Data Standards:
Electronic Health Record Systems

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Educational Objectives

• Learn the need for EHRs
  – Use of the EHRs
  – Understand advantages/disadvantages of computer-based records

• Promoting adoption: Identify key components of an EHR system
  – Recognize the role standards play in HIT
  – Understand the principles and purpose of controlled terminologies
Need for EHR = CDSS: Medical Errors

Estimated annual mortality
Air travel deaths 300
AIDS 16,500
Breast cancer 43,000
Highway fatalities 43,500
Preventable medical errors 44,000 -
(1 jet crash/day) 98,000

Costs of Preventable Medical Errors:
$29 billion/year overall

Need for EHR/CDSS: Evidence of Poor Performance

• USA: Only 54.9% of adults receive recommended care for typical conditions
  – community-acquired pneumonia: 39%
  – asthma: 53.5%
  – hypertension: 64.9%

• Delay in adoption: 10+ years for adoption of thrombolytic therapy

Rationale: “Meaningful Use”

- Monetary incentive program created by ARRA HITECH (2009): Payments by CMS for participation

- **Key ingredients:** Use information technology “meaningfully” (eRx), health data exchange, reporting quality measures

- **Phases**
  - Stage I (2011-2012): Hospitals report 20/24 quality measures
  - Stage II (2013): Electronic data exchange (structured lab data, immunization registries), listing patients by condition, etc
  - Stage III (2017+): 2015 NPRM just closed for public comment

Examples of EHR/CDSS Effectiveness

- **Reminders of Redundant Test Ordering**
  - *intervention*: reminder of recent lab result
  - *result*: reduction in hospital charges (13%)  

- **CPOE Implementation**
  - Population: hospitalized patients over 4 years
  - Non-missed-dose medication error rate fell 81%
  - Potentially injurious errors fell 86%  
Examples (continued)

- **Systematic review**
  - 68 studies
  - 66% of 65 studies showed benefit on physician performance
    - 9/15 drug dosing
    - 1/5 diagnostic aids
    - 14/19 preventive care
    - 19/26 other
  - 6/14 studies showed benefit on patient outcome

Examples (continued)

- **Systematic review:** Meaningful use of EHRs
  - Evaluated studies of health IT functionalities prescribed by recent regulations to key aspects of health care
  - N = 236 studies
  - Main focus = CDS & CPOE (57%)
  - Conclusions:
    - 56% reported uniformly positive results
    - 21% reported mixed positive results

Example (negative) (sort of)

- **Adverse consequences of HIT:** CPOE (Cerner PowerChart) in Children’s Hospital of Pittsburgh
  - N = 1492 admissions 13 months before to 5 months after CPOE
  - Mortality rate: 2.80% -> 6.57%
  - Probably not a fair test: CDS not enabled, workflow not re-engineered

- **Recognition of Challenges**
  - Growing literature on the topic
  - Implementation issues: How you do EHRs/CDS is key
  - Conclusion: HIT is not a panacea

EHR = EMR + PHR + CPOE + (etc)

- **EMR:** A computer-accessible resource of medical and administrative information available on an individual collected from and accessible by providers involved in the individual’s care within a single care setting.

- **EHRs:** A computer-accessible, interoperable resource of clinical and administrative information pertinent to the health of an individual. Information drawn from multiple clinical and administrative sources is used primarily by a broad spectrum of clinical personnel involved in the individual’s care, enabling them to deliver and coordinate care and promote wellness.

ONC Terms Standardization Project, Defining Key Health IT Terms, Interim Draft Report, 21 February 2008
Uses of the Medical Record

- **Main purpose:** Facilitate patient care
- **Historical record:** What happened, what was done
- **Communication among providers (and patients)**
- **Preventive care (immunizations, etc)**
- **Quality assurance**
- **Legal record**
- **Financial:** coding, billing
- **Research:** prospective, retrospective
Characterizing the Record: Representing the Patient’s True State

True State of Patient

Diagnostic study

Clinician

Paper chart

Dictation

Data entry clerk

Transcription

CPR/Chart Representation

Hogan, Wagner. JAMIA 1997;4:342-55
Characterizing the Record: Representing the Patient’s True State

- **Completeness:** Proportion of observations actually recorded
  - 67 - 100%

- **Correctness:** Proportion of recorded observations that are correct
  - 67 - 100%
History of the Medical Record

- **1910:** Flexner Report--Advocated maintaining patient records
- **1940s:** Hospitals need records for accreditation
- **1960s:** Electronic HIS--communication (routing orders) & charge capture
- **1969:** Weed--POMR
- **1980s:** IOM report, academic systems
- **1990s - present:** Increasing commercial systems, increasing prevalence, emphasis on interoperability & standards (ONCHIT, etc)
Trend Toward Outpatient Records

• Inpatient record structured first
  – Regulatory requirement
  – Many contributors (vs solo family practitioner)
  – Reimbursement: More money than outpatient visits

• Now, more attention to outpatient records
  – Multidisciplinary/team care
  – Managed care
Who Enters Data

- Clerk
- RHIT = health record professionals
- Physician: Primary, consultant, extender, “medical scribe”
- Nurse
- Therapist
- Lab reports/ancillary systems
- Machines: Monitors, POC testing
Fundamental Issue: Data Entry

- **Data capture**: External sources
  - Laboratory information systems, monitors, etc
  - Challenges: Interfaces, standards

- **Data input**: Direct entry by clinicians & staff
  - Challenge: Time-consuming and expensive
  - “Free text” vs structured entry
Data Input

- **Transcription of dictation:** Very expensive, error-prone
- **Encounter form:** Various types
  - Free-text entry
  - Scannable forms
- **Turnaround document:** Both presents & captures data
- **Direct electronic entry**
  - Free-text typing
  - Structured entry: Pick lists, etc
  - Voice recognition
Weakness of Paper Record

- Find the record: Lost, being used elsewhere
- Find data within the record: Poorly organized, missing, fragmented
- Read data: Legibility
- Update data: Where to record if chart is missing (e.g., “shadow chart”)
- Only one view
  - Redundancy: Re-entry of data in multiple forms
  - Research: Difficult to search across patients
- Passive: No decision support
Advantages of Computer Records

• Access: Speed, remote location, simultaneous use (even if just an “electronic typewriter”)
• Legibility
• Reduced data entry: Reuse data, reduce redundant tests
• Better organization: Structure
• Multiple views: Aggregation
  – Example: Summary report, structured flow sheet (contrast different data types)
  – Alter display based on context
Advantages of Computer Records (continued)

- Automated checks on data entry
  - Data prompts: Completeness
  - Range check (reference range)
  - Pattern check (# digits in MRN)
  - Computed check (CBC differential adds to 100)
  - Consistency check (pregnant man!)
  - Delta check
  - Spelling check
Advantages of Computer Records (continued)

• **Automated decision support**
  – Reminders, alerts, calculations, ordering advice
  – Limited by scope/accuracy of electronic data
    • Tradeoff: Data specificity/depth of advice vs time/cost of completeness

• **Cross-patient analysis**
  – Research
  – Stratify patient prognosis, treatment by risks

• **Data review**: Avoid overlooking uncommon but important events
Advantages of Computer Records (continued)

- Saves time?
  - 1974 study: find data 4x faster in flow sheet vs traditional record (10% of subjects could not even find some data)
  - 2005 systematic review
    - RN POC systems: decreased documentation time 24%
    - MD: increased documentation time 17%
      - CPOE: More than doubled time

Key Ingredients for EHR Success

• Wide scope of data
• Sufficient duration of data
• Understandable representation of data
• Sufficient access
• Structured data: More than just a giant word processor
Disadvantages of Computer Records

• **Access:** Security concerns
  – Still, logging helps track access
• **Initial cost**
  – **Attempted solutions:** Reimbursement, Office VistA
• **Delay between investment & benefit**
• **System failure**
• **Challenge of data entry**
• **Coordination of disparate groups**
• **Data diversity:** Different data elements, media (images, tracings), format, units, terminology, etc
Examples: “Classical” EHRs

- **COSTAR: MGH (Barnett et al)**
  - Originally in 1960s, disseminated in late 1970s
  - Encounter form input
  - Modular design: security, registration, scheduling, billing, database, reporting
  - **MQL:** ad hoc data queries
  - Display by encounter or problem (multiple views)
“Classical” EHRs (continued)

- **RMRS**: McDonald (IU), 1974
- **TMR**: Stead & Hammond (Duke), 1975
- **STOR**: Whiting-O’Keefe (UCSF), 1985
Commercial EHRs

- **Trend:** Vendor-supported solutions as technology has diffused
  - **Range:** General medical practice to highly specialized

- **Examples**
  - **General:** Centricity, Epic, Eclipsys, Siemens, Cerner, Office VistA EHR
  - **Research:** Remedy MD, Velos
  - **Specialized:** Tele-Results (transplant)
Adoption

• No advantage if not used!
• **Varying prevalence in USA**
  – 20% (MGMA, January, 2005)
  – 17% (CDC ambulatory medical care survey 2001-3, published March, 2005)
  – **Now:** Approximately 50% (“meaningful use”)
• **Higher prevalence elsewhere**
  – Netherlands = 90%, Australia = 65%
  – **Reasons:** Single-payer system, certification, cost-sharing
Barriers to EHR Adoption

- **Financial**: Up-front costs, training, uncertain ROI (misalignment of benefits & costs), finding the right system
- **Cultural**: Attitude toward IT
- **Technological**: Interoperability, support, data exchange
- **Organizational**: Integrate with workflow, migration from paper
Improving Adoption Technologically: Key EHRs Components

- **Support: Compensation**
  - “Meaningful Use”, P4P
  - Beacon communities & other support

- **“Data” standards: Semantic interoperability**
  - Functional definition
  - Data models, DBMS, terminology

- **HIEs: Exchange data**
  - Messaging
Improving Adoption: EHR Functional Model & Specification

- HL7 2004: Funded by US Government
- Identifies key functions of the EHR
- Purpose
  - Guide development by vendors
  - Facilitate certification
  - Facilitate interoperability
- Certification governance: CCHIT
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<td>Capture, review, and manage medical, procedural, social, and family history including the capture of pertinent negative histories, patient-reported or externally available patient clinical history.</td>
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Improving Adoption:
ONC Beacon Communities

• **Goal:** Improve coordination & delivery of care via HIE

• **EHRs** = one component

• **Deliverables/Resources**
  – Template data-sharing agreements
  – HIE infrastructure
  – Technical assistance

• **Nearest:** San Diego Health Connect
  (http://sdhealthconnect.org/)
Improving Adoption: Office VistA

- **VistA**: Veterans Information System Technology Architecture
  - M-based comprehensive VA EHR
  - Includes CPRS = Computer-based Patient Record System
- **Office VistA**
  - Outpatient version
  - Due for release Q4 2005 (available under FOIA)
- **Challenge**: Free up front, but need to implement and maintain
Standard Data Models

• **Candidates**
  – RIM = HL7 Reference Information Model
  – vMR = Virtual Medical Record
  – FHIR = Fast Health Interoperable Resources

• **Purpose:** Promote semantic interoperability
  – Data stored, retrieved, interpreted, displayed and analyzed with the same meaning as when first captured
  – References to data (CDS, research studies, etc) can be shared regardless of vendor or implementation
Standard Data Models: HL7 RIM

- High-level, abstract model of all exchangeable data
  - Concepts are objects: Act (e.g., observations), Living Subject, etc
  - Object attributes
  - Relationship among objects

- Common reference for all HL7 v3 standards

- Facilitates interoperability: Common model for messaging, queries

Schadow G, Russler DC, Mead CN, McDonald CJ. Integrating medical information and knowledge in the HL7 RIM. Proc AMIA Symp 2000;:764-768.
Improving Adoption: CCR / CCD

- ASTM E31 WK4363 (2004). Coalition = AAP, AAFP, HIMSS, ACP, AMA, etc
- Defines the core data elements & content of the patient record in XML
  - Read/write standard data elements: Snapshot of the record
  - Therefore increases interoperability
- Uses: Record sharing, eRx (allergies, medications), certification
- Components: standard content; elements spreadsheet; implementation guide; XML schema
- CCD = CCR implemented using HL7 CDA
<xml version="1.0" encoding="UTF-8" ?>
  <ContinuityOfCareRecord xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
    xsi:schemaLocation="urn:astm-org:CCR:CORE9.xsd" xmlns="urn:astm-org:CCR">
    <CCRDocumentObjectID>6324855902973434750</CCRDocumentObjectID>
    <DateTime>2005-04-08T12:10:29Z</DateTime>
    <Patient>
      <ActorID>AA0001</ActorID>
    </Patient>
    <From>
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        <ActorID>AA0002</ActorID>
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        </ActorRole>
      </ActorLink>
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            <Type>
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            </Type>
            <ExactDateTime>1999-04-01T05:00:00Z</ExactDateTime>
          </DateTime>
        </Problem>
      </Problems>
    </Body>
  </ContinuityOfCareRecord>
Virtual Medical Record (vMR): RIM for Decision Support

- **Goal:** Provide common information model upon which interoperable clinical decision support resources (e.g., rules) can be developed

- **Status:** R1 adopted in 2011 as HL7 standard, with subsequent logical model and implementation guides

- More detailed than the high-level RIM
vMR Problem Model

DeniedProblem

Problem
+ ageAtOnset :PQ [0..1]
+ importance :CD [0..1]
+ problemStatus :CD [0..1]
+ severity :CD [0..1]
+ wasCauseOfDeath :BL [0..1]

ProblemBase
+ affectedBodySite :BodySite [0..*]
+ diagnosticEventTime :IVL_TS [0..1]
+ problemCode :CD
+ problemEffectiveTime :IVL_TS [0..1]

BodySite
+ bodySiteCode :CD
+ laterality :CD [0..1]

ClinicalStatement
+ dataSourceType :CD [0..1]
+ id :II
+ templateId :II [0..*]
Why Not Just Use the CCD as the vMR?

- CCD does not include all needed information
  - E.g., Family history model suitable for CDS

- CCD is not sufficiently intuitive for direct use by CDS knowledge authors
FHIR

• New HL7 data model (DSTU R1.1)
  – (Probably) replaces (discredited) v3 RIM

• Data model = flat collection of “resources”
  – HL7 addressing the challenge of hierarchy

• Resource: Object with attributes representing a (more or less) atomic concept
  – Patient, provider, blood pressure, etc

• Ongoing development effort: Creating libraries of resources for use in applications such as CDS

http://www.hl7.org/implement/standards/fhir/
FHIR Example: Patient

```xml
<Patient xmlns="http://hl7.org/fhir">
  <extension url="http://www.goodhealth.org/consent#trials">
    <valueCode value="renal"/>
  </extension>
  <text>
    <status value="generated"/>
    <div xmlns="http://www.w3.org/1999/xhtml">
      <p>Henry Levin the 7th</p>
      <p>MRN: 123456</p>
    </div>
  </text>
  <identifier>
    <use value="usual"/>
    <label value="MRN"/>
    <system value="http://www.goodhealth.org/identifiers/mrn"/>
    <value value="123456"/>
  </identifier>
  <name>
    <family value="Levin"/>
    <given value="Henry"/>
    <suffix value="The 7th"/>
  </name>
  <gender>
    <text value="Male"/>
  </gender>
  <birthDate value="1932-09-24"/>
  <managingOrganization>
    <reference value="Organization/2"/>
    <display value="Good Health Clinic"/>
  </managingOrganization>
  <active value="true"/>
</Patient>
```
Database Management System

- **DBMS = suite of domain-independent programs for managing data**
- **Typical model = relational (data in “tables”)**
- **Functions**
  - Data entry forms
  - Security: Access control & backup
  - Data modeling (schema implementation)
  - APIs for linkages to other software
  - Data integrity: Type-checking, consistency-checking
- **Typical commercial DBMS: Access (low end), Oracle**
Standard Vocabularies

• CHI + NCVHS efforts: Patient Medical Record Information (PMRI) terminology standards

• Examples: SNOMED-CT, ICD-9, LOINC, CPT, etc

• Facilitation: Free licensing of SNOMED in USA as part of UMLS

• Use: HL7 Common Terminology Services (CTS) standard
What is a vocabulary?

- **Terminology**: Controlled list of concepts
- **Vocabulary**: 1+ terminologies with additional information (relationships, definitions, etc)
- **Controlled**: Limited list of terms (clinician may not use any old term to express a concept)
- **Structured**: Concepts have explicit relationships (ISA, PART-OF, etc) that create a hierarchy with classes & subclasses of related concepts
Vocabulary Structure

- Medical Entity
  - Substance
    - Chemical
      - Carbohydrate
    - Bioactive Substance
      - Glucose
  - Laboratory Specimen
    - Plasma Specimen
      - Plasma
        - Subsampled
      - Has Specimen
        - Plasma Glucose
          - Substance Measured
  - Event
    - Diagnostic Procedure
      - Laboratory Procedure
        - Part of CHEM-7
    - Laboratory Test
      - Has Specimen
        - Plasma Glucose
Concept Structure

• Plasma Glucose
  – CSMC code
  – SNOMED code
  – Misys code
  – Reference range lower limit
  – Reference range upper limit
  – Units
  – Analyte
  – ...
Why do we need one? Uses

- Comprehensive data dictionary: Describe data collected electronically
- Different names for the same thing
  - Data stored using one coding scheme can be translated to another
  - Data from different sources can be stored using a consistent set of concepts
- Uniform representation of data
  - Queries for the CDR, data warehouse
Standard Vocabularies: Examples

• **Endorsed by CMS** (45 CFR 162 = HIPAA requirement)
  – ICD9-CM (ICD10 in Canada/Europe)
  – NDC
  – CPT-4
  – HCPCS (subsumes CPT + non-MD services)
  – Code on Dental Procedures & Nomenclature

• **Others**
  – SNOMED (sponsored by IHTSDO)
  – LOINC
CDEs

- **Challenge:** Burgeoning electronic means for capturing data, but those data are not necessarily standardized
  - Example: REDCap
- **Goal:** Create standard libraries of instrument items and coded answer lists
  - Example: PROMIS (now coded in LOINC)
- **Multiple efforts underway**
  - NIH: ORDR, NINDS, NCI
- **Challenge:** Decentralized efforts not coordinated

Additional Standards: CHI

- Consolidated Health Informatics initiative = health care portion of eGov
- Coalition of DoD, VA and HHS
- Endorsed common standards (3/2003)
  - HL7: messages
  - NCPDP: ordering from pharmacies
  - IEEE 1073: Medical Information Bus (devices)
  - DICOM: imaging
  - LOINC: laboratory, vital signs
UMLS

• NLM’s Unified Medical Language System
  – Goal: Facilitate access to bibliographic material

• Interlingua of multiple terminologies (LOINC, SNOMED, ICD, MeSH, etc)
  – Built-in tools
  – Commercial applications: Apelon, Health Language Inc

• Parts
  – Metathesaurus: Codes + terms
  – Information Sources Map (ISM): Where knowledge is (journals, electronic textbooks, etc)
  – Semantic Network: Concept relationships
Standard Messaging: Health Level Seven

- Defines the envelope in which data travel
  - Vocabularies define the data themselves
  - v2.x: Predefined message formats consisting of “segments,” each of which has “fields”
  - V3: Model-based messaging

- Simplifies system implementation
  - Each interface does not mean reinventing the wheel

- HL7: Started as a messaging scheme
  - Most organizations use v2.x
  - V3 (model-based XML) supposedly was future, now in doubt
HL7 Message Example

MSH!^~\&!resquery!cicsu9!bobsqry!cucis!19930330102416611!!OR
F!19930330102416611!P!2.1!""
MSA!AA!19920720113142729000!RESULT LIST COMPLETED.!!
QRD!19920720113142!RI!0113142729!!1!3131313!RES!*!!
QRF!*!19900601000000!19930203000000!PDQRES2~*~*!78~56~54~PF~
0001CM01921223144005~A~*~*~*~*~*
OBR!!CM01921223765005!19921227651300344321!2203^^L^2235^^L!N
!!1992122318130000000!!!!!!!!!!!!!!1992122819523961234!!!F!
!!!!!!!!!!
OBX!!TX!910^^L^315^^L!1^0!KLEBSIELLA PNEUMONIAE!!!!!!!
OBX!!TX!1235^^L^1181^^L!2^1!>16 R!!!!!!!
OBX!!TX!1187^^L^1181^^L!3^1!S S!!!!!!!
OBX!!TX!1184^^L^1181^^L!4^1!16 R!!!!!!!
OBX!!TX!1193^^L^1181^^L!5^1!>64 R!!!!!!!
OBX!!TX!1223^^L^1181^^L!6^1!<1 S!!!!!!!
Improving Adoption: HIEs

• **Facilitates interoperability:** Mechanism for exchanging data between organizations
• **Important elements**
  – **Standards:** Messaging, data model, terminology
  – **Mechanism:** Clearinghouses
• **Part of a federated NHIN**
• **Important driver:** Public health
  – Integrate data from many HCOs
  – Syndromic surveillance (e.g., RODS, etc)
• **Examples:** Santa Barbara; Indiana; CalRHIO
Archetypal Hospital EHRs

• **Components**
  – Repositories: CDR, CDW
  – HL7 communication interfaces (lab, imaging, etc)

• **Accessing data**: Electronic health records
  – Browser-based portal & viewing
  – Ambulatory EMRs (Centricity, Epic, etc)
  – CPOE (Epic, AllScripts, McKesson, etc)

• **Knowledge sources**
  – Electronic textbooks
  – Bibliographic access
  – InfoButtons
  – Order Sets
ClinicianPortal

Clinical Resources
- MedStar Online Clinical Library (CCL)
- ePocrates RX Online + AHFS DI
- Evidence-Based Medicine
- MedStar Ambulatory Guidelines
- Journals
- Patient Education
- Textbooks
- Point of Care
- Medication Safety
- Clinical Trials

Patient Data
- webAzxxi 2.0 (Best for viewing images)
- webAzxxi 3.0 (Best for viewing Clinical Data)
- Medical Records Document Imaging (MRDI)
- HealthConx
- POAccess Clinsumm

Clinician Practice Resources
- MedStar Centricity Ambulatory EHR Project
- CME Courses
- Discounts on Technology
- Information about Medicare Part D
- OR Scheduling
- Clinical Documents

Hospital Information
- HIM Vacation Notification
- Physician Referral
- Departmental Directories
- MedStar e-Learning
- Lotus Notes Webmail (iNotes)

Announcements
- Passfaces Replaces eToken for Remote Access to webAzxxi MRDI:
  Previously, clinicians accessed the webAzxxi MRDI with a user ID, password and a second
  method of authentication that included a hardware eToken and software installed on your remote
  computer. Now, MedStar is replacing the second form of authentication – eTokens – with a new
  solution called Passfaces.
  Passfaces is entirely Web-based and uses facial recognition. It does not require the use of an
  eToken or software. It takes only a moment to enroll, and is easy to use from any computer
  outside the MedStar network.
  To enroll, click on the “Enroll in Passfaces” button on your left.
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<td>Preliminary E.R. TREATMENT RECORD by Magee</td>
<td>Result No. 01423216651</td>
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</tr>
<tr>
<td>7/5/03 23:23</td>
<td>7/6/03</td>
<td>Brain EXP CHEST PORTABLE 1 VW by Mehrsee</td>
<td>Result No. 3294812</td>
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</tr>
<tr>
<td>7/5/03 23:21</td>
<td>7/5/03</td>
<td>ROUTINE BLOOD COUNT</td>
<td>Accession No. 538560</td>
<td>4.11-10.00/UL</td>
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<tr>
<td></td>
<td></td>
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<td>9.6</td>
<td>4.11-10.00/UL</td>
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<td></td>
<td>RBC COUNT</td>
<td>3.23</td>
<td>4.5-6.0 MILL/UL</td>
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<td>HEMOGLOBIN</td>
<td>16.3</td>
<td>14.1-18.0/UL</td>
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<td>42.3-52%</td>
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<tr>
<td></td>
<td></td>
<td>MCV</td>
<td>84.2</td>
<td>80-100 FL</td>
</tr>
<tr>
<td></td>
<td></td>
<td>MCH</td>
<td>29.4</td>
<td>27-33 P0</td>
</tr>
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<td></td>
<td></td>
<td>MCHC</td>
<td>34.7</td>
<td>32-36%</td>
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<tr>
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<td></td>
<td>RBC ESTRIBUT WIDTH</td>
<td>15.1</td>
<td>11.3-14.5 %</td>
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<tr>
<td></td>
<td></td>
<td>PLATELET SCREEN</td>
<td>306000</td>
<td>150000-400000/UL</td>
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<td>MEAN PLATELET VOL</td>
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<td>7.4-10.4 FL</td>
</tr>
<tr>
<td>7/5/03 23:21</td>
<td>7/5/03</td>
<td>DIFF, AUTOMATED</td>
<td>Accession No. 538560</td>
<td>%</td>
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<td>POLYS</td>
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<td>MONOS</td>
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<tr>
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<td>EOS</td>
<td>4</td>
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<td></td>
<td></td>
<td>BASOS</td>
<td>1</td>
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<tr>
<td></td>
<td></td>
<td>ABS POLYS</td>
<td>3.5</td>
<td>1.8-8.0 1000/UL</td>
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<tr>
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<td></td>
<td>ABS LYMPS</td>
<td>3.1</td>
<td>1.0-4.5 1000/UL</td>
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<tr>
<td></td>
<td></td>
<td>ABS MONOS</td>
<td>0.6</td>
<td>&lt;0.8 1000/UL</td>
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<tr>
<td></td>
<td></td>
<td>ABS EOS</td>
<td>0.3</td>
<td>&lt;0.4 1000/UL</td>
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<tr>
<td></td>
<td></td>
<td>ABS BASOS</td>
<td>0.1</td>
<td>&lt;0.2 1000/UL</td>
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<tr>
<td></td>
<td></td>
<td>RBC MORPHOLOGY</td>
<td>ABNORMAL</td>
<td></td>
</tr>
</tbody>
</table>
ADENOSINE MYOCARDIAL PERFUSION STUDY

Reason: chest pain
Symptoms: atypical chest pain
Medications: beta blocker, calcium blocker

STRESS TEST RESULTS: Type: walking adenosine
- Peak heart rate: 102 bpm
- Blood pressure: Rest: 148/92 Stress: 160/84
- Symptom during test: none
- Resting ECG: 1st degree A-V block, nonspecific T wave abnormality
- Stress ECG: no S-T segment depression

NUCLEAR RESULTS: Dual isotope gated SPECT (stress rest) 18 min rest
- Myocardial Perfusion results: Total defect 0% myocardium (0% reversible, 0% fixed)
- Myocardial Function results: Rest: 1.09, 1.62
- Post stress: 38 min after: 1.17

CONCLUSION:
- Clinical response: Nonspecific
- ECG response: Nonspecific
- Function: Normal

These test results indicate a low (<10%) likelihood for the presence of jeopardized myocardium.

Based on 3,873 patients undergoing adenosine myocardial perfusion SPECT at Cedars-Sinai Medical Center and followed for 2.2 ± 1.1 years, the combined clinical, adenosine stress ECG and perfusion SPECT results observed in this patient are predictive of an annual cardiac death rate of <0.2%. These estimates do not take into account ventricular function or the results of previous testing.

Thank you for referring this patient to us.

Sincerely yours,

[Signature]

John D. Friedman, MD
Cardiac Imaging Specialist
JDF/JDF

16/10/2003 09:24 Printed: 16/10/2003 11:17

tcc@cs.cc.ucsf.edu Fax: 310-423-0925

<table>
<thead>
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<td>LFT</td>
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<td>RBC</td>
<td>1.0 - 4.5</td>
</tr>
<tr>
<td>WBC</td>
<td>4.0 - 10.0</td>
</tr>
<tr>
<td>Hgb</td>
<td>11.5 - 14.5</td>
</tr>
<tr>
<td>MCV</td>
<td>80-100 Fl</td>
</tr>
<tr>
<td>PLT</td>
<td>27-33 Fl</td>
</tr>
<tr>
<td>24-hour</td>
<td>32-36%</td>
</tr>
<tr>
<td>Hct</td>
<td>11.5 - 14.5</td>
</tr>
</tbody>
</table>
Results reported from 4/24/03 through 4/30/04

CEDARS-SINAI MEDICAL CENTER

EMERGENCY TREATMENT RECORD
07/05/2003

CHIEF COMPLAINT: Chest pain.

HISTORY OF PRESENT ILLNESS: A 35-year-old black male presents with chest pain. The patient reports that about 2-3/8 to 3 hours ago, he began complaining of a mild left-sided chest pain. He said he only noticed the pain with movement of the chest and the left arm. He said that he has no pain at the present time. He has no pain at rest. He has not had a similar problem in the past. He said the pain came on after he was wrestling with a 7-year-old child. He has had no shortness of breath. No nausea, no vomiting, no sweating, no cough, no spuets, no hemoptysis, no fever, no night sweats and no chills.

PAST MEDICAL HISTORY: Aortic valve replacement five months ago.

MEDICATIONS: Leotin, Norvasc, hydrochlorothiazide, aspirin.

ALLERGIES: NO KNOWN DRUG ALLERGENS.

SOCIAL HISTORY: The patient smokes, occasional alcohol, no drugs. Lives with girlfriend.

EMERGENCY DEPARTMENT REVIEW OF SYSTEMS: All systems were reviewed and all systems were negative, except for HPI.

PHYSICAL EXAMINATION: GENERAL: A well-appearing black male, in no distress. He is alert and oriented to person, place, and time. He is in no apparent distress. He is in good condition. He is afebrile, normotensive, and pulse is regular.

LABS:

- ABS POLYS: 2.5
- ABS LYMPHES: 3.1
- ABS MONOS: 0.6
- ABS EOS: 0.3
- ABS BASOS: 0.1
- RBC MORPHOLOGY: ABNORMAL

Ref. Range:

- RBC: 4.11-10.00x10^6/UL
- WBC: 4.5-7.5x10^3/UL
- PLT: 150-400x10^3/UL
- Hgb: 13.5-16.5 g/dL
- Htc: 39-46%
- MCV: 80-100 FL
- MCH: 27-33 pg
- MCHC: 32.5-36.0 g/dL
- RDW: 11-14.5
- BUN: 8-20 mg/dL
- Creat: 0.7-1.7 mg/dL
- Na: 135-145 mEq/L
- K: 3.5-5.0 mEq/L
- CO2: 22-28 mEq/L
- Glucose: 60-100 mg/dL
# Physician Encounter Form

**Patient Name:** JENDERS, ROBERT  
**Medical Rec. No.:** 001417091  
**Date of Admit:**  

**Admitting Physician:**  
**Date of Service:**  

**Referring Physician:**  
**Date of Injury:**  

**Billing Physician:** ROBERT A. JENDERS (379)  
**Physician Email:** jenders@csem.edu  

**Resident:**  
**Assistant’s Email:**  

**I attest that:**  
- I personally provided the services indicated.  
- I was physically present and directly participated with the resident/fellow in the patient's care (CC modifier for Medicare only).  
- I am a primary care physician for this patient.  
- I am a consultant for this patient.  

## Evaluation and Management

### History
- **(PF) Problem Focused**
  - Brief HIPI (1-3 elements)  
- **(EF) Expanded Problem Focused**
  - Basic HIPI (1-3 elements)  
  - Problem pertinent ROS (1 system)  
- **(D) Detailed**
  - Extended HIPI (4 or more)  
  - Extended ROS (2-5 systems)  
  - Pertinent PFSH (1 area)  

### Exam
- **(PF) Problem Focused**
  - Limited exam of affected body area or organ system  
- **(EF) Expanded Problem Focused**
  - Limited exam of affected body area or organ system (up to 7)  
- **(D) Detailed**
  - Extended exam of affected body area or organ system (up to 7 in depth)  

### Medical Decision Making
- **(SF) Straightforward** (2 of 3)
  - Minimal input options/Dx  
  - Minimal risk  
- **(LC) Low Complexity** (2 of 3)
  - Minimal input options/Dx  
  - Limited data  
  - Low risk  
- **(MC) Moderate Complexity** (2 of 3)
  - Multiple input options/Dx  
  - Moderate data  
  - Moderate risk  
- **(HC) High Complexity** (2 of 3)
  - Extensive input options/Dx  
  - Extensive data  
  - High risk  

### Supplementary Documentation
- Face-to-Face Time with Patient (minutes):  
- Counseling/Coordination Time (minutes):  

## Inpatient Encounter Type

- Initial Inpatient Hospital Care (Admit)  
- Subsequent Inpatient Hospital Care  
- Hospital Discharge Services  
- Inpatient Consultation  
- Hospital Observation  
- Observation or Admit with Same Day Discharge  
- Follow-up Inpatient Consultation  
- Prolonged Services
  - First Hour  
  - Additional 30-Minute Increments  

## Inpatient E&M Codes

### Initial Inpatient Hospital Care (Admit)
- 99221 D or C/D or CABF or LC (30 min)  
- 99222 CC/MCC (30 min)  
- 99223 C/MCC (70 min)  

### Subsequent Inpatient Hospital Care
- 99231 FF/FP/SF or LC (15 min)  

### Hospital Discharge Services
- 99238 30 minutes or less  
- 99239 More than 30 minutes (document time in medical record)  

### Inpatient Consultation
- 99241 PR/PP/SF (30 min)  

### Critical Care Services
- None  
- 30-74 minutes  
- 75-104 minutes  
- 105-134 minutes  
- 135-164 minutes  
- 165-194 minutes  

### Prolonged Inpatient Services
- 99201 First 30-74 minutes  
- 99202 Each additional 30 minutes  

(prescription on demand basis only for basic inpatient E&M services)
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<thead>
<tr>
<th>Collection Date/Time</th>
<th>Result Date/Time</th>
<th>Test Name</th>
<th>Result</th>
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<td>9/23/05 11:33</td>
<td>Logistician HEMATOLOGY-ONCOLOGY OFFICE VISIT by Chaisanguanthum</td>
<td>Result No. 1443087104351910</td>
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<td>9/26/05 01:18</td>
<td>Outpatient Clinic MEDICATION LIST</td>
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<td>POC INR 2.4</td>
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<td>INR REFERENCE RANGE THERAPEUTIC: 2.0-3.0</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>HIGH DOSE: 2.5-3.5</td>
</tr>
</tbody>
</table>

Confidentiality Warning: The information in this system should only be viewed by patient care personnel with a "need to know" for purposes of diagnosis and treatment. All accesses are logged with your name, the patient's name, the type of data viewed, the date and time. Inappropriate accesses are subject to disciplinary measures and/or legal action, up to and including termination of employment on the first offense. Any printouts from this system should be disposed of properly.
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<thead>
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<th>Instructions</th>
<th>Stop Date</th>
<th>Status</th>
<th>Micro Medex</th>
<th>Skolar MD</th>
<th>Care Notes</th>
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<tbody>
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<td>ASCORBIC ACID 500 MG</td>
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<td>Verified</td>
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<td>7/4/2005</td>
<td>COREG</td>
<td>3.125 mg BID</td>
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<td></td>
</tr>
<tr>
<td>5/12/2005</td>
<td>COUMADIN 5 MG TABS (WARFARIN SODIUM)</td>
<td>Take 7.5mg every Thurs &amp; 5mg on all other days of the week.</td>
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<tr>
<td>7/22/2005</td>
<td>FERROUS SULFATE 325 MG TABS</td>
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<td>7/22/2005</td>
<td>ISOSORBIDE MONONITRATE CR 60 MG TB24</td>
<td>Take one daily</td>
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<td>Verified</td>
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<td></td>
<td>LIPIITOR 10 MG TABS (ATORVASTATIN CALCIUM)</td>
<td>take 1 daily</td>
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<td>8/26/2005</td>
<td>LOVENOX 70MG</td>
<td>70 mg sub-q bid; restart lovenox after procedure</td>
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<td>VASOTEC 10 MG TABS (ENALAPRIL MALEATE)</td>
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<td>Verified</td>
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<tr>
<td>9/23/2005</td>
<td>XELODA 150 MG TABS (CAPECITABINE)</td>
<td>2 tabs po bid</td>
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<tr>
<td>9/23/2005</td>
<td>XELODA 500 MG TABS (CAPECITABINE)</td>
<td>3 tabs po bid</td>
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<td>Verified</td>
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<td></td>
<td>ZETIA 10 MG TABS (EZETIMIBE)</td>
<td>take 1 daily</td>
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<td>Verified</td>
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<td></td>
<td>ZOFTRAN 4 MG TABS (ONDANSETRON HCL)</td>
<td>1 tab every 6-8 hours as needed for nausea after chemotherapy</td>
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<td>Verified</td>
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</tbody>
</table>

Note: Click medication dose for detailed dosing and administration information. Click 📚 for on-line search of information resources.

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Clinical significance

- NOT helpful for diagnosis in patients without anemia.
  - Red cell size distribution width should be used in conjunction with other diagnostic tests.
- Useful in the early classification of some anemias.
  - Red cell size distribution width often becomes abnormal earlier than other red cell parameters.
  - More sensitive in microcytic conditions than macrocytic.
  - Useful to distinguish early iron deficiency from:
    - Anemia of chronic disease
    - Thalassemia minor
    - Useful to improve detection of early iron, vitamin B12, or folate deficiency.
- Usually interpreted in conjunction with the mean cell volume (MCV).

Indices | Red cell size distribution width elevated | Red cell size distribution width normal
---|---|---
MCV low | Anemia of chronic disease (occasionally) | Anemia of chronic disease (occasionally)
Diabetes Mellitus – Adult > Ambulatory Hemoglobin A1c Reminder

Evoke:

[A patient’s electronic medical record is closed in an outpatient setting] OR [the “Adult Diabetes Ambulatory” order set is signed]

Logic:

[The patient is age ≥ 18 years] AND [the problem list includes “diabetes mellitus”] AND [there is no hemoglobin A1c level recorded within the last year] AND [a hemoglobin A1c level has not been ordered on the “Adult Diabetes Ambulatory” order set] AND [a hemoglobin A1c level is not preselected on the customized “Adult Diabetes Ambulatory” order set defined by the hospital] AND [a “hemoglobin A1c testing exclusion form” has not been completed during this encounter]

Action:

A reminder is presented that states: “No hemoglobin A1c level has been documented in the last year.”

Option: Dismiss reminder
Option: Order a hemoglobin A1c level
Option: Document reason for not ordering a hemoglobin A1c level

Date Entered: 7/29/2002
Date Modified: 5/12/2003
Authors: Ertina Yen MD, Victor Lee MD, David Rhow MD
Version: 1.7
Institution: Zynx Health
Purpose: When an electronic medical record is closed in an outpatient setting for an adult patient with diabetes mellitus, or an adult diabetes ambulatory order set is signed, a reminder that a hemoglobin A1c (HbA1c) level has not been documented in the last year will be displayed to the user if certain criteria are met.
Explanation: The annual testing of HbA1c in patients with diabetes mellitus is a quality of care measure in the 7th Scope of Work by the Centers for Medicare & Medicaid Services, and is a national performance measure according to the National Quality Forum.
Keywords: diabetes mellitus, hemoglobin A1c, HbA1c

© 2004, Zynx Health, Incorporated
Hypertension Visit

History of Present Illness - Hypertension

Current symptoms: none

Current Status
Compliance with tx: poor
Comments: Cupous salt consumption

Risk Factors
Tobacco use: current
Cigarettes: 1 pack(s) per day

Review of Systems
General: Denies fevers, chills, sweats, anorexia, fatigue, malaise, weight loss.

Vital Signs
Height: 70 inches
Blood Pressure: 200/100 mm Hg

Physical Exam
General appearance: well developed, well nourished, no acute distress

Ears, Nose and Throat
Teeth/Gums/ Palate: poor dentition

Respiratory
Neck
Neck veins: no JVD; a, v or cannon a waves
Thyroid: no nodules, masses, tenderness, or enlargement

Respiratory
### Prescriptions: Raul R. Torres

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<th>Quantity</th>
<th>#Refills</th>
<th>Date</th>
<th>Refill Quantity</th>
<th>#Refills</th>
<th>P&amp;L Info</th>
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<td>0</td>
<td>10/22/1998</td>
<td></td>
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<td></td>
<td></td>
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</tr>
<tr>
<td>PINNIVIL TABS 20 MG (LISINOPRIL)</td>
<td>30</td>
<td>2</td>
<td>10/22/1998</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 po qd</td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>LUMULIN INJ 70/30 INSULIN REG &amp; ISOPHANE (HUMAN)</td>
<td>600 u</td>
<td>0</td>
<td>10/22/1998</td>
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<tr>
<td>20 units ac breakfast</td>
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<tr>
<td>PROZAC CAPS 10 MG (FLUOXETINE HCL)</td>
<td>30</td>
<td>2</td>
<td>10/22/1998</td>
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<tr>
<td>1 po qd</td>
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<tr>
<td>CALAN SR 180 MG TBCR (VERAPAMIL HCL)</td>
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<td></td>
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<tr>
<td>1 tab po qd</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Pharmacy:**
- 24-Hour Pharmacy
  - 137 SW 183rd
  - Aloha, OR 97007 USA
  - Ph: 503-842-9547
  - Fax: 503-842-9540

**Authorized By:** Janoff MD, Robin C.

**Prescribing Method:** Telephone

**State:** Oregon

---

For Help, press F1
**Protocol “USPS 65 Yrs & Older Males”:**

Male patients with an age of greater than 65 years.

Should have the following:

<table>
<thead>
<tr>
<th>Test</th>
<th>Schedule</th>
<th>Last Done</th>
<th>Last Rslt</th>
<th>Status</th>
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</thead>
<tbody>
<tr>
<td>HEMOCCULT</td>
<td>Every 12 months</td>
<td></td>
<td></td>
<td>Due Now</td>
</tr>
<tr>
<td>or SIGMOID</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BP DIASTOLIC</td>
<td>Every 24 months</td>
<td>06/18/2007</td>
<td>80</td>
<td>Due On: 06/18/2008</td>
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<tr>
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<td>Every 24 months</td>
<td>06/18/2007</td>
<td>140</td>
<td>Due On: 06/18/2008</td>
</tr>
<tr>
<td>FLU VAX</td>
<td>Every 12 months</td>
<td></td>
<td></td>
<td>Due Now</td>
</tr>
<tr>
<td>PNEUMOVAX</td>
<td>Every 7 years</td>
<td></td>
<td></td>
<td>Due Now</td>
</tr>
<tr>
<td>TD BOOSTER</td>
<td>Every 10 years</td>
<td></td>
<td></td>
<td>Due Now</td>
</tr>
</tbody>
</table>

Comment: “Height and weight are recommended as part of the periodic health examination. Visual screening questions, assessment for hearing impairment, and assessment for problem drinking are recommended as part of the health examination.”

**Protocol “Nursing Compliance”:**

Patients of either sex.

Should have the following:

<table>
<thead>
<tr>
<th>Test</th>
<th>Schedule</th>
<th>Last Done</th>
<th>Last Rslt</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>SEATBELT USE</td>
<td>Every 6 months</td>
<td>06/18/2007</td>
<td>100</td>
<td>Due Now</td>
</tr>
<tr>
<td>FLU VAX</td>
<td>Every 12 months</td>
<td></td>
<td></td>
<td>Due Now</td>
</tr>
<tr>
<td>PAIN NOW?</td>
<td>Every 1 months</td>
<td></td>
<td></td>
<td>Due Now</td>
</tr>
<tr>
<td>TOBACCO USE</td>
<td>Every 6 months</td>
<td></td>
<td></td>
<td>Due Now</td>
</tr>
</tbody>
</table>
Inquiry

Find
- Patients
- Active Patients Only

Where
- Problem Code, Active (Diagnosis lookup)
- is
- Hypertension (ICD-401.9)

Add Delete Replace

Combine With
- AND
- OR

Find Patients where:
- Problem Code, Active (Diagnosis lookup) is 'Hypertension (ICD-401.9)'

Count Result:

Search Result: Patients found: 18
Blair, Linda
Branson, Marjorie L.
calloway, cab
Davenport, Scott L.
duck, donald
Gelner, Kevin S.
Greene, Loren
Inishi, Robert S.
Johnson, Cheryl L.
Lopez, Lisa
Mann, Michelle
Nyberg, Carl O.
O'Malley, Martha A.
PEES, ALOT
Simpson, Laura P.
test, more
TESTING, CMIS A
Training8, Test8

Select... Save... Clear... Count... Search... View item... Print...
<table>
<thead>
<tr>
<th>Date</th>
<th>Diabetes Patients</th>
<th>HbA1c Control</th>
<th>Blood Pressure Control</th>
<th>Eye Examination</th>
<th>Smoking Status</th>
<th>Nephropathy Assessment</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.31.2011</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Summary

• **EHRs:** Key tool for biomedical data acquisition and analysis
  – Many advantages, some disadvantages
  – **Key:** integration of data

• **Aspects of the EHR:** Functions, advantages, disadvantages

• **Important architectural elements:** Repositories, messaging, data models and terminologies
  – **Standards are key**
Additional Resources


Additional Resources: Web

- www.hl7.org
- www.healthit.gov
- www.amia.org
- www.himss.org
Thanks!

jenders@ucla.edu
jenders@cdrewu.edu

http://jenders.bol.ucla.edu