Building a Perioperative Data Warehouse

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Mount Sinai

Disclosures

- None

Outline

- Overview and general considerations
- Sinai experience
- Vanderbilt experience
- Summary and wrapup

Define: Data Warehouse

da·ta ware·house

noun COMPUTING

noun: **data warehouse**; plural noun: **data warehouses.**

1 a large store of data accumulated from a wide range of sources within a company and used to guide management decisions.

https://www.google.com/search?num=20&site=&source=hp&q=define%3A+data+warehouse&oq=define%3A

Define:Perioperative data warehouse

1 a large store of data accumulated from a wide range of sources within a health care organization and used to?

- support/enable PQRS reporting
- support/enable departmental or hospital PI/QA
- support/enable research
- archive data from legacy AIMS systems
- support Perioperative Surgical Home?

Tools for building a periop DW

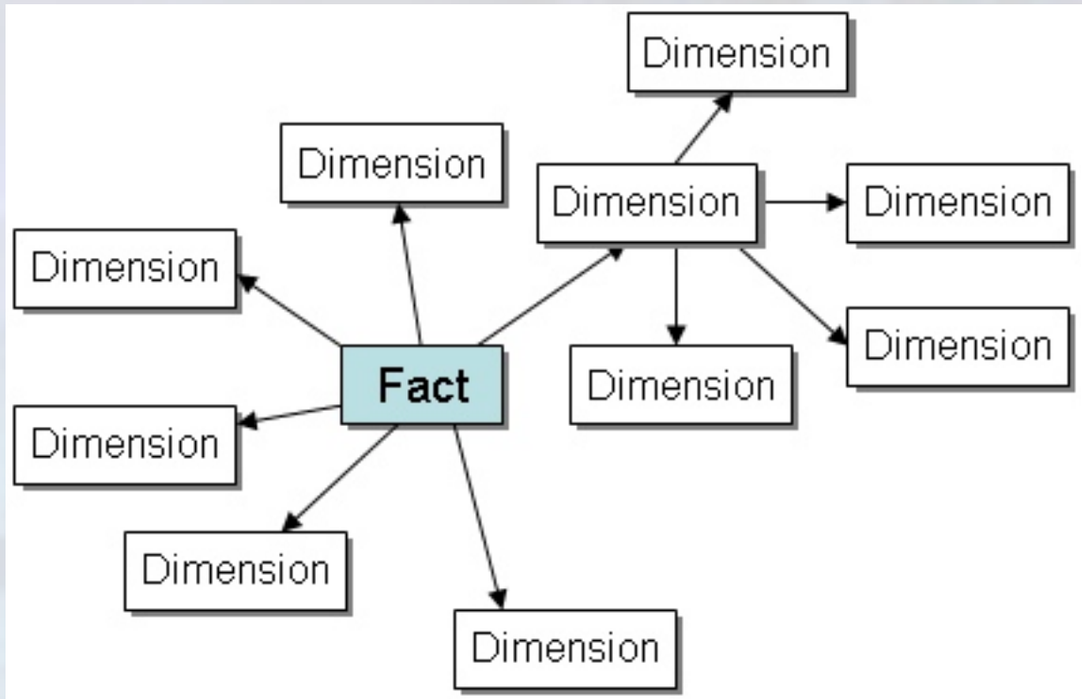
- People
- Support
- Hardware
- Software

Challenges

- Getting data out of AIMS
- Integrating hospital data
- Integrating non-hospital data
- Validation/cleaning/phenotyping
- Ongoing HW/SW support
- Who will pay for all of this??

Dimensional vs Normalized Approach

- **Dimensional aka "star schema"**
  - single "fact" table, many reference "dimension" tables
- **Normalized**
  - like a regular relational database
- **Pluses and Minuses to each**



Is my AIMS a periop DW?

- AIMS is a tool for intraop charting
- AIMS usually only includes limited periop data
- AIMS reporting may be limited to pre-built reports
- AIMS cannot archive from other AIMS systems (e.g., legacy)

DW as an archive

- **What to do with old data when migrating to a new AIMS?**
  - Keep an old machine to access old data?
  - Declare data bankruptcy and start anew?
  - Build a warehouse and populate with old data?
- **Many issues with schema mapping, patient identifier mapping, etc.**
- **Build a feed that adds new data from new AIMS**

Can Epic be a Periop DW?

- **Not really**
- **Hierarchal db, can't query across patients/encounters**
- **Restricted access**
  - need to go to Verona, WI (pop. 10,632 including cows)

Can Epic be a Periop DW?

- **Yes, maybe, sortof**
- **Reporting workbench - runs directly off Cache**
- **Clarity - Relational reporting extract from Cache**
- **Cogito - Star schema extract from Clarity**

Epic Clarity Is Not a Data Warehouse

Posted on July 27, 2012 by edgewatertech

It's not even the reporting tool for which your clinicians have been asking!

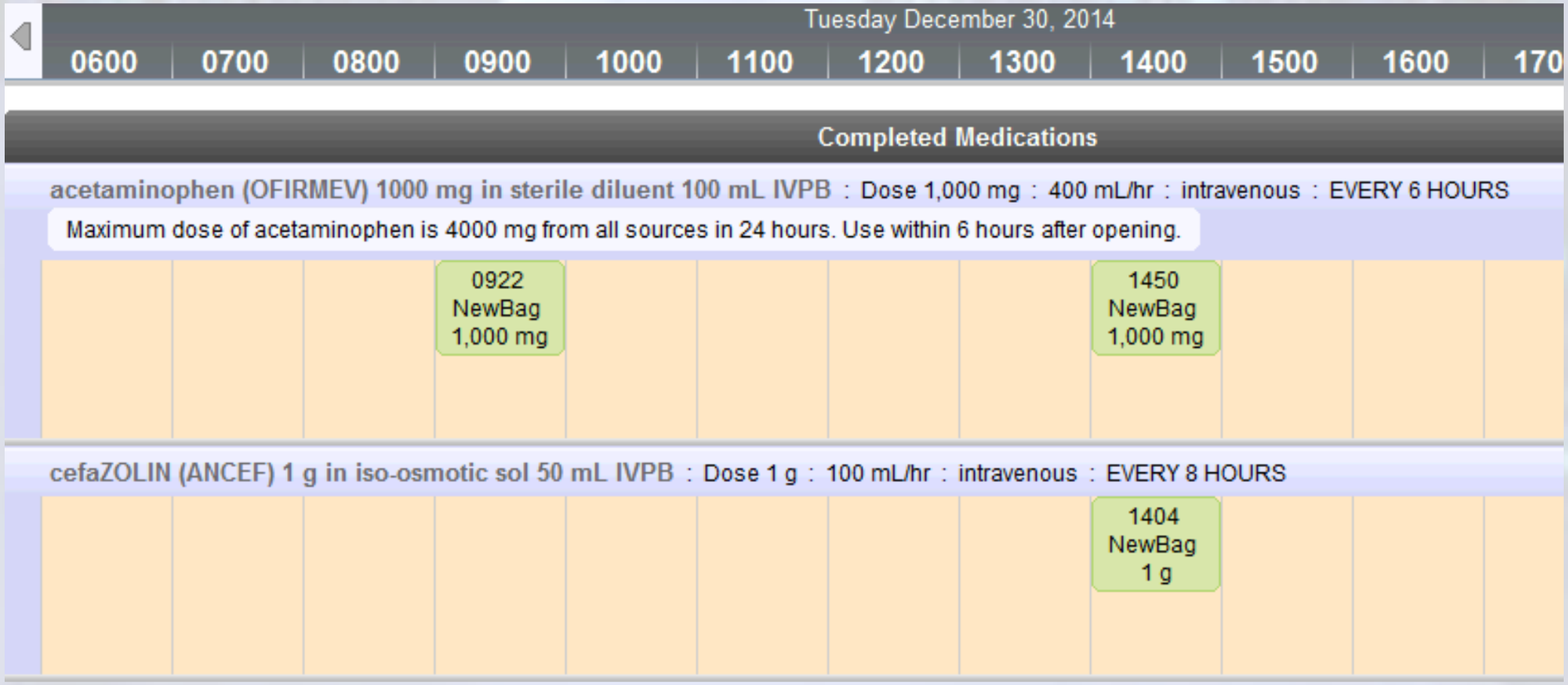
- http://blog.edgewater.com/2012/07/27/epic-clarity-is-not-a-data-warehouse/
- https://uccsc.ucsf.edu/session/cogito-data-warehouse-technical-impressions
- http://blogs.perficient.com/microsoft/2013/12/implementing-and-extending-epics-cogito/
- http://ehrintelligence.com/2014/08/28/how-the-integrated-epic-ehrpm-system-handles-reporting/

Getting data out of Epic

- **Reporting (via Clarity)**
- **Realtime - email alerts fired by BPA's**
- **Realtime - Custom feed**
  - Web Services (Epic as provider, SOAP protocol)
  - External calls (Epic as consumer)
  - Message Passing (bi-directional SOA model, XML/XSD schemas)
  - $$$$

Epic data - Caveats

- **No real-time intraoperative vitals**
  - will have to collect vitals directly*
- **No realtime MAR (Medication Administration Reconcilation) data**



Can a Cloud-based AIMS be a Periop DW

- There are now several “cloud” based AIMS
- They all store case data on remote servers
- They all provide facilities for reporting (dashboards, analytics) and for sending PQRS data to AQI
- Unclear how they integrate periop data

Can AQI be a periop DW?

- **Qualifed yes**
- **AQI is a Patient Safety Organization (PSO) and a Qualified Clinical Data Registry (QCDR)**
- **They've built a robust data mining infrastructure (see poster #29)**
- **Whatever data you give them, they can mine for you - if you ask**
- **But, not realtime, and de-identified**
  - No dashboard, no way to link back to individual cases in your data warehouse

The Sinai Experience - ORDW

event- and data-driven notifications

q15 sec

Physiologic data

q30 sec;1-2 min latency

ORDW

monthly

Social Security Death Index

bi-weekly

MSDW

manually*

RxNORM

Reporting Server

Billing Server

Epic

Cerner Applications

SCC Softlab

Anesthesia Quality Institute

Reports

Research

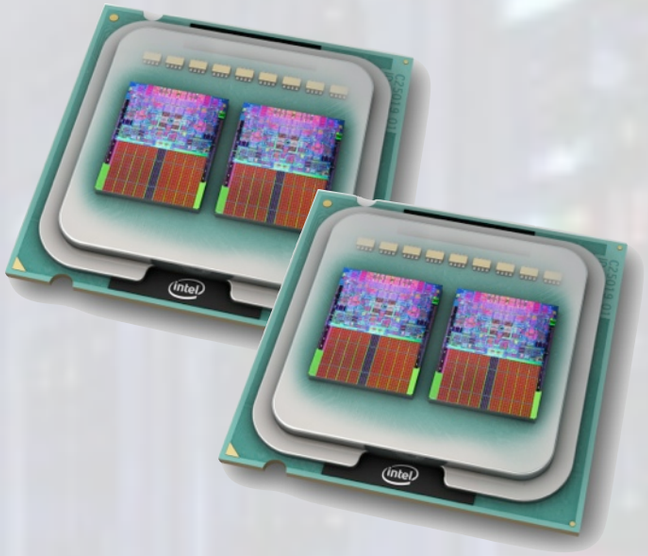
*not actively updated

ORDW external data

- **Social Security death index via automated loader**
  - kept in separate db to limit access
- **Other data loaded manually**
  - CPT codes, HCUP CCS, personnel lists…

Hardware & software

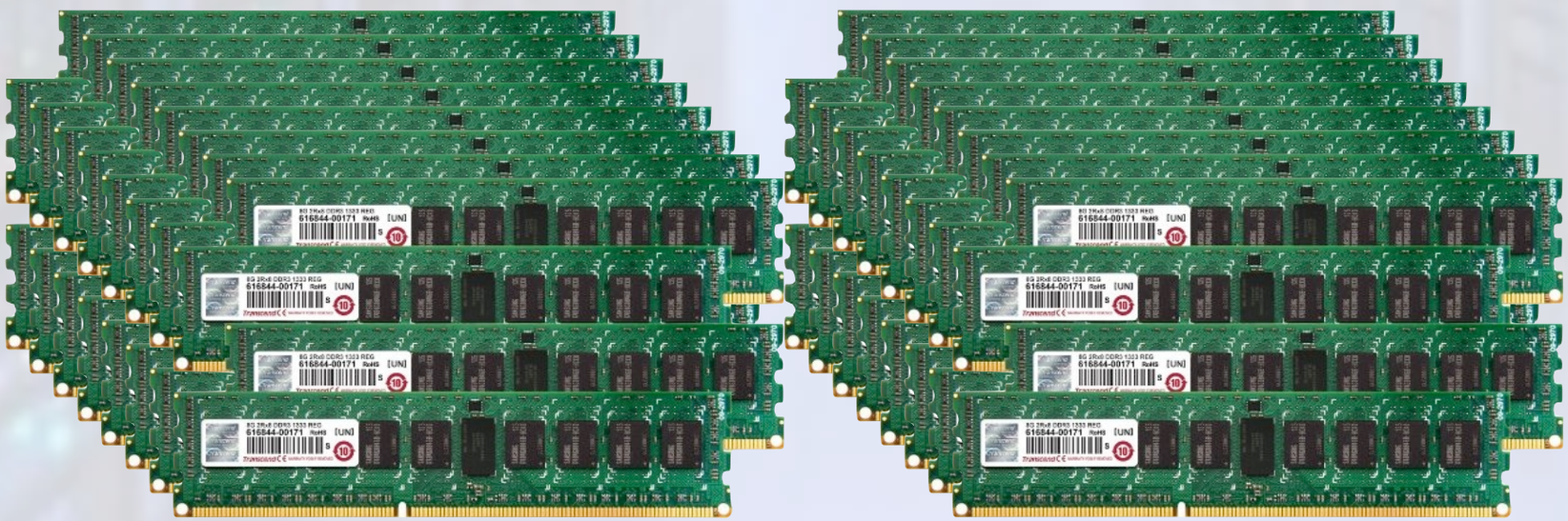
- 16 core machine
- 144 GB RAM, 3 TB disk
- Ubuntu 14.04, MySQL 5.6 (Percona Server)



ubuntu

MySQL®

PERCONA SERVER



Schema

- **Main tables mimic CompuRecord schema**
- **Separate db for Periop data, quasi-relational**
  - Already abstracted so won't have to change
- **Separate databases for ssn, summary table, realtime vs historical data**
- **Continuously updated summary table**

Perioperative data schema

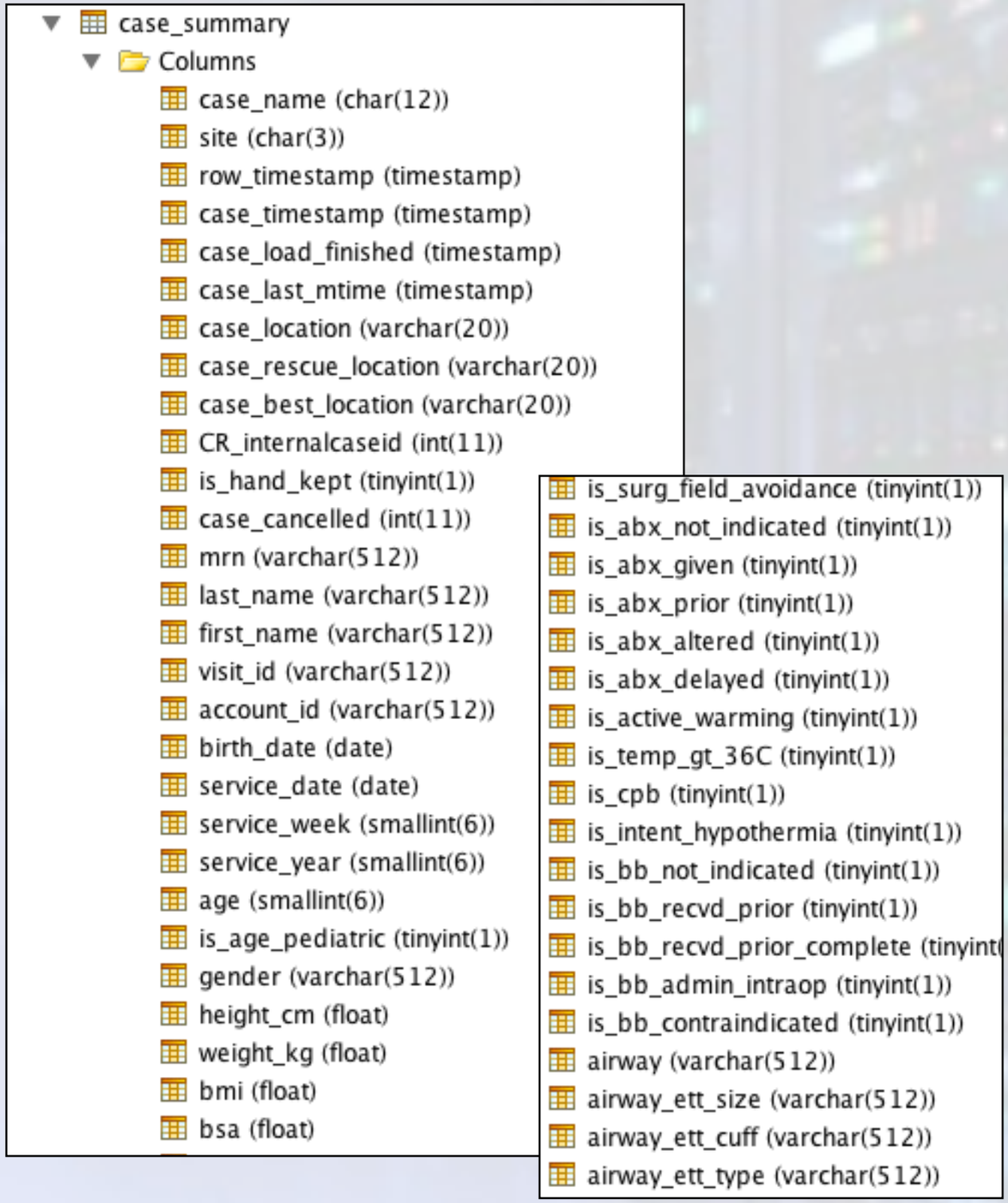
- **Custom feed, designed with and implemented by MSDW team**
- **Separate database, separate schema, quasi-normalized**
  - 2 week lag (matches lag in MSDW Epic feed)
- **Rich set of perioperative data**

Info | Tables | Columns | I

Name	Engine	V.	R.	Rows
ANESTHESIA_ADT	InnoDB	1	C	1395893
ANESTHESIA_CURRENT_MEDICATION	InnoDB	1	C	475186
ANESTHESIA_EKG_RESULTS	InnoDB	1	C	12515
ANESTHESIA_LAB_RESULT	InnoDB	1	C	48636253
ANESTHESIA_MED_ADMINISTERED	InnoDB	1	C	12558515
ANESTHESIA_MED_REPORTED	InnoDB	1	C	703871
ANESTHESIA_PAST_MEDICAL_HISTORY	InnoDB	1	C	130176
ANESTHESIA_PATIENT_DETAILS	InnoDB	1	C	468225
ANESTHESIA_PREOP_MEDICATIONS	InnoDB	1	C	16515
ANESTHESIA_PROBLEM_LIST	InnoDB	1	C	2195166
ANESTHESIA_REJECT_LIST	InnoDB	1	C	6161
ANESTHESIA_VITAL_SIGNS	InnoDB	1	C	33382004

Summary table

- **Key for DW use**
- **Wide (300 column) table which aggregates data from many base CR tables**
- **Many calculated fields and flags**
- **Table definition abstracted**
  - programmatic schema update and table regeneration (perl script)
- **Primary initial query table for:**
  - Research
  - Billing
  - Reporting and compliance

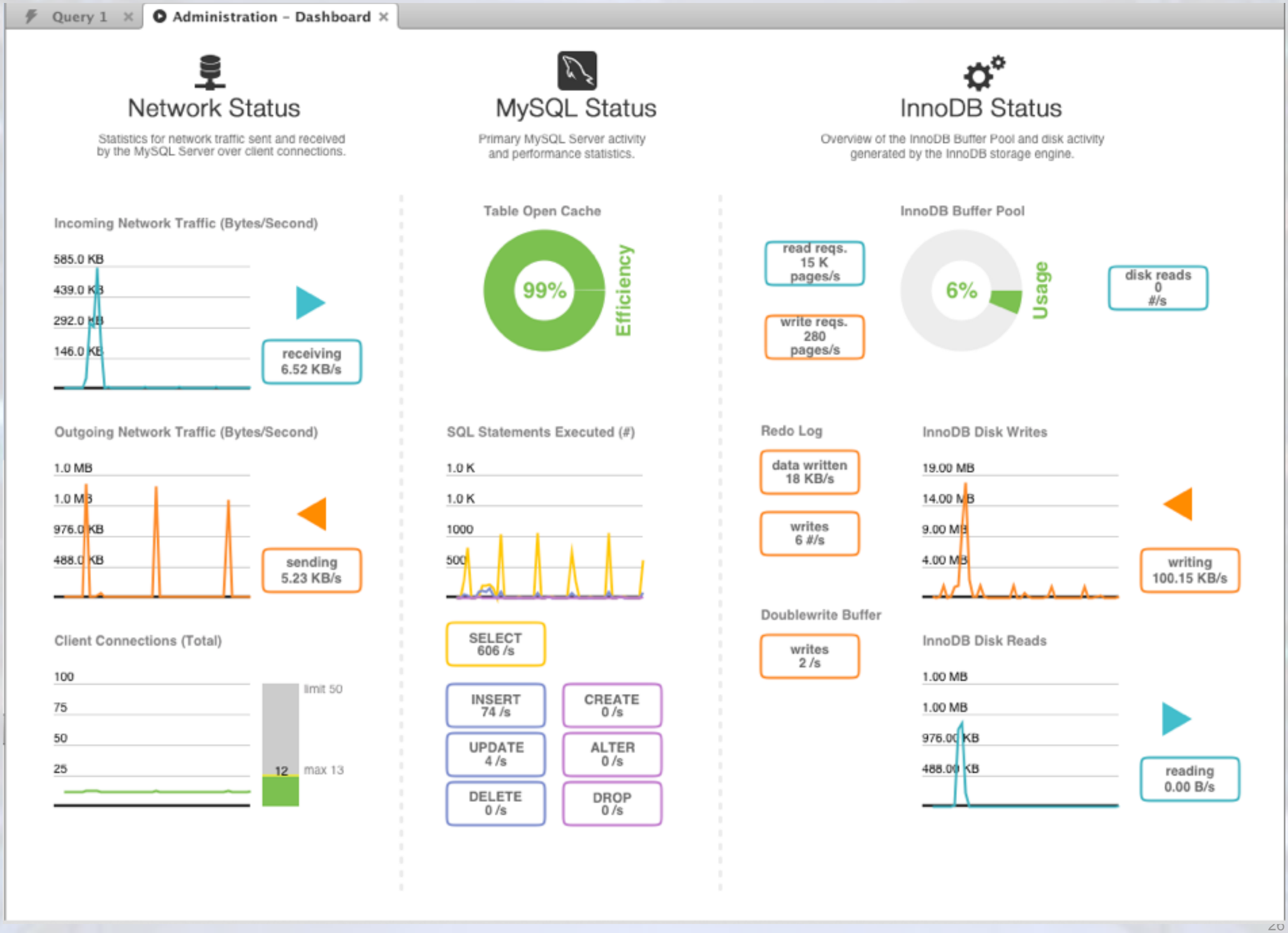


1	Columns	Type	Description/Comments
19	birth_date	date	PHI
20	service_date	date	PHI; Date of service. If doesn't exist, use date of anesthesia_start
21	service_week	smallint	Week of service date
22	service_year	smallint	Year of service date
23	age	smallint	datediff of birth_date and service_date
24	is_age_pediatric	bool	True if age < 19
25	gender		Can be Male, Female, Undetermined
26	height_cm	double	Height in centimeters
27	weight_kg	double	Weight in kilograms
28	bmi	double	BMI based on height and weight
29	bsa	double	BSA using Mosteller formula: (cm*kg/3600)
30	ibw	double	IBW using Devine for males (50 + 2.3 * (in - 60)) or Robinson for females (45.5 + 2.3 * (in-60))
31	patient_class		Combo ItemID=43; Restricted to Inpatient, DAS, Ambulatory in decreasing order of precedence; Office if location is anesfluoro
32	asa_status		ASA Physical Status (1 through 6)
33	is_pregnant	bool	6402=N/A, 6403=Not pregnant, 6404=Pregnant, 0=Other
34	is_emergency	bool	True if emergency flag set
35	mallampati		Mallampati score
36	primary_cpt		The "primary" CPT; usually the CPT with the highest number of anesthesia RVUs
37	proc_cpt_list		list of all CPTs, comma separated; ordered by CPT; excludes 99100
38	cpt1		First CPT listed; exclude 99100
39	cpt2		Second CPT
40	cpt3		Third CPT

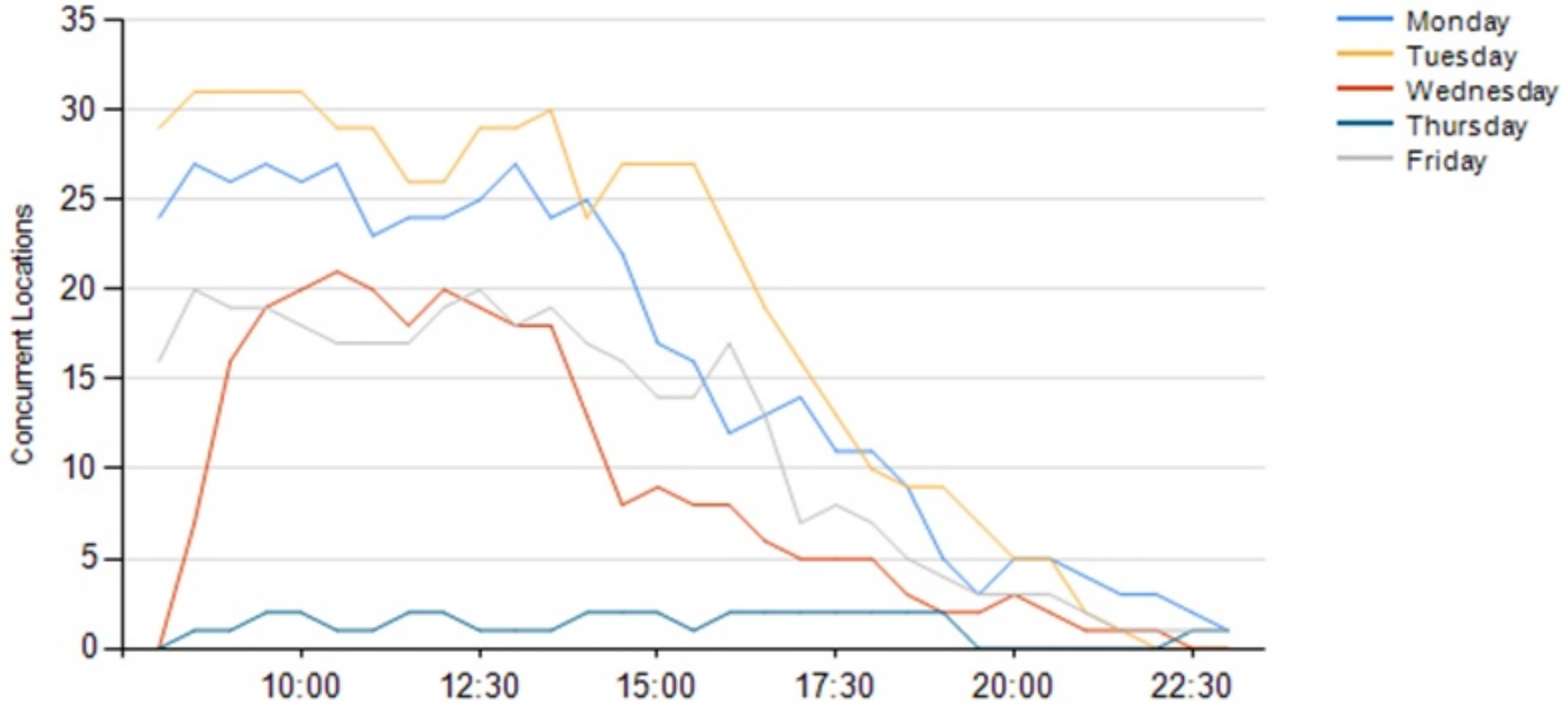
Size

- **~550,000 cases**
  - 300-400 new cases added daily, from 4 hospitals
  - no periop data from 3 new sites
- **~770 GB**
- **Vitalsigns table: ~600 GB, 5+ billion rows**

Performance



OR Occupancy for 12/29/2014 through 1/3/2015



Time	Monday	Tuesday	Friday	Wednesday	Thursday
08:00	24	29	16	0	0
08:30	27	31	20	7	1
09:00	26	31	19	16	1
09:30	27	31	19	19	2
10:00	26	31	18	20	2
10:30	27	29	17	21	1
11:00	23	29	17	20	1
11:30	24	26	17	18	2
12:00	24	26	19	20	2

ORDW and Epic

- **MSDW acts as intermediary**
  - Daily export from Cache to Clarity
  - From Clarity to MSDW every 2 weeks
    - feed designed and maintained by MSDW team in collaboration with Epic reporting team
- **From MSDW to us every 2 weeks**
- **From us to Epic q15 min**
- **Result: we get what we want and don't really have to deal with Epic**

Progress Notes Info

Author	Note Status
Matthew A Levin, MD	Addendum

Link on 12/29/2014 by Matthew A Levin, MD

Document

Type	ID
ANESTHESIA	36CT7I04.106

Signed by Matthew A Levin, MD on 12/31/14 at 0100

Document Text

Anesthesia Summary Report

Performed Procedure	CORONARY ARTERY BYPASS, USING VENOUS GRAFT(S) AND ARTERIAL GRAFT(S); TWO VENOUS GRAFTS; CORONARY ARTERY BYPASS, USING ARTERIAL GRAFT; SINGLE ARTERIAL GRAFT; LV ANEURYSMECTOMY WITH THROMBUS EVACUATION AND GORETEX PATCH; LIGATION OF LA APPENDAGE
Anesthetic Technique Primary	General
Anesthetic Technique Secondary	
Position	Supine
Anesthesia Start Date	2014-12-29 07:37:00
Procedure Start Date	2014-12-29 08:48:00
Procedure End Date	2014-12-29 13:10:00
Anesthesia End Date	2014-12-29 13:45:00
Anesthesia Care Team	ACUNA,J
ASA Status	4
Emergency	No
OP Room	anesngpor04
Prophylaxis	Antibiotic(s) given as per protocol

ORDW - what we don't have

- **Full text of notes**
  - 90% of note content is redundant and useless anyway
- **Imaging reports, or image data**
- **Allergies (Epic reported)**
- **All Epic flowsheet data**
  - For example, vent data for ICU patients
    - not contained in any existing Clarity reports
    - would have to have Epic reporting team build a new report
      - low priority for reporting team
    - MSDW then has to modify their Clarity feed (and test/validate)
    - MSDW then has to modify our anesthesia feed (and test/validate)

The Vanderbilt* experience

VANDERBILT UNIVERSITY MEDICAL CENTER

- **SQL Server based**
- **Batch loads of both AIMS and external periop data**
  - AIMS data loaded from backup files q8h
  - Periop data loaded from Enterprise Data Warehouse daily
- **Cleaning/modeling using T-SQL MERGE statements**
- **Phenotyping - risk score calculation, etc.**
- **Reporting via Tableau software**
  - Custom one-off queries for research requests
- **680,000+ cases**
- **5 billion+ vitalsigns**

*Thanks to Jon Wanderer MD for this information

ORDW - future directions

- Enable distributed queries for improved performance
- Integration with other local data warehouses - genomics!
- Periop data from other Mount Sinai health system sites
- More summarization and phenotyping
- Visualization

Summary

- Building a periop DW is a major effort
- Reward is a rich dataset that can be used to answer deep research questions
- Most groups will not need a periop DW or want to build one. Built in reporting facilities will be good enough.
- Epic is not a data warehouse

Thank you

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