

A close-up photograph of hands typing on a white computer keyboard, with a blurred background.

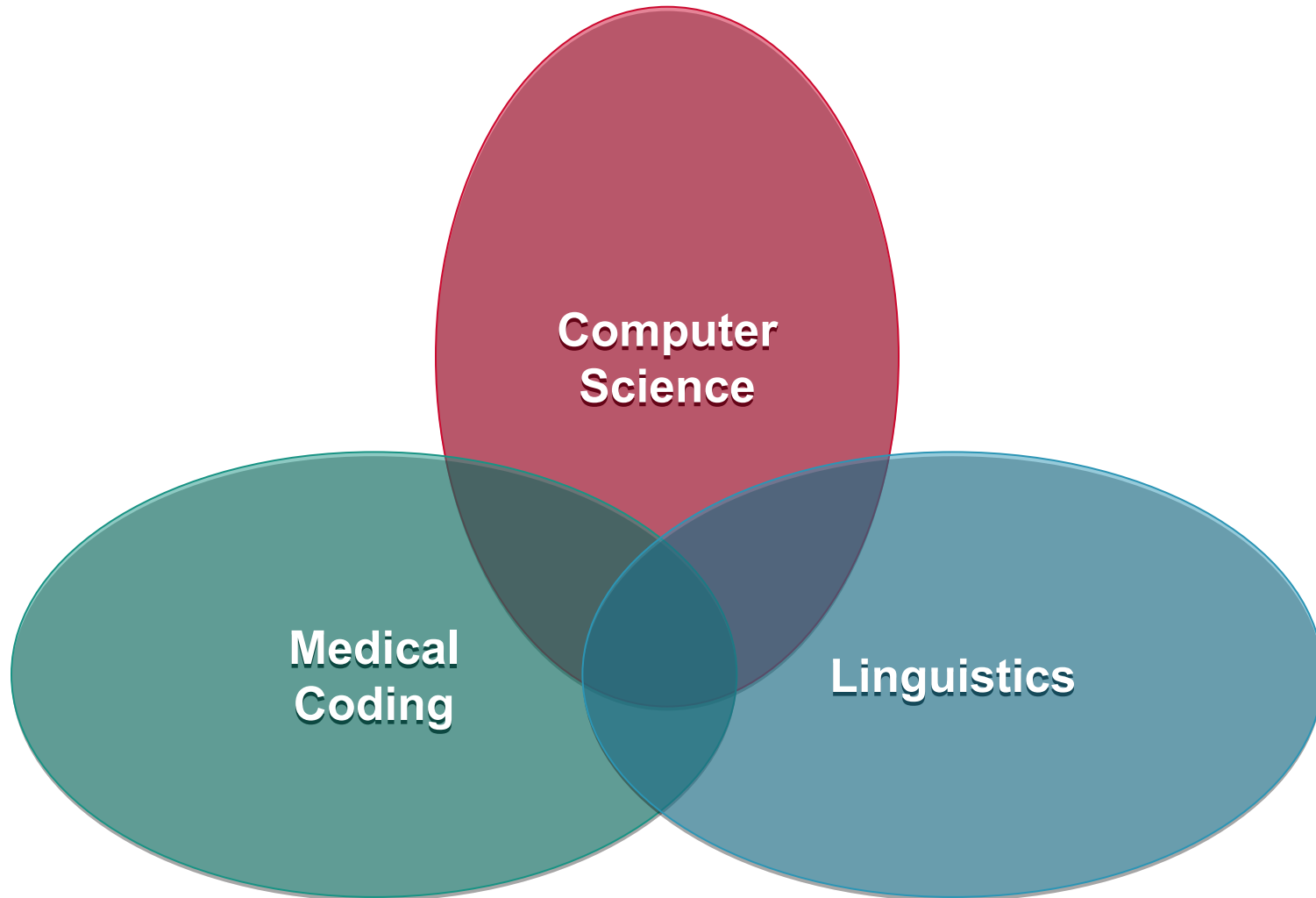
Natural Language Processing (NLP): The Technology Behind CAC

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April 2011

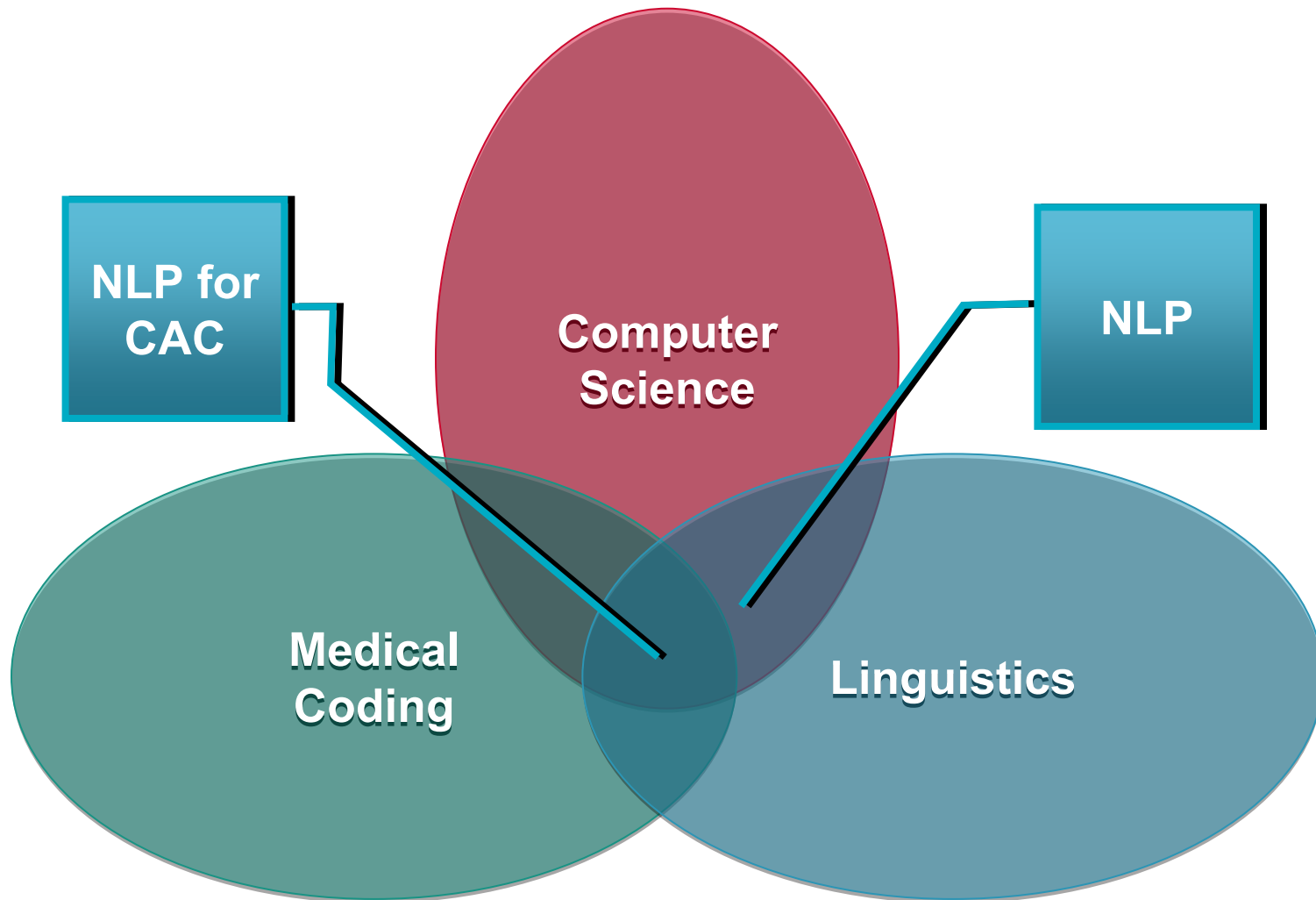
Computer Assisted Coding & NLP

- “The use of computer software that **automatically** generates a set of medical codes for review/validation and/or use based upon clinical documentation provided by healthcare practitioners.”
 - *Delving into Computer Assisted Coding, AHIMA Practice Brief*
- Natural Language Processing (NLP)
 - Software that can ‘read’ physician documentation, identify key clinical facts and map those facts to codes
 - Physicians use standard dictation/transcription, speech recognition, or templates with free-text fields
 - LifeCode® is a type of information extraction NLP technology.

Natural Language Processing



Natural Language Processing



Linguistics

Linguistics is
the scientific analysis
of all facets of language.

What does that mean?

Here are the most fundamental fields of study...

Phonology & Phonetics

What are the mechanics and acoustic properties of the sounds in languages?

lɪŋ'wɪstɪks æt 'eɪ laɪf 'mɛdɪkəl

How do the sounds of a language interact?

The Plural in English

cat → cats dog → dogs

/kæt/ → /kæts/ /dag/ → /dagz/

[-voice] → / s /

[+voice] → / z /

Morphology

How are words formed?

anti-dis-establish-ment-arian-ism

[anti-] meaning “**opposite**” or “**against**”

[dis-] meaning “**not**” or “**no longer**”

[establish] root verb

[-ment] changes verb to noun

[-arian] meaning “**follower of**”

[-ism] meaning “**belief in**”

Syntax

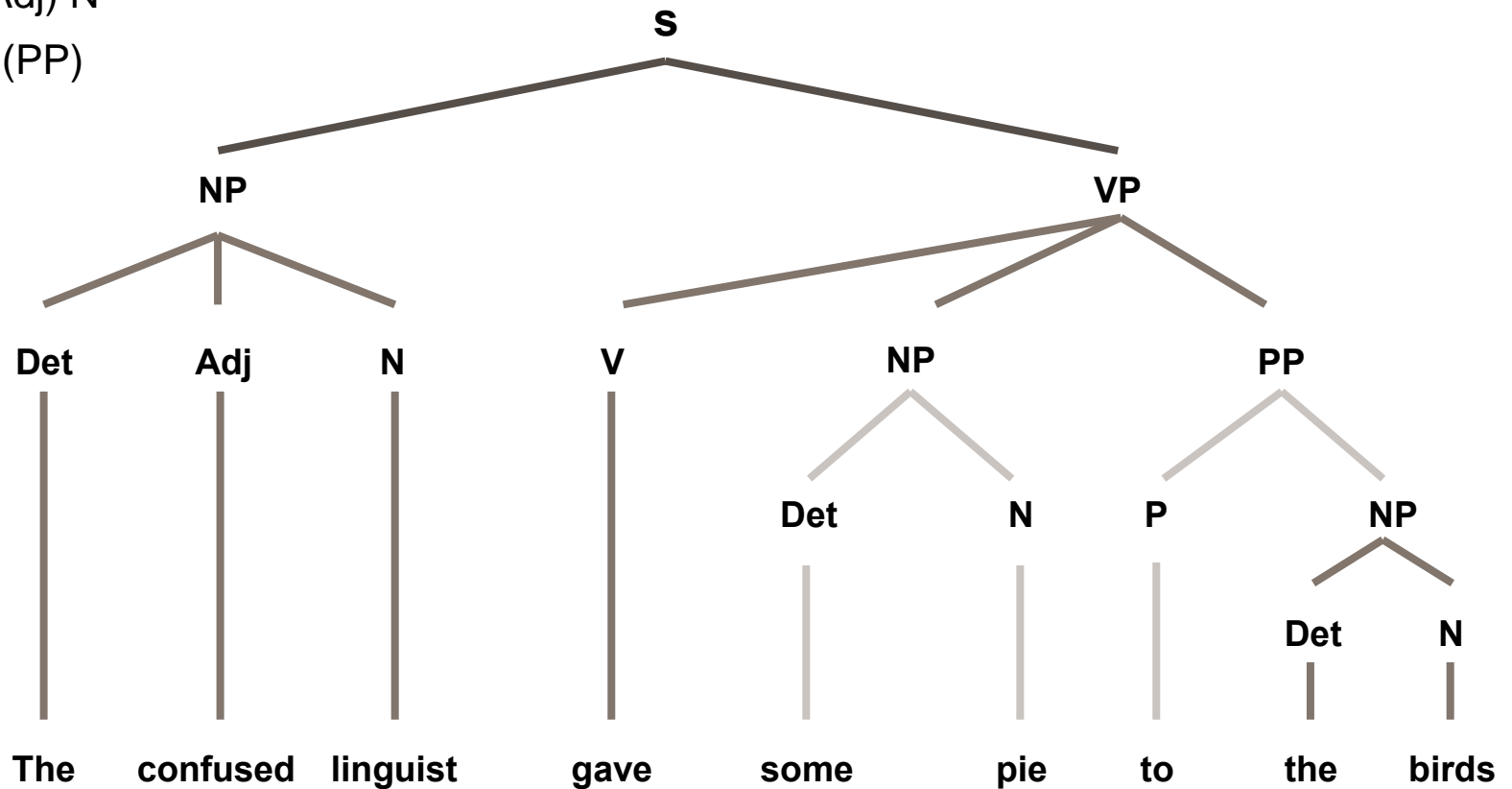
How are words put together to form sentences?

$S \rightarrow NP VP$

$NP \rightarrow (Det) (Adj) N$

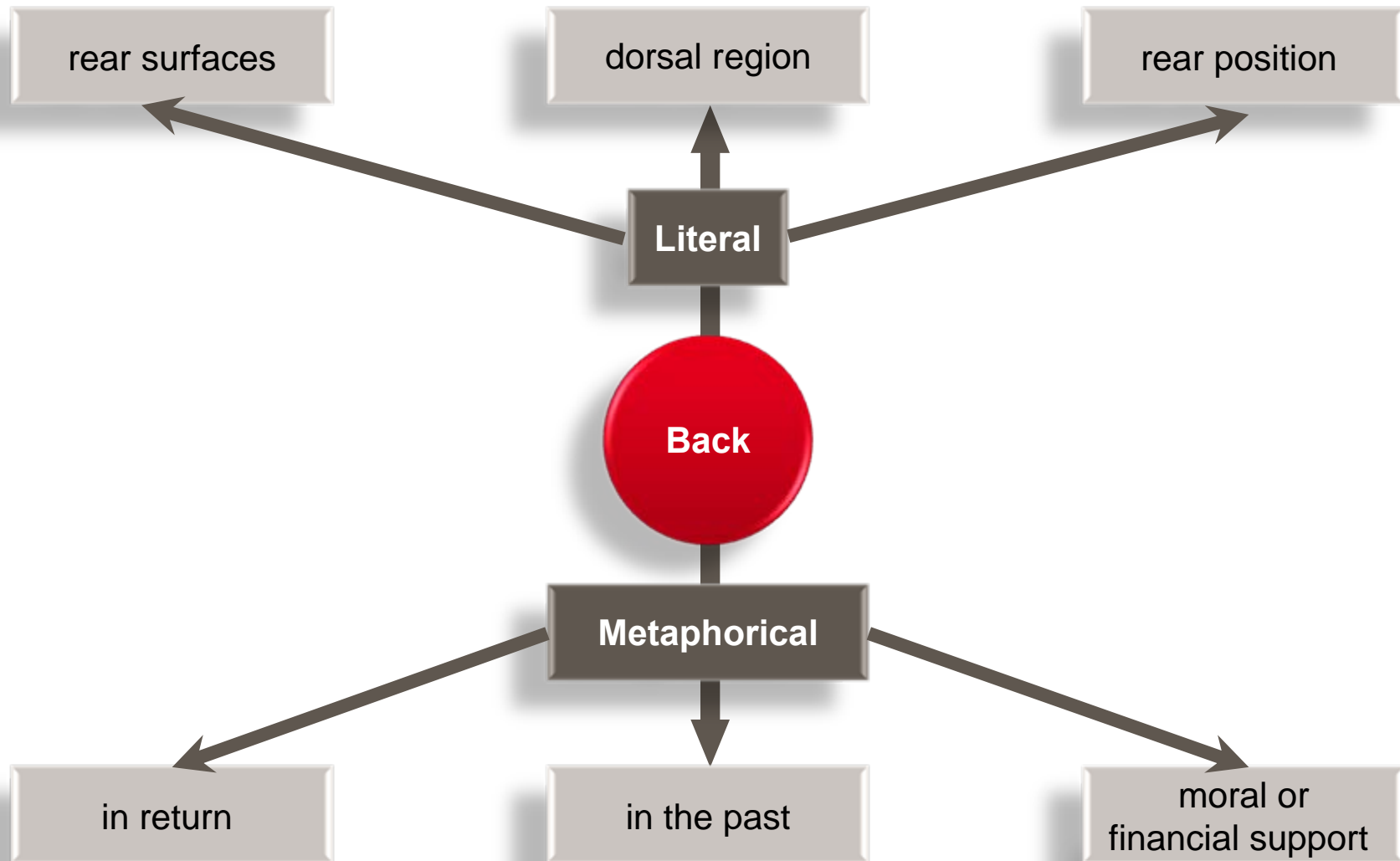
$VP \rightarrow V (NP) (PP)$

$PP \rightarrow P NP$



Semantics

What is meaning?



Applications of NLP

- Voice recognition
- Speech to text / text to speech
- Foreign language translation
- Grammar analysis
- Search engines
- Email categorization and auto-response
- Information extraction
- Document summarization
- **Medical Coding!!**

NLP – Challenges to Understanding

Context

Plumber: Hand me the replacement elbow.

Doctor: Hand me the replacement elbow.

Ambiguity

Truckstop Sign: Eat here and get gas.

Medical: The patient had a change of heart.

Inference

Could you tell me the time?

Medical: 2 View Chest.

Real World Knowledge

The girl ate the apple with a smile/with a bruise.

➔ *How did the girl eat the apple?*

With a smile.

With a bruise.

Why Does This Matter?

- Each NLP evaluates text differently
 - “The patient has **breast cancer**”
 - “The patient had **breast cancer** in the 1980’s”
 - “The patient’s mother had **breast cancer** 17 years ago”
 - “The patient has h/o **brca**”
- Language Evaluation
 - “the patient has pain in the **abdomen** as well as the **neck**”
- Negation
 - “the patient has **chest pain** and denies **SOB** and **abdominal pain**”
- Different NLP engines may code these examples differently!

NLP and Medical Coding

Example: CT Scan

CLINICAL

HISTORY: MELANOMA LEFT LEG; STAGING.

CT SCAN OF THE THORAX COMPLETE:

Multiple CT images were obtained through the thorax on a multi-slice scanner before and after intravenous nonionic contrast given due to history of chronic illness. Images were evaluated on a digital work station.

The trachea and major bronchi are not remarkable. The heart is mildly enlarged. There is calcification in the aortic arch. The pulmonary arteries are normal. There is no evidence of significant hilar or mediastinal adenopathy.

The lung fields are free of acute disease. Scattered linear densities are felt to represent scarring. There is no sign of pleural or pericardial fluid. Degenerative bone changes are present.

IMPRESSION: MILD CARDIOMEGALY.

OTHERWISE, NORMAL CT SCAN OF THE THORAX.

NO SIGN OF MASS LESION OR ADENOPATHY.

Example: Segmentation

~~~~~1-2 history~~~~~

MELANOMA LEFT LEG; STAGING.

**Historical  
Information**

~~~~~1-3 proc\_head~~~~~

CT SCAN OF THE THORAX COMPLETE:

**Procedure
Ordered**

~~~~~1-4 findings~~~~~

Multiple CT images were obtained through the thorax on a multi-slice scanner before and after intravenous nonionic contrast given due to history of chronic illness. Images were evaluated on a digital work station.

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The lung fields are free of acute disease. Scattered linear densities are felt to represent scarring. There is no sign of pleural or pericardial fluid. Degenerative bone changes are present.

~~~~~1-5 impression~~~~~

MILD CARDIOMEGALY. OTHERWISE, NORMAL CT SCAN OF THE THORAX. NO SIGN OF MASS LESION OR ADENOPATHY.

Diagnosis

**Discussion of
What's Seen**

Example: Language Analysis

CLINICAL HISTORY (history):

melanoma left leg PUNC_10_
staging PERIOD_10_

CT SCAN THORAX COMPLETE (proc_head):
of complete cat_sg_thorax PUNC_10_

CAT_SG_THORAX

CT SCAN THORAX COMPLETE (findings):
PERIOD_10_

(-) ct multiple images BE_011_
(-) thorax obtained through ON_011_
(-) before multi slice scanner AND_0011_

Status Post


STATUS_POST_11_
(-) post nonionic contrast given intravenous TO_011_

IMPRESSION (impression):
cardiomegaly PERIOD_10_

Example: Concept Matching

CLINICAL HISTORY (history):


melanoma left leg PUNC_10_

 172.7 [664] 0 *melanoma leg*
172.7 [660] 0.001 *melanoma left leg*

(-) staging PERIOD_10_

CT SCAN THORAX COMPLETE (proc_head):

of complete cat_sg_thorax PUNC_10_

 71250 [15771] 0.007 0 *cat_sg_thorax*

CT SCAN THORAX COMPLETE (findings):

PERIOD_10_


(-) ct multiple images BE_011_

(-) thorax obtained through ON_011_

(-) before multi slice scanner AND_0011_


STATUS_POST_11_

(-) post nonionic contrast given intravenous TO_011_

 Q9945 [307] 0.012 0 *nonionic contrast*

IMPRESSION (impression):

cardiomegaly PERIOD_10_

 429.3 [6929] 0 *cardiomegaly*

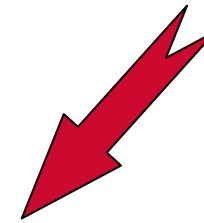
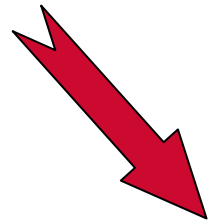
Example: Coding Guidelines

ICD

172.7 [664] 0 *melanoma leg*
172.7 [660] 0.001 *melanoma left leg*
429.3 [6929] 0 *cardiomegaly*

CPT

71250 [15771] 0.007 0 *cat_sg_thorax*
Q9945 [307] 0.012 0 *nonionic contrast*



Diagnosis Coding – Excludes, includes, combinations, and sequencing
Cross-coding Rules (which ICDs medically support CPTs)
RVU (Rules for ordering CPTs)
Contrast Association



ICD9_CODE|0|17:46||172.7

CPT_CODE|0|243:535|0,1|71270

Example: ICD-9 Coding of Twins

651.03 Twin pregnancy, antepartum

- V76P (pregnancy)
- V76G (twins)
- P76806 (fetus)
- 651.0A (multiple gestation)

Example: Twin Pregnancy

CLINICAL DATA TWINS, FOLLOW-UP GROWTH AND CHECK WELL BEING.

| TWIN 'A' | MEASUREMENTS | MEAN AGE (WEEKS/DAYS) |
|----------------|--------------|-----------------------|
| BPD | 7.9 CM | 31/6 |
| HC | 29.6 CM | 32/6 |
| AC | 27.5 CM | 31/4 |
| FL | 6.2 CM | 32/3 |
| HUMERUS LENGTH | 5.6 CM | 32/3 |

ESTIMATED FETAL WEIGHT 1864 PLUS OR MINUS 15%

| TWIN 'B' | MEASUREMENTS | MEAN AGE (WEEKS/DAYS) |
|----------------|--------------|-----------------------|
| BPD | 8.7 CM | 35/1 |
| HC | 31.4 CM | 35/1 |
| AC | 28.3 CM | 32/3 |
| FL | 6.2 CM | 32/2 |
| HUMERUS LENGTH | 5.5 CM | 32/2 |

ESTIMATED FETAL WEIGHT 2064 GRAMS PLUS OR MINUS 15%

TWIN 'A' WAS IN BREECH POSITION ON THE RIGHT AND TWIN 'B' WAS IN CEPHALIC POSITION ON THE LEFT, HEAD CLOSEST TO CERVIX.
THERE ARE SEPARATE ANTERIOR AND POSTERIOR PLACENTAS. NORMA FLUID IN EACH SAC.

BIOPHYSICAL PROFILE SCORE 8/8 FOR BOTH. CREDIT GIVEN FOR FETAL BREATHING, GROSS BODY MOVEMENT, FETAL TONE, AND AMNIOTIC FLUID VOLUME. NORMAL CORD DOPPLER RESISTANCE INDEX OF .44 AND .53 FOR TWIN 'A' AND .57 AND .60 FOR TWIN 'B'.

CERVICAL LENGTH WITH VAGINAL SCANNING MEASURES 3.2 CM. NO CANAL DILATATION.

IMPRESSION:

1. PREDICTED GESTATIONAL AGE IS 32+ WEEKS. TODAY'S MEASUREMENTS GIVE AVERAGE AGES OF 32 WEEK 1 DAY AND 33 WEEK 5 DAY FOR TWIN 'A' AND 'B' RESPECTIVELY.
2. NORMAL FLUID IN EACH SAC.
3. BIOPHYSICAL PROFILE SCORE 8/8 FOR BOTH. NORMAL CORD DOPPLERS.
4. ADEQUATE CERVICAL LENGTH FOR AGE.

V76P
Pregnancy

Example: Twin Pregnancy

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P76806
Fetus

Another Example: Twin Pregnancy

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651.0A
Multiple
gestation

Example: Twin Pregnancy

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Info used to
code
651.03

651.03 & Preventing False Positives

Other types of “Twin” talk- What could be mistaken for twins

- Family history
 - Twin in family had some condition
- Other types of examinations
 - Discussion of previous pregnancies/births
- Personal history
 - Patient is a twin

Natural Language Processing & CAC

- CAC with NLP combines the expertise of:
 - Computer Science
 - Medical Coding & HIM
 - Linguistics
- Morphology, Syntax and Semantics are all important to understanding medical notes
- Context, Ambiguity, Inference and ‘Real World’ Knowledge are essential to correctly apply coding guidelines

Questions?

