Research Using Military Health System Data

DaVINCI (DoD-VA System)

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KENNELL & ASSOCIATES, INC.

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Objectives

Define the Military Health System (MHS)

Describe the Beneficiaries of the MHS

Overview of the MHS Data Repository (MDR)

DaVINCI – new combined DoD-VA System

Examples of Current Research & Potential Areas of Future Research

Gaining access to MDR/DaVINCI for Research

Military Health System (MHS)

What is the Military Health System?

The MHS is a network of military hospitals and clinics ('direct care'), supplemented by programs to enable beneficiaries to seek care in the private sector ('purchased care') in order to fulfill their healthcare needs according to access standards and to assure medical readiness of the force.

Our Mission

Enhance the Department of Defense and our nation's security by providing health support for the full range of military operations and sustaining the health of all those entrusted to our care.

Our Vision

Be a world-class health care system that supports the military mission by fostering, protecting, sustaining and restoring health.

What is the Military Health System?

Eligible Beneficiaries: 9.4 million

Number of Hospitals: 50+

Number of Medical Clinics: 500+

Number of Dental Clinics: 300+

Inpatient Admissions to Military Hospitals: 240K

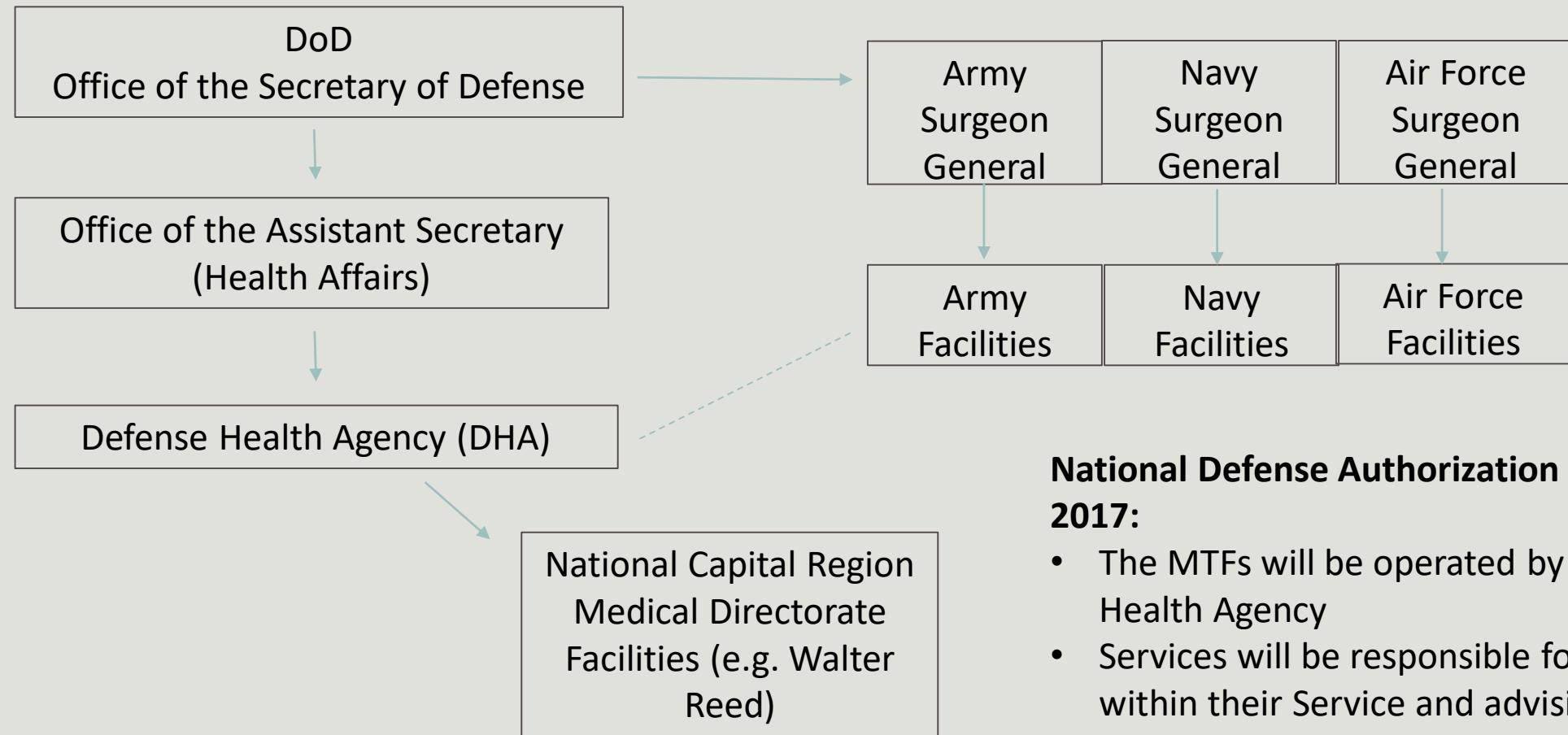Inpatient Admissions in the Private Sector: 770K

Office Visits in Military Hospitals/Clinics: 41M

Office Visits in the Private Sector: 86M

Number of Prescriptions from Military Pharmacies: 34M

Number of Prescription from the Private Sector: 55M

Organizational Structure – Military Hospitals and Clinics – Current State

DoD Office of the Secretary of Defense

Office of the Assistant Secretary (Health Affairs)

Defense Health Agency (DHA)

National Capital Region Medical Directorate Facilities (e.g. Walter Reed)

Army Surgeon General	Navy Surgeon General	Air Force Surgeon General
Army Facilities	Navy Facilities	Air Force Facilities

National Defense Authorization Act (NDAA) 2017:
- The MTFs will be operated by the Defense Health Agency
- Services will be responsible for readiness within their Service and advising the line on medical issues

Direct Care vs. Purchased Care

MHS Direct Care System

- Refers to the acute care hospitals, clinics, and dental facilities operated by DoD.
  - Most of the hospitals are small facilities. There are only 6 hospitals with more than 100 patients in their average daily census and scores of hospitals with less than 50. OB is the most popular service provided in MTFs.
  - Many hospitals have Graduate Medical Education programs.
  - Clinics can vary from those serving only Active Duty for primary care needs, to full service clinics with same day surgeries and such.
  - The MHS has an active patient centered medical home (PCMH) program, which most MTFs participate in.
- There is no cost sharing (other than paying for food for some patients) for care at MTFs. Can be particularly useful when studying the impacts of cost-sharing on access to care.
- There is an established priority for care and in some places, eligible beneficiaries cannot get appointments at MTFs.

Data Available in Direct Care

CHCS/AHLTA EHR

Source	Name	Content
Standard Inpatient Data Record	SIDR	Inpatient Hospital
Comprehensive Prof Encounter Record	CAPER	Professional Services
Appointment	APPT	Appointments
Referral	REF	Referrals (MTF or Purchased Care)
Chemistry	Chem	Chemistry Exams & Results
Microbiology	Micro	Microbiology Exams & Susceptibility
Pathology	Path	Pathology Exams & Results
Radiology	Rad	Radiology Exams & Results
Schedulable Entity	SE	MTF Appointment Schedules
Pharmacy	RX	Dispensing Events
Subjective/Objective Notes	SO	Clinical Notes (AHLTA based only)
Immunizations	IMM	Immunization History
Vital Signs	Vitals	Vitals and Other questionnaire type data

Direct Care vs. Purchased Care

TRICARE Purchased Care (MCSC)

◦ TRICARE Claims represent more than <u>half</u> of the care provided to MHS beneficiaries.

◦ Particularly important for those who live near small MTFs and for those who don't have priority at MTFs, such as retirees or Medicare eligibles.

◦ Only administrative data is available (similar to what would be available for Medicare claims) when TRICARE has obligation for payment.

◦ Limits the ability to use the data for some studies and some cohorts.

◦ TRICARE offers numerous health plans with various cost-sharing (e.g., Prime, Select, USFHP, TRICARE Reserve Select, TRICARE for Life). The relationship a beneficiary has with the MHS determines their eligibility for specific plans and premiums/cost-shares.

Data Available in Purchased Care:
TRICARE Institutional and Non-Institutional Claims

TRICARE Claims include:
- Physician Services
- Hospital Stays or Services
- Ancillary Services
- Emergency Room
- Durable Medical Equipment
- Pharmacy
- Home Health
- Hospice
- Others

- Individual claims are available
- Diagnosis and Procedure Codes, dates and location of care
- Billing and patient data
- Patient and Provider
- Other administrative data
- Clinical data are not available
  - Lab and Rad CPTs, but no results.
  - No vital signs
  - No electronic notes

- Claims are only sent to TRICARE if TRICARE has a liability.
- If 100% of the allowed amount is paid by another payor, TRICARE is blind to the fact that the care occurred.

MHS Beneficiaries

Who are the Beneficiaries of the MHS?

Eligible Beneficiaries

Active Component
- Active Duty Service Members (ADSMs) gain eligibility upon entry into the Service.
- ADSMs enroll eligible family members (ADFMs) in DEERS, including spouses, children, foster children, wards, dependent parents
- ADSMs and ADFMs enjoy the best access priority and generally do not have co-pays when receiving care in the private sector.

Active Component Beneficiaries
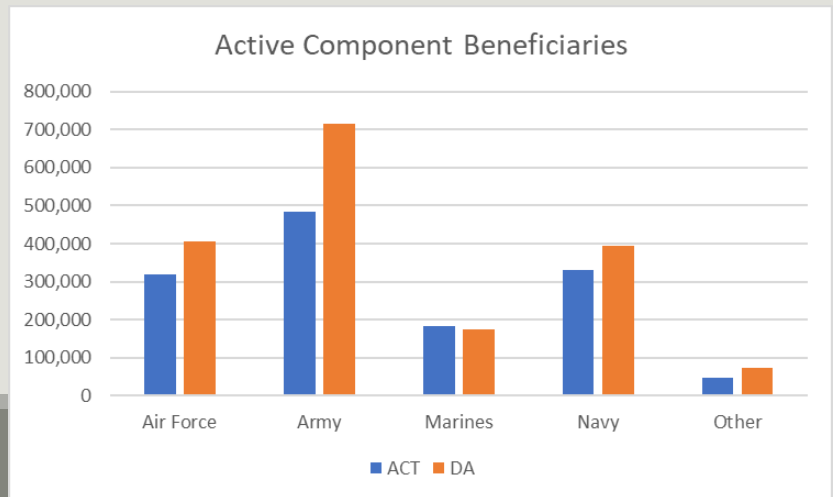
Beneficiaries by Service

	ACT	DA	Sum:
Air Force	318,104	406,083	724,187
Army	483,752	715,695	1,199,447
Marines	183,920	173,470	357,390
Navy	329,355	392,866	722,221
Other	48,230	74,615	122,845
Sum:	1,363,361	1,762,729	3,126,090

Who are the Beneficiaries of the MHS?

Eligible Beneficiaries

National Guard/ Reserve Component
- National Guard and Reserve gain eligibility when activated for a period of 30 days or more. There is a 30 day pre-activation eligibility period as well as 6 months of transitional assistance at no cost to the NG/R member associated with the activation.
- NG/R can also purchase MHS eligibility in the TRICARE fee programs (e.g., TRICARE Reserve Select) when not on active duty.
  - NG/R family members are enrolled into DEERS, just as active duty family members.
- While on active duty, NG/R and their families have the same legal benefit as ADSMs and ADFMs.

Types of Beneficiaries by Service

	Air Force	Army	Marines	Navy	Other	Sum:
1: Active NG/R	41,829	106,620	7,516	16,040	489	172,494
2: Family of Active NG/R	68,526	162,913	6,959	25,042	710	264,150
3: Inactive NG/R	40,538	107,431	6,577	17,053	2,614	174,213
4:Family of Inactive NG/R	67,381	168,121	8,844	28,996	4,431	277,773
Sum:	218,274	545,085	29,896	87,131	8,244	888,630

Who are the Beneficiaries of the MHS?

Eligible Beneficiaries

Retirees, Retiree Family Members and Survivors
◦ Most active duty service members separate from the Service w/o a retirement benefit ('Separatees').
◦ Service members are eligible for retirement benefits after 20 years of Service or if medically retired.
◦ These beneficiaries have lower priority to receive services in MTFs and many do not live near them. These are heavier users of private sector care than the active duty.
◦ Many of the retiree population are eligible for other government coverage, such as the VA or Medicare. Many also purchased private health insurance.

Types of Beneficiaries by Service

	Air Force	Army	Marines	Navy	Other	Sum:
1: Retiree	683,605	828,948	128,645	500,441	49,701	2,191,340
2: Retiree Family	743,883	1,002,728	178,946	578,445	58,588	2,562,590
3: Survivor	194,110	232,273	32,723	135,714	9,620	604,440
Sum:	1,621,598	2,063,949	340,314	1,214,600	117,909	5,358,370

MHS Population FY 2000+

Eligible Population Trend by Bencat
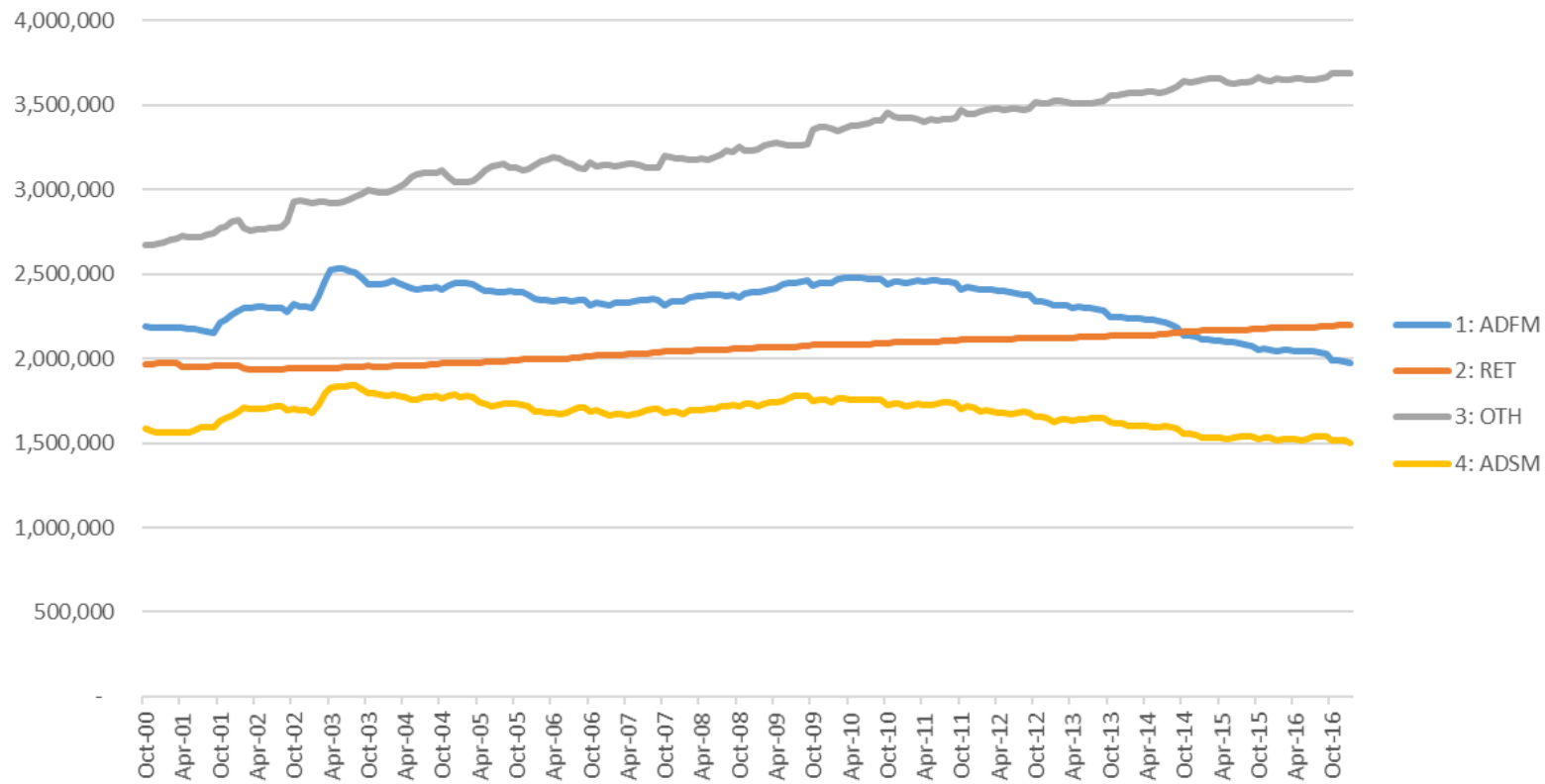
- Observations:
  - Increase in AD/ADFM when OIF/OEF began
  - The decrease in AD/ADFM and increase in others.
    - Others include inactive guard/reserve and their families (as well as retiree family members)

Who are the Beneficiaries of the MHS?

Dual Eligibility

- There are many patients who have more than one reason to access the MHS, which can cause an issue with identifying patients over time.

- There are also beneficiaries with eligibility for **Medicare** and the **VA**.

  - TRICARE For Life: Medicare is first payer.

  - VA: These patients can switch between systems routinely because they are dual eligible or because of resource sharing agreements between VA-DoD facilities.

  Therefore there is a need for a DoD-VA combined system like **DaVINCI** (with plans to incorporate CMS in future).

Military Health System (MHS) Data Repository (MDR)

MHS Data Repository

- What is the MDR?
  - The most robust source of MHS data centrally available going back decades
  - Enhances data from existing operational systems (increasing data quality).
    - PDTS – Pharmacy Detail Transaction Service
    - AHLTA/CDR - Armed Forces Health Longitudinal Technology Application/ Clinical Data Mart
    - DEERS – Defense Enrollment Eligibility Reporting System
    - CHCS - Composite Healthcare System
    - MHS GENESIS – New Cerner EHR
    - TED ODS - TRICARE Claims
    - TMDS – Theater Medical Data Store
    - Etc.

Basic Data Flow
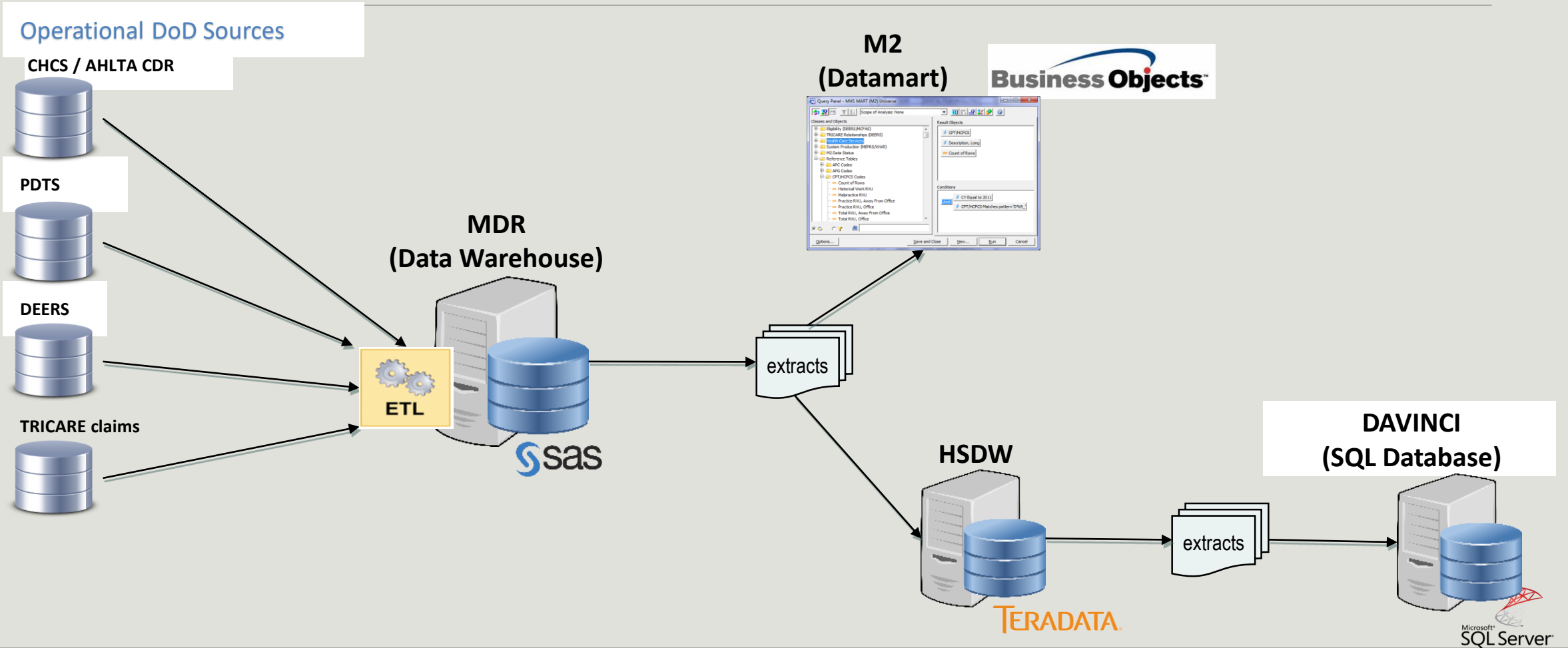
MHS Data Repository

Many data warehouses simply display source data as provided.

◦ The MDR always stores original values that are received from sources,

◦ But, when possible, programs have been written to add new variables, to correct source system errors, to standardize data amongst sources or to enhance utility.

◦ This makes the MDR a cleaner source of data than other systems.

◦ Corrections are not always possible so the data are not perfect.

Routine MDR Enhancements

Person Identification Enhancement:

◦ MDR maintains a "Master Person Index" file that contains all known person identifiers and associations for each member.

◦ John has three records in DEERS; one associated with two active duty parents, and one for himself, when he goes on active duty.

◦ Enables the MDR to consistently assign the DEERS ID no matter how John presents for care.

Person	Sponsor SSN	Relation	Pat SSN	DEERS ID
John Smith	111-11-1111 (Mom)	Child	333-33-3333	1111111111
John Smith	222-22-2222 (Dad)	Child	333-33-3333	1111111111
John Smith	333-33-3333 (John)	Sponsor	333-33-3333	1111111111

Routine MDR Enhancements

Uses DEERS files to properly assign benefit information, enrollment information and demographics.

Fixes inconsistencies related to there being 100+ separate CHCS servers.

Groups diagnosis and procedure codes into categories

Diagnosis Related Groups (TRICARE Unique)

Major Diagnostic Categories

Ambulatory Payment Classifications

AHRQ Clinical Classification Software

Risk Adjustment (TRICARE Unique)

Routine MDR Enhancements

Application of workload weights:

Relative Value Units

Relative Weighted Products (DRG weights)

Application of risk scores

Financial risk

DoD Risk Adjustment Model (Concurrent)

Application of estimated costs

Full costs and variable costs for direct care data

MDR Enhancements

The idea behind the MDR enhancements is:
◦ Get the most accurate data available to the users
◦ Apply consistent tools/logic to the data
◦ Make the data easy to use
◦ Transparency, transparency, transparency

There are many other enhancements as well, some unique to each type of data.

All enhancements are fully documented (transparency).

Reference Documents for MDR Processing of Data: https://health.mil/Military-Health-Topics/Technology/Support-Areas/MDR-M2-ICD-Functional-References-and-Specification-Documents

MHS Data Repository and official reporting

- Determining the contribution from DoD to a joint DoD/Medicare fund that pays for TRICARE for Life.
- Management of purchased care claims payment.
- Developing payment rates used by TRICARE.
- Calculating "risk sharing" amounts on billion dollar. managed care support contracts. Estimating costs of changes to the contracts.
- Calculating the Services budgets from DoD for operating MTFs.
- Calculating payment amounts for third party payors such as the Coast Guard and the VA.
- Reports to Congress, such as the recent MHS Review, or the Military Compensation and Retirement Commission.
- Hundreds of clinical research studies, including feeding DaVINCI
- IOM reports, CDC reporting, etc.

MHS Data and Research

The MHS has a long history of using data for research.

◦ There are active agencies within each Service dedicated to conducting research.

◦ There is not a research mandate within the MHS, however.

◦ Receiving and using MHS data w/o DoD sponsorship can be difficult. The most difficult part tends to be finding a way to get the data pulled.

◦ The DaVINCI project is intended to streamline and assist researchers and other users in gaining easier access to data to combine the DoD and VA experience for a more robust set of data to study.

It is particularly important that users understand the MHS and the different benefits in order to properly apply the data to research.

Summary of Data in the MDR

| Source	Name	Content
DEERS	VM6	Eligibility, enrollment, demographics, service, etc
DMDC	Contingency Tracking System (CTS)	Deployment related information
DMDC	Separatee	Separation from Service information
DMHRS	DMHRS	Human Resources/Staffing
MDR-Processed	Health Risk	Disease State, Financial Risk Adjustment
Death File	Death	Deaths from SSA, DMDC, Casualty Affairs, etc.

Source	Name	Content
Standard Inpatient Data Record	SIDR	Inpatient Hospital
Comprehensive Prof Encounter Record	CAPER	Professional Services
Appointment	APPT	Appointments
Referral	REF	Referrals (MTF or Purchased Care)
Chemistry	Chem	Chemistry Exams & Results
Microbiology	Micro	Microbiology Exams & Susceptibility
Pathology	Path	Pathology Exams & Results
Radiology	Rad	Radiology Exams & Results
Schedulable Entity	SE	MTF Appointment Schedules
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Subjective/Objective Notes	SO	Clinical Notes (AHLTA based only)
Immunizations	IMM	Immunization History
Vital Signs	Vitals	Vitals and Other questionnaire type data

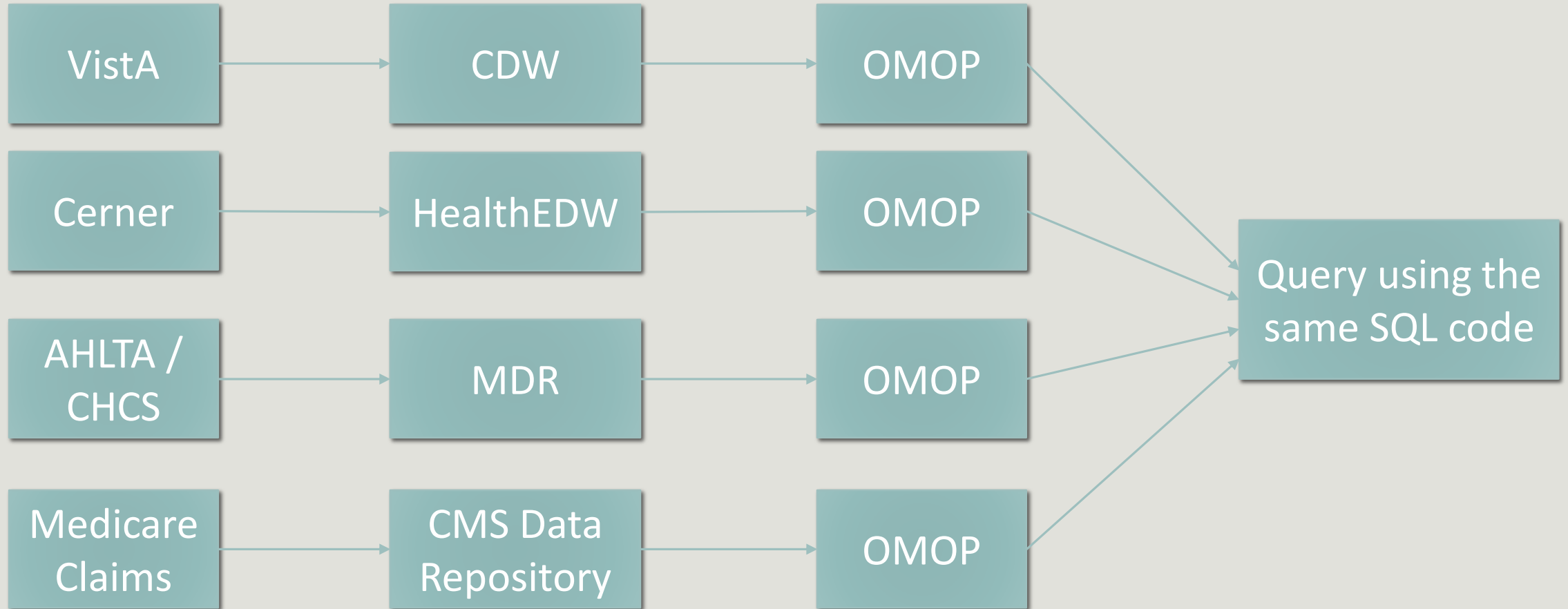| Source	Name	Content
MEPRS	MEPRS	MTF Accounting and Staff
Pharmacy Data Transaction Service	PDTS	Pharmacy Utilization Review
TRICARE Encounter Data - Institutional	TEDI	Purchased Care Claims - Institutional
TRICARE Encounter Data - Non Inst'l	TEDN	Purchased Care Claims - Non Institutional
National Provider ID	NPI	Provider Directory
Designated Provider	DP	Purchased Care Claims - Designated HMO
Theater Medical Data Store	TMDS	Theater Healthcare Data
Direct Care Dental	DC Dental	Direct Care Dental records
Purchased Care Dental	PC Dental	Purchased Care Claims - Dental
Case Management	CM	Case Management - Direct Care
Behavioral Health Data Portal	BHDP	Behavioral Screening Exams

DaVINCI

DaVINCI Cohort
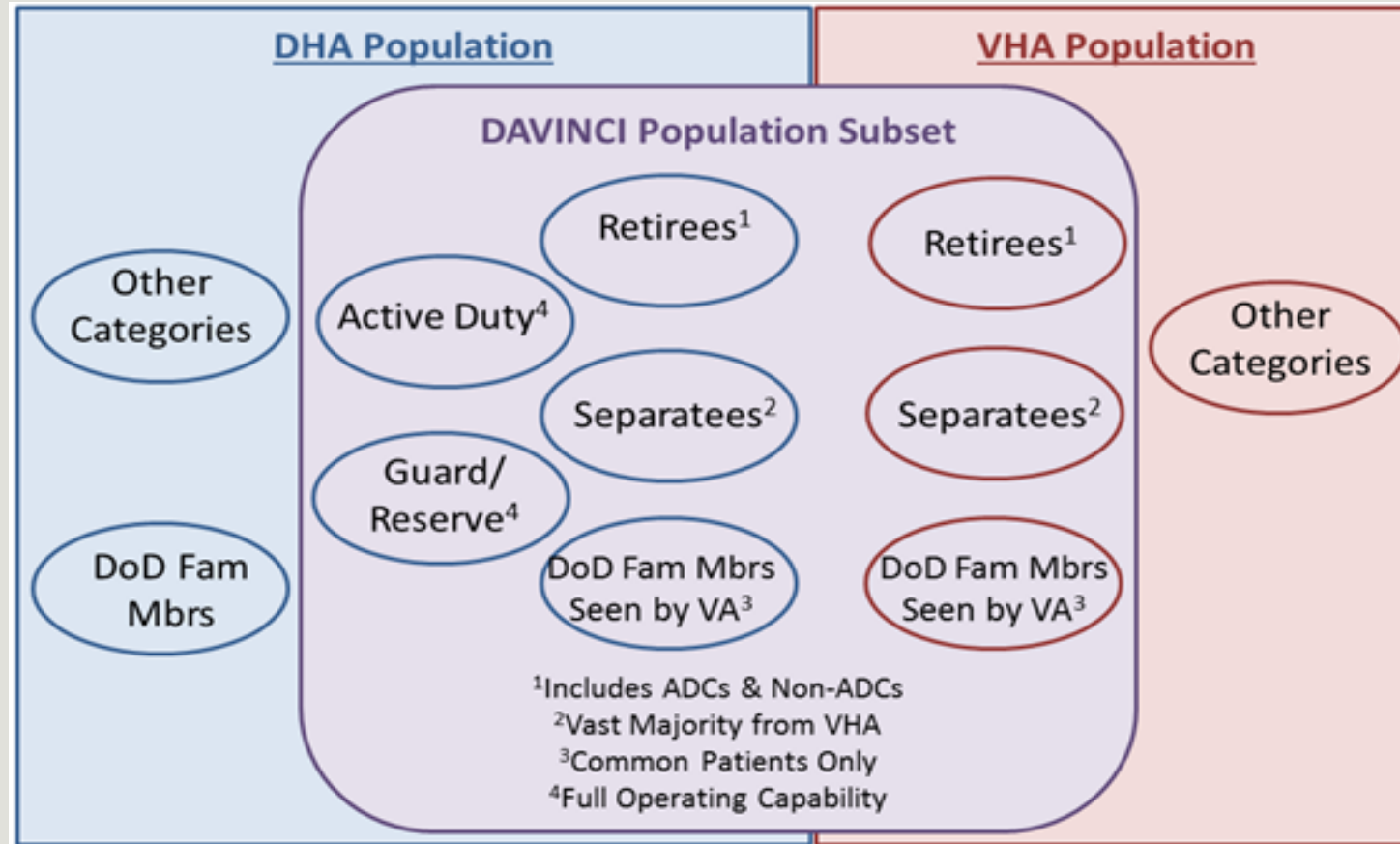
OMOP Common Data Model (CDM)

- The Observational Medical Outcomes Partnership (OMOP) has developed a Common Data Model (CDM) that allows for analysis of disparate observational databases.

- Data from the DoD and VA are stored in different formats both within and between the two agencies.

- Different terminologies or vocabularies are used between the two agencies (e.g. MEPRS Codes vs. Stop Codes) and within the two agencies (e.g. transitioning from ICD-9 to ICD-10 diagnosis codes).

- The OMOP CDM standardizes both the data model and the common representation of data in the model.

- Theoretically, users can use data mapped to the OMOP CDM without knowing specifics about the source data systems.

- The Extract, Transfer, Load (ETL) logic that builds the OMOP CDM must be carefully designed to accurately represent the source data.

Mapping any data source to the OMOP model

VistA	→	CDW	→	OMOP
Cerner	→	HealthEDW	→	OMOP
AHLTA / CHCS	→	MDR	→	OMOP
Medicare Claims	→	CMS Data Repository	→	OMOP

Query using the same SQL code

Pros and Cons of the OMOP CDM

Pros

- Analyze data from multiple sources in one format using one set of standardized vocabularies.

- No need to know every nuance of each source.

- Combining many data sources provides a more comprehensive view of a patient's medical history.

- Generally, the provenance of the data is contained in the model so records can be linked back to the source data for confirmation or more detailed analysis.

Cons

- Some source-specific data is not easily represented in the OMOP CDM.

  - e.g. Commonly used DoD variables like Beneficiary Category or VA variables like Service Era are not available.

  - e.g. The OMOP CDM is not designed to track changes to a person's status (Primary Care Manager, location) over time.

- The CDM is only as good as the process that was used to transform the source data.

- There are some nuances to using the OMOP CDM which requires its own learning curve.

Concepts

Nearly everything in the OMOP CDM is represented by a concept

The most important application of this is for administrative codes like diagnosis and procedure codes

Each code is represented by a concept and concepts are mapped to standard concepts

The tables in the OMOP CDM contain:

- Source value: The code as it appears in the source data
  - E.g. ICD-9 Diagnosis of PTSD 309.81

condition_source_value	30981
condition_source_concept_id	44836990
condition_concept_id	436676

- Source concept ID: The ID for the concept that represents the source value
  - 44836990 represents the source concept ID of that specific PTSD diagnosis code
- Concept ID: The ID for standard concept that the source concept maps to
  - Most diagnosis codes are mapped to SNOMED; 436676 represents the concept ID for the specific PTSD code in the standard concept of SNOMED

Concepts are also used for things like race, ethnicity, place of service, provider specialty, etc.
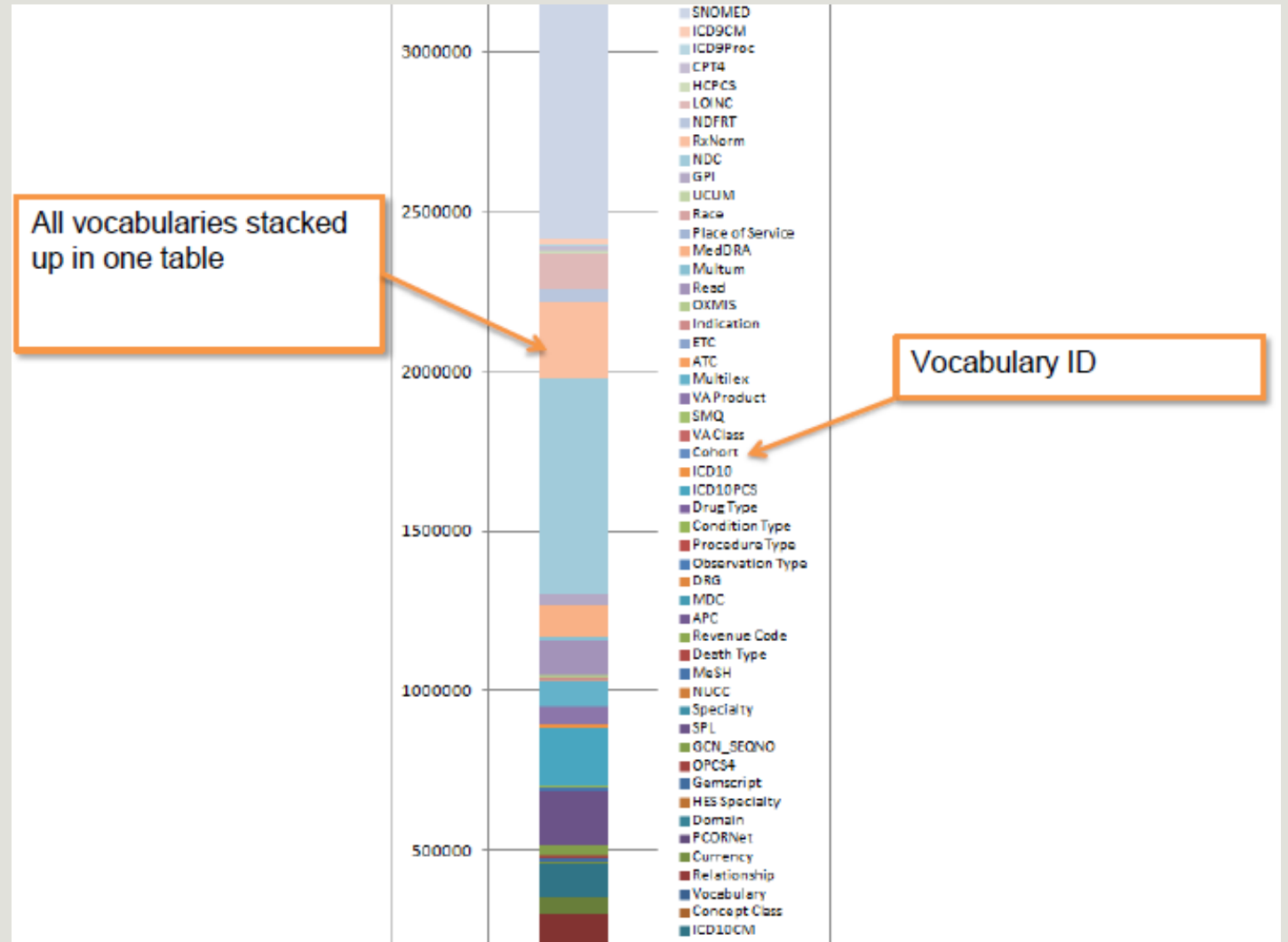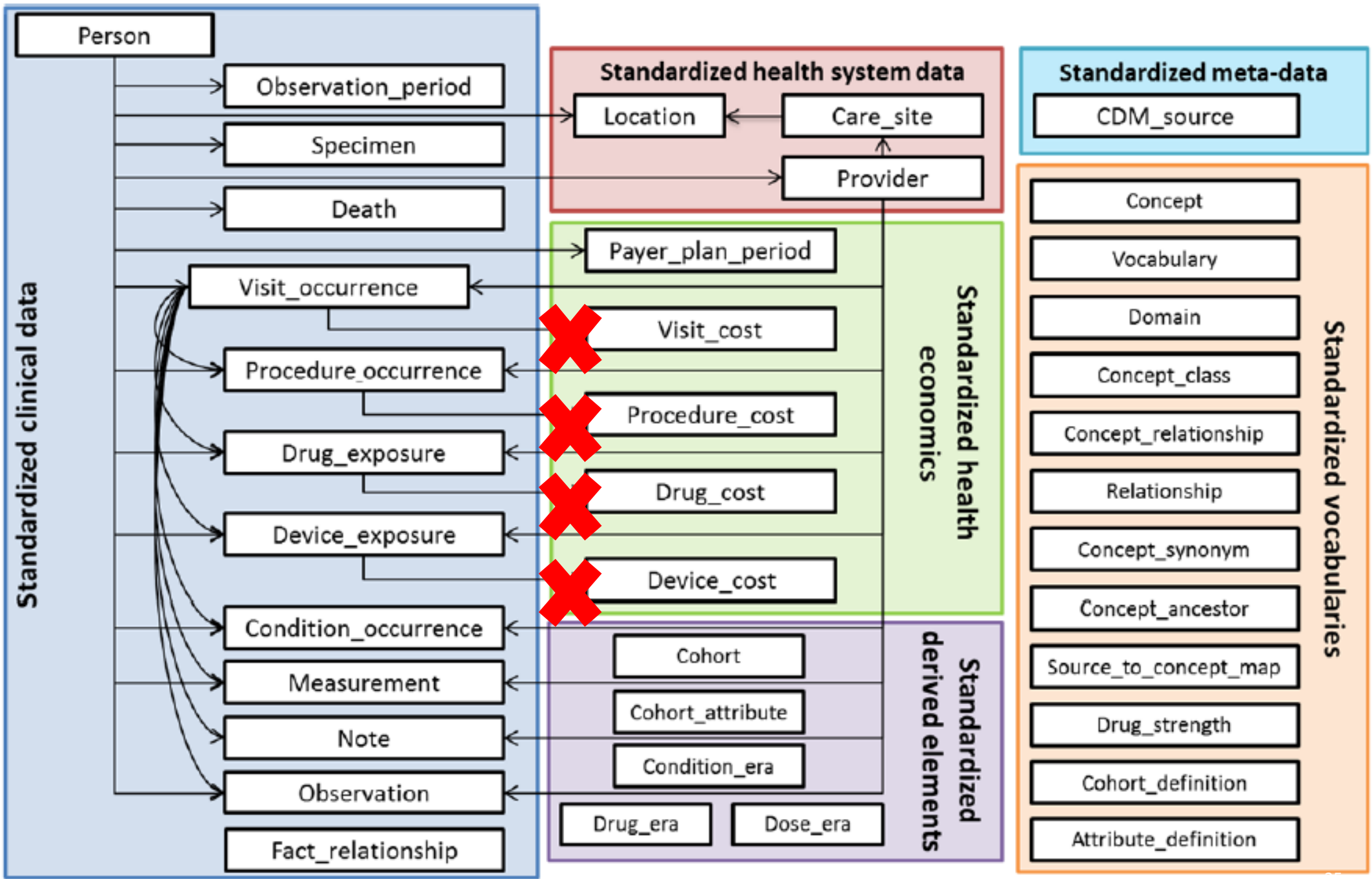
Single Concept table:

For every code that exists there is a map to a Standard Concept:

- ICD-9-CM Diagnoses to SNOMED
- ICD-10-CM to SNOMED
- NDC to RxNorm

Some common vocabularies are used as standard concepts:

- CPT-4
- CVX
- HCPCS
- ICD-9-CM Procedures
- ICD-10-PCS
- LOINC

All vocabularies stacked up in one table

Vocabulary ID

Person table

Person_source_value contains familiar identifiers

◦ DoD model: EDIPN

◦ VA model: ICN

Person_id is the best way to uniquely identify a person across both models

◦ e.g. If Bob Smith (EDIPN = 1001122334, ICN = 1998877665) appears in both models, they will have the same person_id (maybe 12345)

person

🔑	person_id
	gender_concept_id
	year_of_birth
	month_of_birth
	day_of_birth
	time_of_birth
	race_concept_id
	ethnicity_concept_id
	location_id
	provider_id
	care_site_id
	person_source_value
	gender_source_value
	gender_source_concept_id
	race_source_value
	race_source_concept_id
	ethnicity_source_value
	ethnicity_source_concept_id

Full OMOP Model, Record Counts (DoD & VA)

	Patient Records in DoD OMOP only	Patient with Records in Both, from DoD table	Patient with Records in Both, from VA table	Patient Records in VA OMOP only
Active Duty				
Demographics	1,248,553	309,349	309,349	0
Visits	99,683,887	26,320,796	3,144,993	0
Diagnoses	145,856,522	39,409,327	1,840,957	0
Procedures	238,313,832	60,788,838	2,312,451	0
Medications	100,189,589	26,894,652	1,083,981	0
Measurements (Labs/Vitals)	386,050,481	97,456,079	17,033,118	0
Deceased				
Demographics	287,245	578,302	746,855	7,258,887
Visits	32,568,006	62,576,727	115,518,986	852,056,466
Diagnoses	83,519,832	166,733,440	92,154,692	660,747,860
Procedures	63,148,155	121,798,103	94,464,044	668,350,486
Medications	39,936,219	84,598,676	358,607,532	2,322,152,763
Measurements (Labs/Vitals)	28,037,299	68,648,844	691,115,014	5,342,926,233
Retirees				
Demographics	651,199	1,560,401	1,560,401	0
Visits	100,675,545	301,603,347	233,034,899	0
Diagnoses	209,146,876	621,327,467	184,222,388	0
Procedures	176,373,144	548,881,599	185,812,747	0
Medications	145,110,827	407,040,836	279,525,828	0
Measurements (Labs/Vitals)	162,955,937	554,144,045	1,038,773,588	0

Significant Overlap in Clinical Data

The longitudinal record for these patients for visits, conditions, drugs, and procedures is significantly longer and more complete than just using VA or DoD data alone.

Of the 4B+ procedure records (FY 2000+) in the full combined (DoD + VA) model, 41.7% are for patients who have been seen in both the DoD and VA healthcare systems:

| Full Combined OMOP Procedure Table (DoD + VA)				
DaVINCI Cohort	Frequency	Percent	Cumulative Frequency	Cumulative Percent
In Both	1,697,885,785	41.67	1,697,885,785	41.67
DoD Only	665,445,050	16.33	2,363,330,835	58.00
VA Only	1,711,061,807	42.00	4,074,392,642	100.00

For procedures, the median timespan between the first and last procedure in the combined OMOP model is 12.7 years for patients in both the DoD and VA data, vs. just 6.5 years for patients only in VA data:

# of Years between First and Last Procedure					
Cohort	N (# patients)	25th Pctl	50th Pctl	Mean	75th Pctl	99th Pctl
In Both	5,116,558	7.13	12.72	11.20	15.33	19.25
DoD Only	3,878,946	1.25	5.02	6.60	12.43	16.33
VA Only	10,076,639	1.33	6.52	7.56	13.26	18.60

Significant Overlap in Clinical Data

Likewise for the Visit_occurrence table, using the combined model shifts the median # years of data available about 6 years:

# of Years between First and Last Visit					
Cohort	N (# patients)	25th Pctl	50th Pctl	75th Pctl	99th Pctl
In Both	5,152,414	7.69	13.09	15.76	19.33
DoD Only	3,890,676	1.23	5.00	12.44	17.00
VA Only	10,823,640	1.52	7.47	14.19	19.07

Years
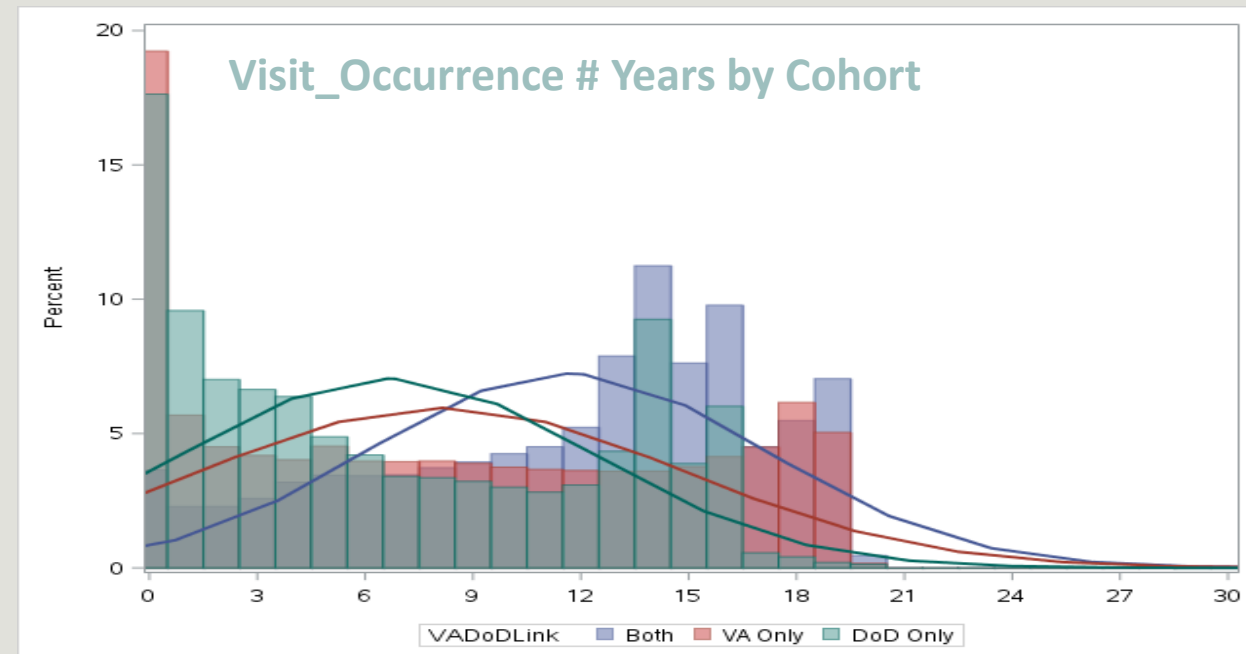
Limitations of DaVINCI

- No cost data, no deployment data

- DaVINCI cohort does not include the majority of family members

- Limitations of source data are reflected in DaVINCI (e.g., DoD Lab Results only go back to FY 09)

Examples of Research in MHS/DaVINCI

Examples Current Research Projects

MDR
- Clinical Examples:
  - Asthma (Vanderbilt)
  - Musculoskeletal Injuries/Surgeries
  - Mental Health/Suicide/TBI
  - Opioids
  - Wounded Warriors
  - OB/GYN
- Cost/Utilization/Policy
  - Price elasticity / Demand for healthcare
- Access to Care/GIS:
  - Drive time files
- AI/NLP
  - Google CRADA – radiology/pathology

DaVINCI
- Clinical research using:
  - Diagnosis Codes/SNOMED
  - CPTs
  - NDCs/RxNorm
- Long longitudinal studies
  - 10 years+
- The effect of transitioning between healthcare plans

Access to MDR/DaVINCI

MDR

- Guide to DoD Researchers on using MHS Data
  - https://health.mil/Reference-Center/Publications/2012/10/10/Guide-for-DoD-Researchers-on-Using-MHS-Data
- DoD Sponsor (Co-Investigator), Regulatory Paperwork (Protocol, IRB, Data Sharing Agreement)
- Extraction vs. Access

DaVINCI

- Operates under existing MOU between DoD and VA, so only need approval from VA or DoD, depending if working with a DoD or VA Sponsor (Co-Investigator)
- The VA's Health Services Research and Development (HSRD) website is a great resource for information and has a similar guidebook
  - https://www.hsrd.research.va.gov/for_researchers/cyber_seminars/archives/video_archive.cfm?SessionID=405

Thank you!!

Questions?

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