.gov/policy-researchers-implementers/clinical-decision-support-cds

Clinical Decision Support is a process for enhancing health-related decisions and actions with pertinent, organized clinical knowledge and patient information to improve health and healthcare delivery. Osheroff JA et al. (2012). *Improving outcomes with clinical decision support: an implementer's guide (2nd Edition).* Chicago: Healthcare Information and Management Systems Society Press

The Challenge: Data Volume in the ICU



Microbiology, labs, medications, chest X-ray, Nurses flow sheet, Clinical notes (history and impression/plan) –

Vitals Signs excluded!

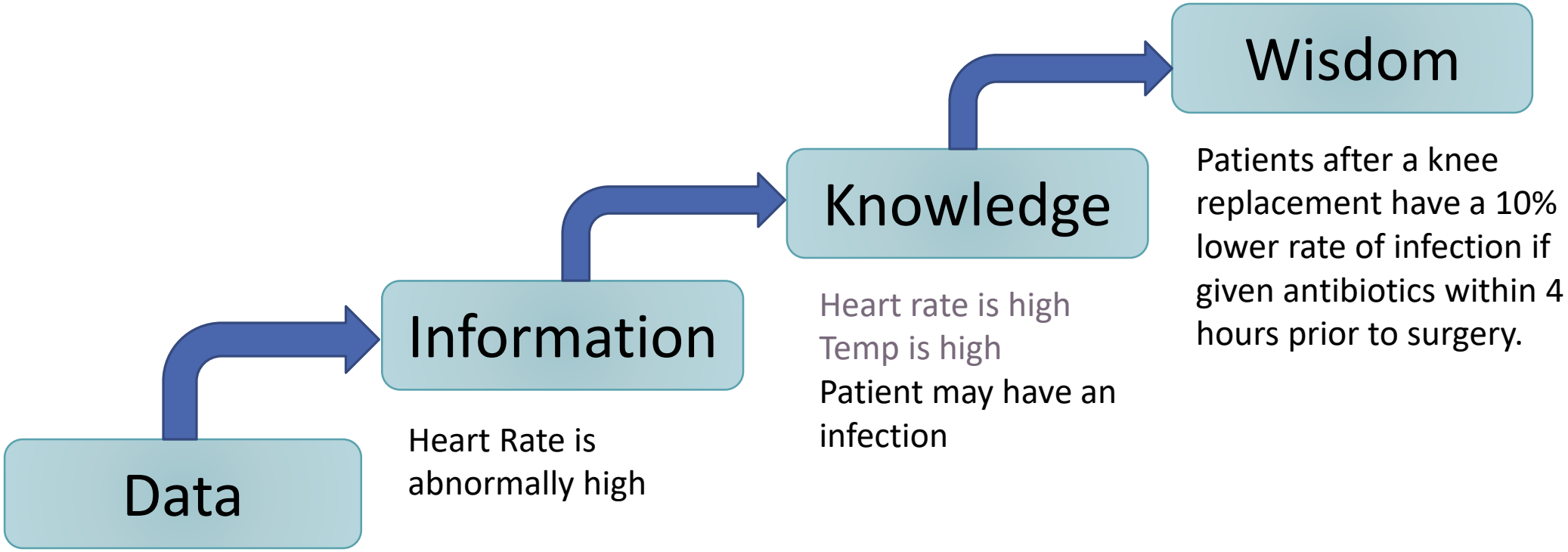
An average of 1348 points of data are collected each day per patient, with the quantity of data increasing 26% over 5 years. [1]

Day 1 represents the first day of ICU admission

Herasevich V, Litell J, Pickering B. Electronic medical records and mHealth anytime, anywhere. *Biomed Instrum Technol*. 2012 Fall;Suppl:45-8. doi: 10.2345/0899-8205-46.s2.45. PubMed PMID: 23039776.

[1] Manor-Shulman O, Beyene J, Frndova H, Parshuram CS. Quantifying the volume of documented clinical information in critical illness. *J Crit Care* 2008; 23(2): 245-250.

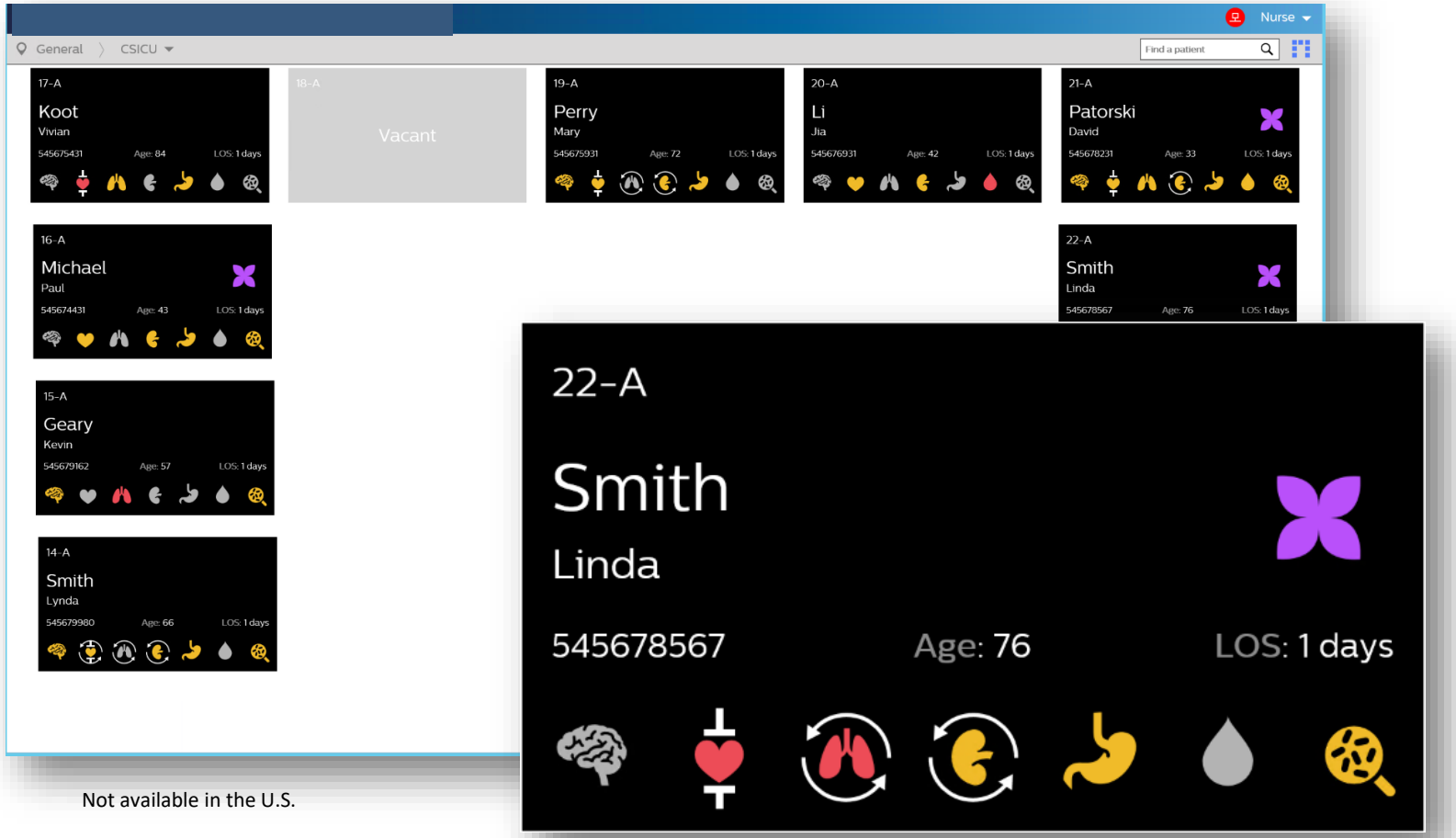
DIKW Hierarchy



Russel, L. A. (1989). From data to wisdom, *Journal of Applied Systems An*alysis,16
Zeleny, M. (1987). Management support systems: towards integrated knowledge management." *Human Systems Management,* 7

One Solution to the Challenge: A CDSS

Care Unit View



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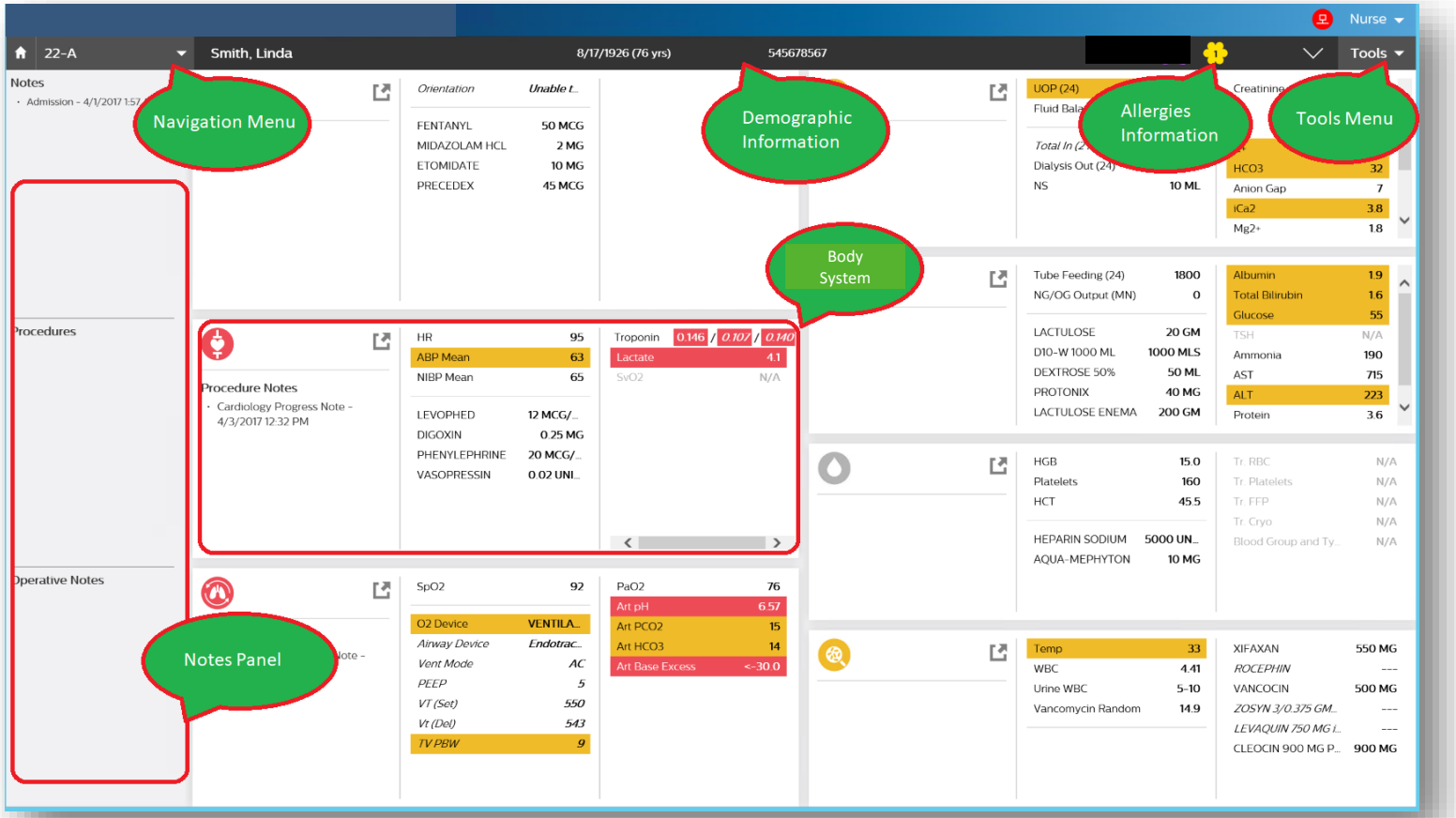
A CDSS system

- Critical care adults
- Purpose is to transform patient data into knowledge and information
- Design based upon usability and clinician data usage studies
- Supported by research grants from the USA government
- Focus of research at 3 hospitals
- Shows positive results
- Is now commercially available

Individual Patient View



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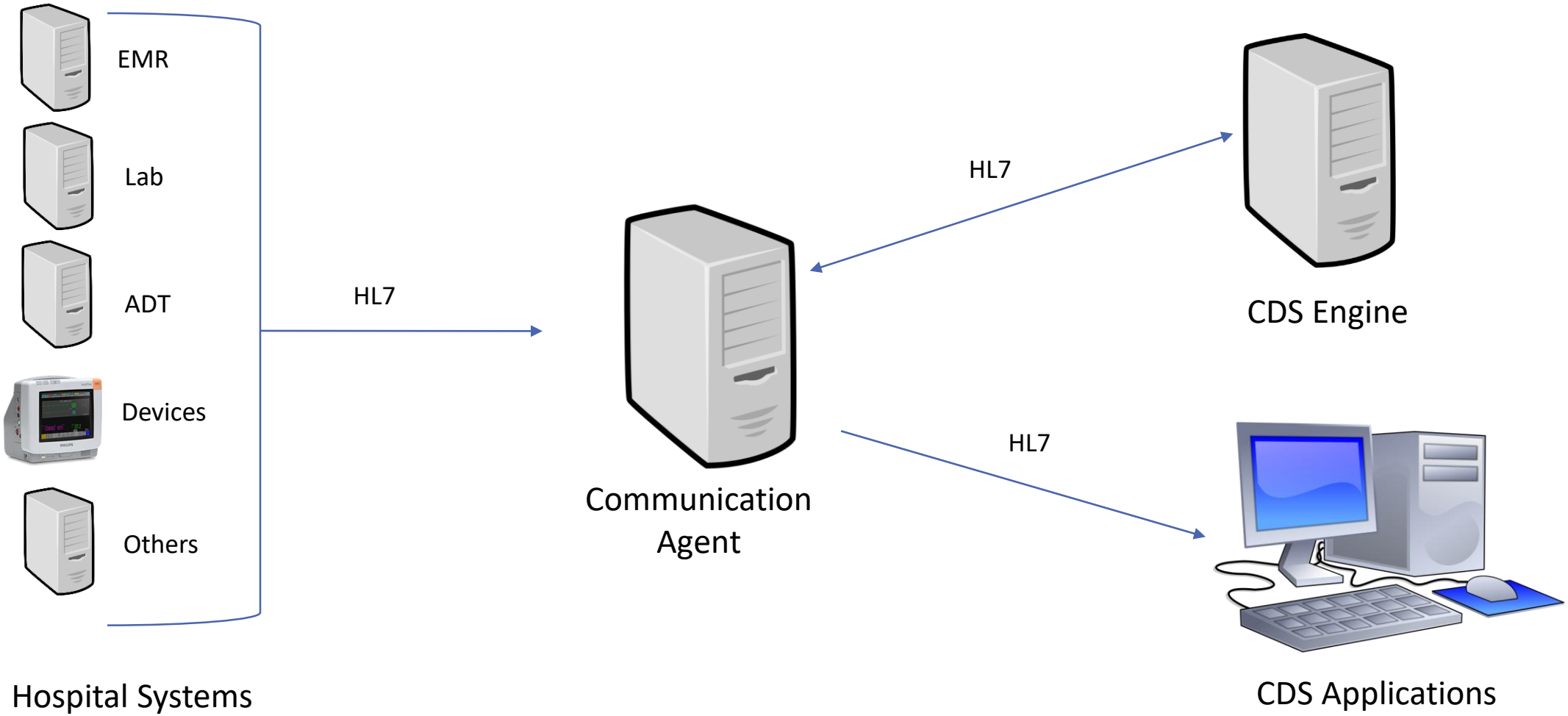
- Presents high-value relevant patient information on a single screen
- Provides more in-depth medical history and physiologic data organized by organ system and with visual cues indicating status

CDSS Topology



IT Systems to Communication Agent

- HL7 Messages to Communication Agent
  - ADT HL7 messages such as the A01, A08, A02, etc. to admit, transfer, discharge patient
  - ORU messages from EMR, devices, and labs for patient observations
  - MTM messages for documents and test reports
- IT systems data is identified by the sending system using the senders desired terminology such as LOINC
- Only those data elements pertinent to the CDS algorithms and to the application are captured

Role of Communication Agent in Inbound

- **Transform** inbound data into HL7 messages understood by the CDS engine
  - Transform inbound HL7 messages to ORU messages
  - Translates ADT messages as needed
- **Translates** inbound identifiers into SNOMED CT concepts
  - Maps any inbound identifiers to SNOMED CT using a mapping file for a fixed set of identifiers
  - Maps inbound drugs to key drug therapeutic category, based upon American Hospital Formulary Service (AHFS)
- **De-Identifies** patient data sent to the CDS engine
  - In preparation to place the CDS engine in the cloud – if desired by customers. Research program was cloud based
- **Exports** HL7 messages as ORU and ADT to the CDS Engine

Example of Customer Mapping

SNOMED CT	Name	UOM	Inbound Identifiers
59573005	Potassium measurement (procedure)	mmol/L	L14 (Basic Metabolic Panel), "Potassium^POTASSIUM" L10407 (Comprehensive Metabolic Panel), "Potassium^POTASSIUM" L174 (Potassium), "Potassium^POTASSIUM"
105011006	Blood urea nitrogen measurement (procedure)	mg/dL	L1190 (Urine, Urea Nitrogen), "Urine, Urea Nitrogen^UREA NITROGEN UR" L14 (Basic Metabolic Panel), "Urea Nitrogen^UREA NITROGEN" L10407 (Comprehensive Metabolic Panel), "Urea Nitrogen^UREA NITROGEN" L191 (Urea Nitrogen), "Urea Nitrogen^UREA NITROGEN" L10257 (Pre and Post Dialysis BUN with Kt/V Ratio), "Pre-Dialysis Urea Nitrogen^Pre-Dialysis BUN" L10257 (Pre and Post Dialysis BUN with Kt/V Ratio), "Post-Dialysis Urea Nitrogen^Post-Dialysis BUN"
25197003	Sodium measurement (procedure)	mmol/L	L10431 (Venous, Blood Gas, Comprehensive), "Venous, Sodium^Sodium, Venous" L10401 (Venous, Blood Gas, Electrolytes and Metabolites), "Venous, Sodium^Sodium, Venous" L14 (Basic Metabolic Panel), "Sodium^SODIUM" L10407 (Comprehensive Metabolic Panel), "Sodium^SODIUM" L181 (Sodium), "Sodium^SODIUM" L10429 (Capillary, Blood Gas, Comprehensive), "Capillary, Sodium^Cap Sodium" L10291 (Capillary, Blood Gas, Electrolytes and Metabolites), "Capillary, Sodium^Cap Sodium" L10427 (Arterial, Blood Gas, Comprehensive), "Arterial, Sodium^SODIUM-BLOOD GAS" L128 (Arterial, Blood Gas, Electrolytes and Metabolites), "Arterial, Sodium^SODIUM-BLOOD GAS"

Contents of file is used to configure the mapping in the communication agent

ORU message from Agent to CDS Engine

MSH|^~\&|||||20150726000524||

ORU^R01|HP0726000525998-7-842|P|2.3|||||8859/1|||Monitor

PID|||B3B604A7AD4E4A2E8D7EF321FE4B7B44^^^^MR||284CD224E2FA4475AC93395BDB28E665

PV1||I|1^9^9^1

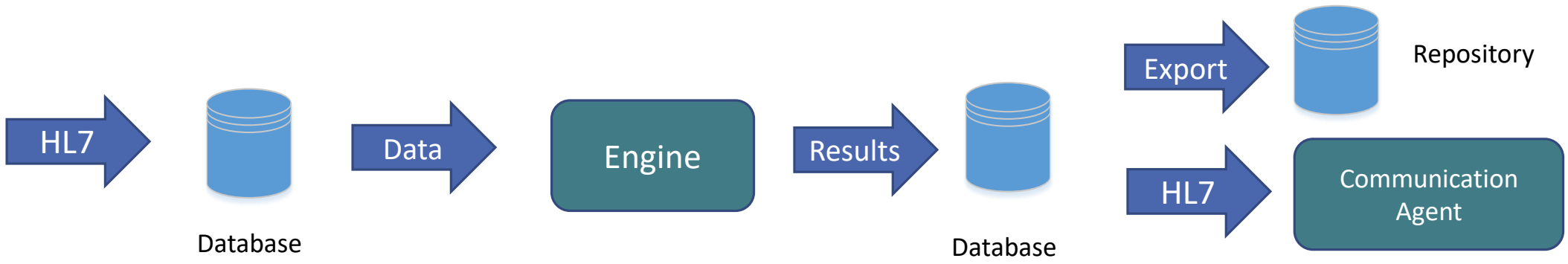
OBR|2|||364075005^Heart rate (observable entity)^SNM|||20150726000524

OBX|1|NM|364075005^Heart rate (observable entity)^SNM|0|107|||||F

OBX|3|ST|118170007^Source^SNM||Monitor

CDS Engine

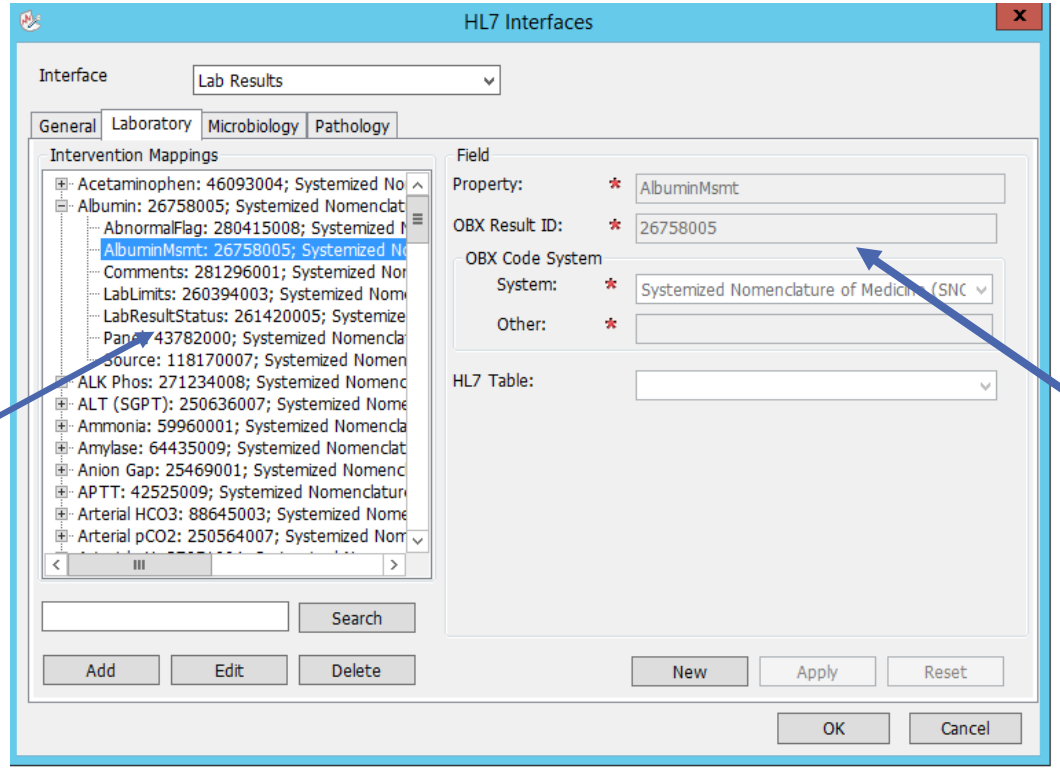
- Accepts the inbound patient data and stores it into the database.
- Inbound data is mapped to CDS engine data dictionary using SNOMED CT.
- Executes clinical algorithms on that data and generates results, stored in the database
- Results data dictionary items are tagged with SNOMED CT
- Results are exported via HL7 as ORU messages with SNOMED CT
- Inbound data and results are copied into in a data repository with SNOMED CT



CDS Algorithms

- A fixed set of algorithms as defined by the research program
- Algorithms do the following in general
  - Assigns parameter to body system
  - Identifies whether the data is normal, abnormal, or critical based upon clinical algorithms
  - Identifies whether the data is current, old, very old, or obsolete
  - Totals fluids intakes
  - Identifies the statuses of a body systems as normal, abnormal, or critical
  - Identifies whether the patient is on key therapies like vasopressor drugs or respiratory ventilation
- Algorithm Source
  - Algorithms are based upon clinical research for adult critical care patients in multiple US hospitals
  - Identify issues important to survival and recovery

Mapping SNOMED CT Inbound in Engine

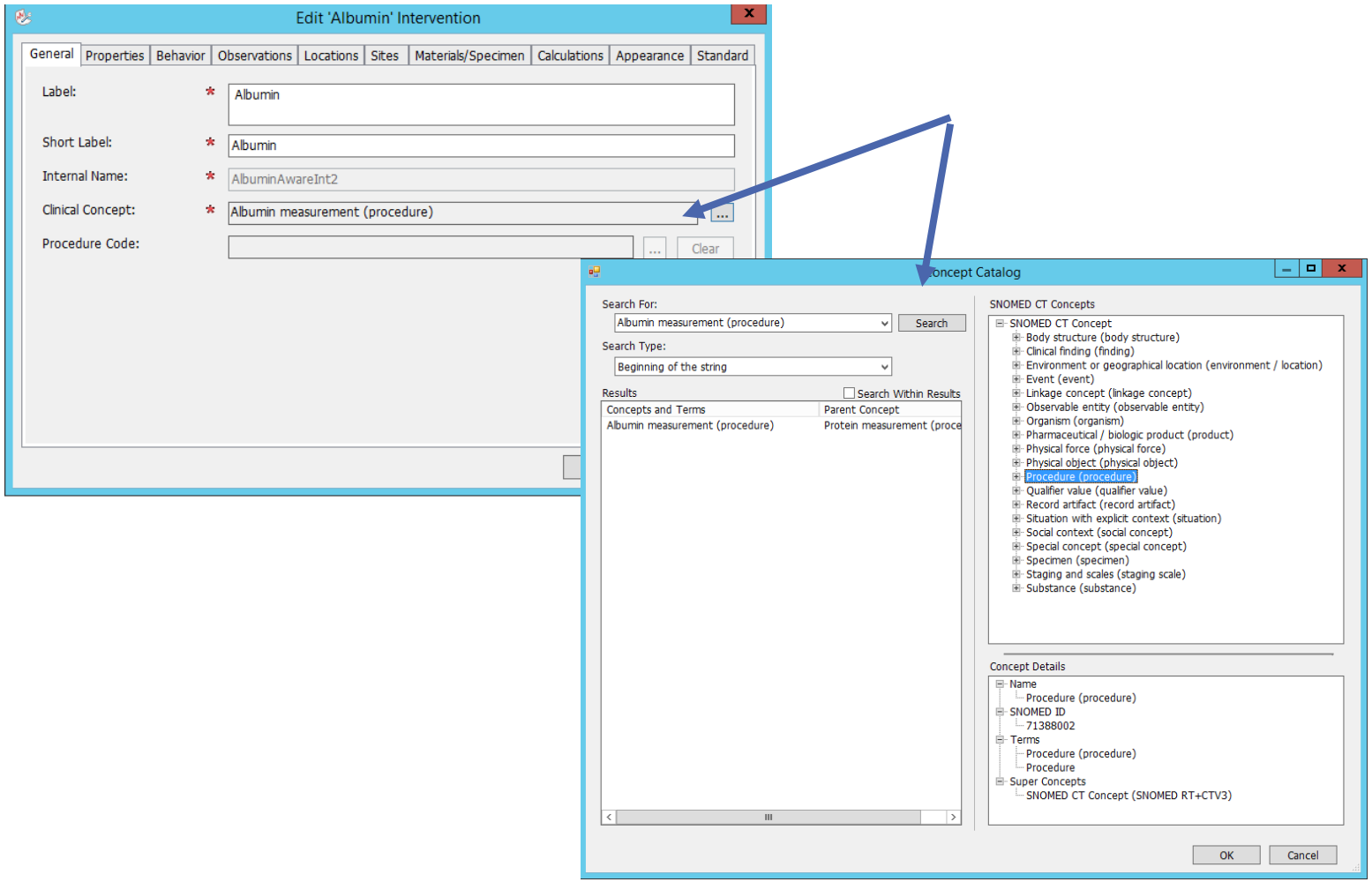


SNOMED CT

SNOMED CT

Patient data is mapped to data dictionary interventions for storing into the CDS Engine database using SNOMED CT.

Results Data Dictionary use of SNOMED CT



All outbound data is identified with SNOMED CT

Configuration Editors allow one to assign SNOMED CT concepts to resulting interventions and attributes for outbound

Example of an Outbound HL7 Message

MSH|^~\&|System.CIS.PatientResult.BL^PAPAppSvr1^DNS|Philips.CIS.CVC|||20150825181014||

PID|||04Aug_29^^^System.CIS.ADT^MR||9E0B829A514C4CB48B7E0A8B012F6127

PV1||I|1_3^^1_3_7_7

OBR|1|||26758005^Albumin^SNM|||20150825180600|||||2.7 20150825220600 Albumin 2.7 25 Aug 2015 18:06####20150825180600 CALC LAB ||||||||||||F

OBX|5|ST|278195005^BodySystem^SNM||GI|||N|||F|||20150825180500||^Services^D

OBX|6|ST|371234007^ColorRGB^SNM||rgb(255,255,0)|||N|||F|||20150825180600||^Services^D

OBX|15|ST|26758005^Result^SNM||2.7|||N|||F|||20150825180600||^Services^D

Communication Agent to Application

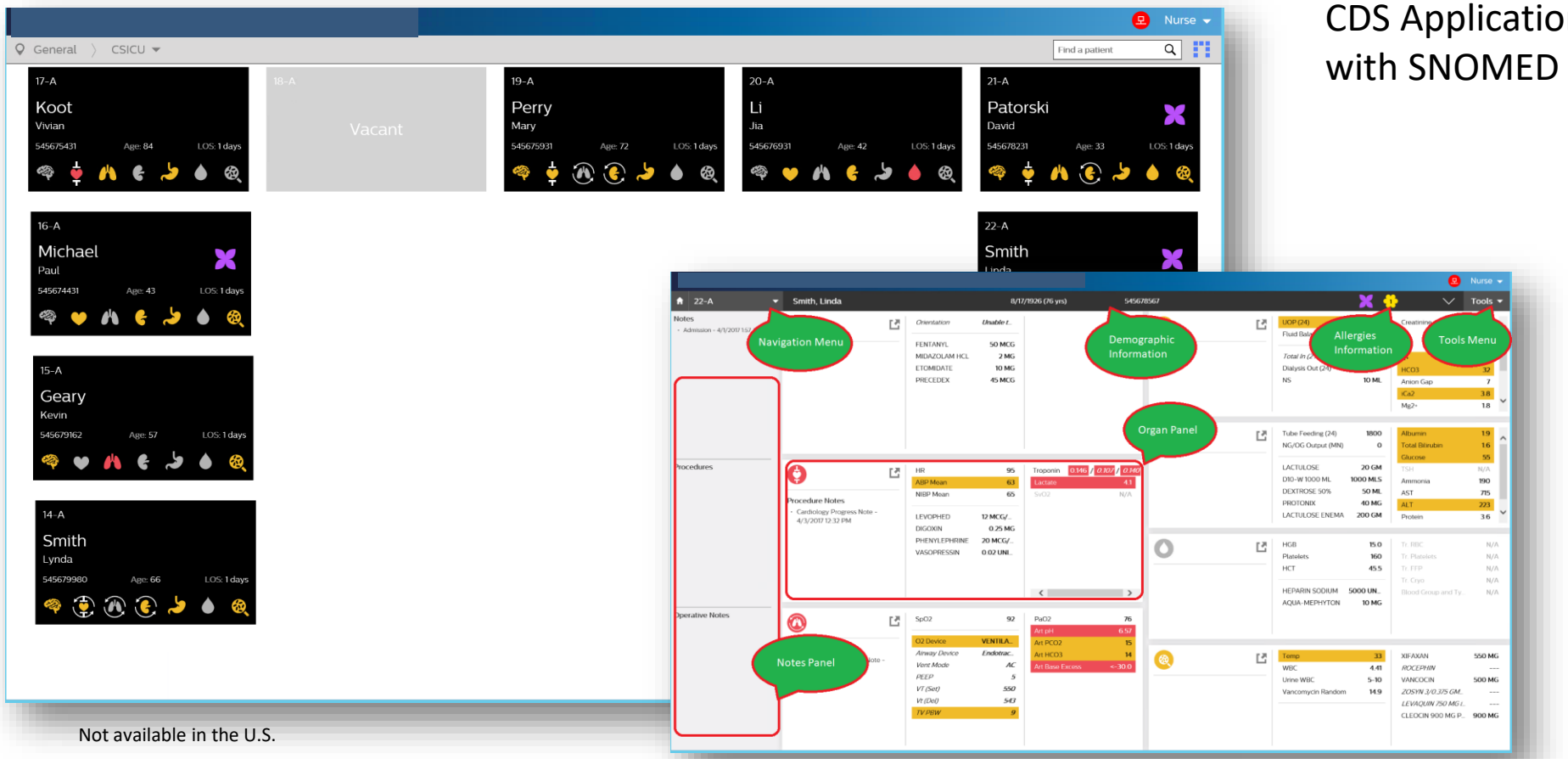
- **Re-identifies** the patient in the HL7 messages by adding medical record numbers, bed number, etc.
- **Attaches** information that was removed during anonymization
- **Sends** ADT and ORU messages to the CDS Application. All data is identified with SNOMED CT concepts in ORU messages.

CDS Application

- Admits, discharges, and transfers the patients based upon the HL7 ADT messages
- Displays patient information based upon the ORU messages from the CDS engine including
  - Intake and Output totals for current day and as trend over days
  - Patient parameters with their severity status, their age, their most recent value, and their values as a trend over days
  - The status of body systems as normal, abnormal, and critical as icons on the multi-patient view and the single patient view
  - Pertinent diagnostic reports and clinical notes along with their age
  - Key and recent therapies, medications, and procedures, pertinent to critical care

CDS Application

All patient data is stored in the CDS Application database tagged with SNOMED CT concepts



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In Summary

- The incoming data from hospital systems are mapped to a fixed set of defined SNOMED CT concepts.
- The data, tagged with SNOMED CT concepts, are processed through CDS algorithms by the CDS engine.
- The data is sent to the Applications as HL7 messages with SNOMED CT concepts to be displayed in the applications
- SNOMED CT can be used to normalize diverse inbound patient data and supports the exchange of that data among the components of the CDSS.
- SNOMED CT covers all of the concepts required for the data and the outbound results of the algorithms for these specific algorithms for critical care adult patients

References for more information

Herasevich, V., Gajic, O., and Pickering, B (2013, March 3-7). Information Technology Can Reduce Time Spent on Data Gathering Activities in the ICU. Poster presentation at HIMSS 2013 Physicians Symposium, New Orleans, LA

Manor-Shulman, O., Beyene, J., Frndova, H., & Parshuram, C. S. (2008). Quantifying the volume of documented clinical information in critical illness. *Journal of Critical Care*, 23(2), 245-250.

Olchanski, N., Dziadzko, M.A., Tiong, I.C. et al. (2017) Can a novel ICU data display positively affect patient outcomes and save lives? *J Med Syst* 41: 171. https://doi.org/10.1007/s10916-017-0810-8

Pickering, B. W., Herasevich, V., Ahmed, A., & Gajic, O. (2010). Novel representation of clinical information in the ICU: developing user interfaces which reduce information overload. *Appl Clin Inform*, 1(2), 116-131.

Thank You

Questions?

Feel free to contact me with questions at

Maria.Hendrickson@Philips.com