Examples of the EHR

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Examples of the EHR

- Using the Veterans Health Information Systems and Technology Architecture (VistA)
- Why VistA?
  - State-of-the-art EHR that has transformed healthcare in the Veteran's Health Administration (VHA) (Perlin, 2006; Byrne, 2010)
  - Not that pretty, but has all of the modern features of the EHR, e.g., clinical decision support (CDS), computerized provider order entry (CPOE), etc.
  - Distributed under open-source model, unlike most other vendors who do not even allow screen shots to be shown outside their customers' institutions
- Fascinating story (Allen, 2017), but VistA now being phased out in favor of Cerner EHR adopted by Department of Defense
  - https://www.ehrm.va.gov/

WhatIs06

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Some details about VistA

- Server written in M (formerly called MUMPS), accessed via command-line interface
  - Runs in commercial Intersystems Cache (on many platforms) or open-source GT.M (Linux only)
- Client (called CPRS) written in Delphi and providers graphical user interface
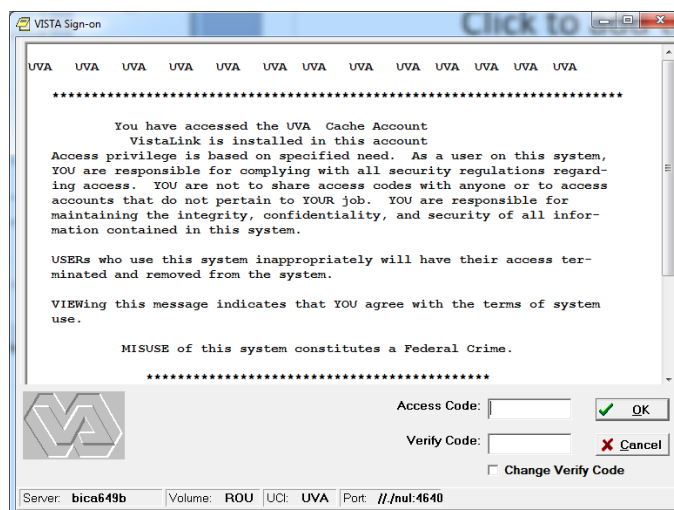 - Only runs on Windows (just about all versions)

WhatIs06   3

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Logging on to CPRS, the front end to VistA

WhatIs06   4

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Choosing a patient

Cover sheet – overview

Drilling down to details of a problem

7

Details of an allergy

8

Viewing vital signs over time

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More details on problems

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List of active orders

11

Viewing the patient's notes

12

Writing a new note

13

Viewing labs

14

Including critical values

15

More information on lab tests

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Including (for some) cost

Lab Test Description

Cbc	CBC $2.34
Cbc	Highest urgency allowed: STAT
Cbc & Diff (with Morphology)	Tests included in panel:
Cd4	WBC
Cd4 %	RBC
Cdf	HGB
Cea	HCT
Cell Count (fluid)	MCV
Ceruloplasmin	MCH
Chem 10 Test (bronx)	MCHC
Chem 20	RDW
Chem 3	PLATELET COUNT
Chem 4	MPV
Chem 7	
Chem/Ria Panel	
Chemistry Admission Panel	
Chemistry Fluids	

Close

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Another patient

VistA CPRS in use by: Doctor,One (BROKERSERVER)

File Edit View Tools Help

EIGHT,PATIENT
666-00-0008   Apr 07,1935 (75) Provider: DOCTOR,ONE

Visit Not Selected

Primary Care Team Unassigned

Flag VistaWeb Remote Data

Postings
CAD

Active Problems
- Headache
- Hypertension
- Hyperlipidemia
- Acute Myocardial Infarction, Unspecified Site, Episode Of Care Unspecified
- Chronic Systolic Heart Failure
- Diabetes Mellitus Type II Or Unspecified

Allergies / Adverse Reactions
- Penicillin
- Chocolate

Postings
- Allergies
- Crisis Note   May 21,2000
- Advance Directive Completed   May 16,2007
- Advance Directive   Oct 18,2000
- Advance Directive   Oct 18,2000

Active Medications
Metoprolol Tartrate 50mg Tab	Active	
Simvastatin 40mg Tab	Active	
Non-VA Aspirin 81mg Ec Tab	Active	

Clinical Reminders   **Due Date**
Depression Screening	DUE NOW
PC Nutritional Screening	DUE NOW
Diabetes - Urinalysis	DUE NOW
Influenza Vaccine	DUE NOW
Pneumococcal vaccine (Pneumovax)	DUE NOW

Recent Lab Results   **Vitals**
No Orders Found.

T	98.5 F	Mar 05,2010 09:00 (36.9 C)
P	74	Mar 05,2010 09:00
R	22	Aug 31,2009 10:00
BP	134/81	Mar 05,2010 09:00
HT	70 in	Aug 31,2009 10:01 (177.8 cm)
WT	178 lb	Mar 05,2010 09:00 (80.7 kg)
PN	1	Mar 05,2010 09:00
POX	98	Dec 01,2009 08:53
BMI	25.59	Mar 05,2010 09:00

Appointments/Visits/Admissions
Aug 26,10 21:19	Cardiology	Action Required
Aug 12,10 08:00	General Medicine	Action Required
Aug 11,10 08:00	General Medicine	Action Required
Aug 10,10 08:00	General Medicine	Action Required
Aug 09,10 08:00	General Medicine	Action Required

Cover Sheet | Problems | Meds | Orders | Notes | Consults | Surgery | D/C Summ | Labs | Reports

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Clinical decision support: reminders

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Clinical decision support uses allergy information

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Let's try to prescribe a medication

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How about some amoxicllin?

22

Oops, patient is allergic

Order Checking

Remote Order Checking not available - checks done on local data only

Previous adverse reaction to: (INACTIVE) PENICILLINS: (LOCAL)

Accept Order   Cancel Order

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Maybe erythromycin?

Medication Order

ERYTHROCIN   <ERYTHROMYCIN TAB >   Change

Dosage	Complex	Schedule	
250MG	ORAL (BY MOUTH)	BID	□ PRN

250MG
250MG   ORAL (BY MOUTH)   5XD
500MG   AT ONSET
500MG   BID
1000MG   BID AC
                               CONTINUOUS DRIP

Comments:

Days Suppl Pick Up   Priority
30   ○ Clinic ○ Mail ● Window   ROUTINE

ERYTHROMYCIN TAB 250MG   Accept Order
TAKE ONE TABLET BY MOUTH TWICE A DAY
Quantity: 60 Refills: 0   Quit

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No, interacts with statin drugs

Order Checking

CRITICAL drug-drug interaction: ERYTHROMYCIN & SIMVASTATIN (SIMVASTATIN TAB 40MG
TAKE ONE TABLET BY MOUTH EVERY EVENING [ACTIVE])

Accept Order   Cancel Order

Another patient – drug interactions

VistA CPRS in use by: Doctor,One (BROKERSERVER)

File Edit View Action Tools Help

ZZZTWO,IMAGEPATIENT   Visit Not Selected   Primary Care Team Unassigned   Flag   VistaWeb   No Postings
666-06-1002   Apr 15,1953 (57) Provider: DOCTOR,ONE   Remote Data

Sort by Status/Exp. Date (IMO first on Inpt)

Action	Outpatient Medications	Expires	Status	Last Filled	
	SILDENAFIL CITRATE 50MG TAB Qty: 10		Pending		
	Sig: TAKE ONE TABLET BY MOUTH AS NEEDED				
	ATORVASTATIN CALCIUM 40MG TAB Qty: 90		Pending		
	Sig: TAKE ONE TABLET BY MOUTH EVERY DAY				

Action	Non-VA Medications	Start Date	Status	

Action	Inpatient Medications	Stop Date	Status	Location

Cover Sheet | Problems | Meds | Orders | Notes | Consults | Surgery | D/C Summ | Labs | Reports
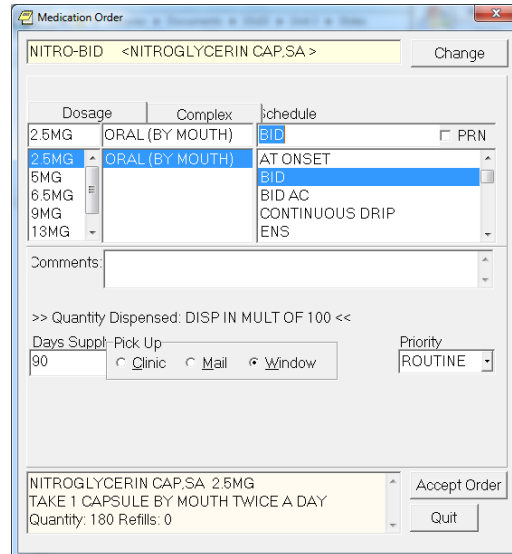
Prescribing nitrates for angina

Medication Order

NITRO-BID   <NITROGLYCERIN CAP,SA >   Change

Dosage	Complex	Schedule
2.5MG	ORAL (BY MOUTH)	BID □ PRN

2.5MG | ORAL (BY MOUTH) | AT ONSET
5MG | | BID
6.5MG | | BID AC
9MG | | CONTINUOUS DRIP
13MG | | ENS

Comments:

>> Quantity Dispensed: DISP IN MULT OF 100 <<

Days Suppl Pick Up   Priority
90   ○ Clinic ○ Mail ● Window   ROUTINE
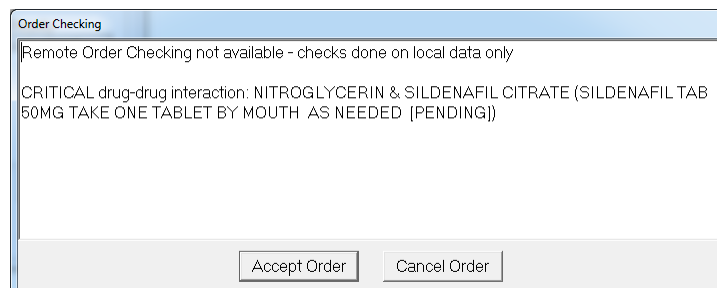
NITROGLYCERIN CAP,SA 2.5MG
TAKE 1 CAPSULE BY MOUTH TWICE A DAY
Quantity: 180 Refills: 0   Accept Order   Quit

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Oops!

Order Checking

Remote Order Checking not available - checks done on local data only

CRITICAL drug-drug interaction: NITROGLYCERIN & SILDENAFIL CITRATE (SILDENAFIL TAB 50MG TAKE ONE TABLET BY MOUTH AS NEEDED [PENDING])

Accept Order   Cancel Order

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More about VistA

- Pure open-source version is also known as FOIA VistA
- There are two other streams of VistA activity
  - WorldVistA (http://worldvista.org/) follows a more traditional open-source pathway
  - OpenVista more commercially oriented, and some vendors have proprietary extensions from the base code (e.g., https://www.medsphere.com/)
- Transitioning to commercial Cerner EHR
  - Based on success of nearly complete transition by US Department of Defense
    - https://www.health.mil/Military-Health-Topics/Technology/MHS-GENESIS
  - But VA transition has been much more problematic (GAO, 2023)
    - https://www.ehrm.va.gov/

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Other open-source EHRs

- Most recent analysis of free and open-source EHR systems (Purkayastha, 2019)
  - Many downloads but tiny operational usage
- Only two currently have ONC certification
  - OpenEMR – https://www.open-emr.org/
  - WorldVista – https://worldvista.org
- More use of other noteworthy systems
  - Indian Health Service Resource and Patient Management System (RPMS) – derived from VistA; future unclear (HIS, 2019; Cullen, 2020)
    - http://www.ihs.gov/rpms/
  - OpenMRS – https://openmrs.org/
  - OpenEHR – https://www.openehr.org/
  - LibreHealth – https://librehealth.io/

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Despite appeal of open source, EHR market belongs to commercial vendors

- Market leader is Epic (Newman, 2019; Jennings, 2021)
  - https://www.epic.com/
  - Company privately held
  - Over 40 years old
  - Run by CEO Judy Faulkner
  - Lynchpin of Madison, WI economy (Eisen, 2020)
- Early research-oriented "home grown" EHR systems have given way to commercial systems (Hersh, 2017)
- Second-largest EHR is Cerner, which was purchased by DBMS vendor Oracle in 2022 (Landi, 2022)

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How did Epic come to dominate EHR market?

- Halamka (aka, Geek Doctor) noted "Era of Epic," where integration and vendor performance trump innovation and "best of breed" (Halamka, 2013)
  - Epic dominates high end of market, e.g., academic and other large medical centers
  - "No one ever got fired for buying Epic"
  - Epic methodology focuses on workflow
  - Product cycle creates effective demand management
- Epic focuses on integration – hospital and ambulatory, revenue cycle and billing, etc., especially in large medical centers (Bruce, 2023)
- Epic touts itself as "healthcare company," different from technology companies (Perna, 2023)
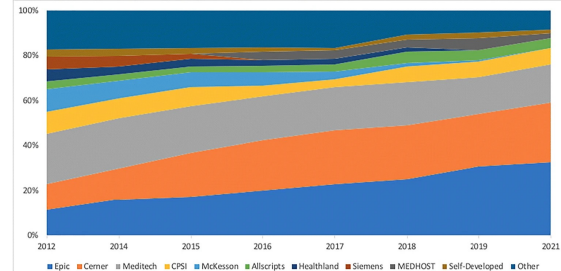- Almost all EHR vendors focused only on healthcare market

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US EHR market share

- Hospital EHR market has consolidated around two vendors – Epic and Cerner – especially among large hospitals (Holmgren, 2022)
- Four vendors provided service to largest hospitals (>500) beds in 2018 (Landi, 2020)

a EHR Vendor Market Share by Number of Hospitals, 2012-2021

b EHR Vendor Market Share by Number of Beds, 2012-2021
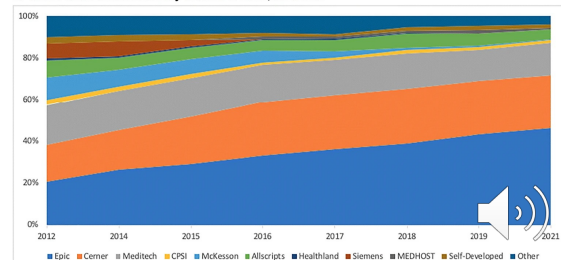
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Ambulatory EHR marketplace in US (Definitive Healthcare, 2022)

Rank	Vendor	# of Installs	% of Market Share
1.	Epic Systems Corporation	2,502	41.10%
2.	Oracle Cerner	1,413	23.21%
3.	MEDITECH	805	13.22%
4.	Evident, a CPSI Company	486	7.98%
5.	Allscripts	182	2.99%
6.	Athenahealth	123	2.02%
7.	Altera Digital Health, a Harris Company	99	1.63%
8.	Netsmart Technologies	78	1.28%
9.	eClinicalWorks	41	.67%
10.	Proprietary Software	39	.64%

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