



# Clinical Safety & Effectiveness Cohort # 9

**Appropriate utilization of procalcitonin for  
infections in hospitalized patients**



**Educating for Quality Improvement & Patient Safety**

# Financial Disclosure

Marcos Restrepo, MD, has no relevant financial relationships with commercial interests to disclose.

# What We Are Trying to Accomplish?

- ✓ *To increase the knowledge of the appropriate use of procalcitonin from 50% to 75% in health care providers\* ordering procalcitonin at the STVHCS by January 10, 2012*
- ✓ *To increase the appropriate use of procalcitonin from 41% to 62% (by 50%) in hospitalized patients with presumed infections at the STVHCS by February 16, 2012*

\* Health care providers = Faculty, fellows, residents and medical students

# The Team

- Division

- CS&E Participant: Marcos I. Restrepo, MD, MSc
- Team Member: Kelly Echevarria, PharmD
- Team Member: Jose Cadena, MD
- Team Member: Gregory Smith, DDS
- Team Member: Elena Laserna, MD, PhD
- Team Member: Anisha Arora, MD
- Team Member: Elizabeth A. Bowhay, MD
- Facilitator: Amruta D. Parekh, MD, MPH

- Sponsor Department & Mentors

- Antonio Anzueto, MD -Division Chief (P/CCM) - VA
- Jay Peters, MD – Division Chief - UTHSCSA

# Project Milestones

- Team Created Sep - 2011
- AIM statement created Sep - 2011
- Weekly Team Meetings Oct-Dec 2011
- Background Data, Brainstorm Sessions,  
Workflow and Fishbone Analyses Oct-Nov 2011
- Intervention Design Oct-Dec 2011
- Intervention #1 Implemented Jan 10, 2012
- Data collection Jan 11 – Feb 20, 2012
- Data Analysis Feb 21, 2012
- CS&E Presentation Feb, 24 -2012

# Background

## What is procalcitonin (PCT)?<sup>1</sup>

- A precursor to calcitonin, a polypeptide hormone that regulates calcium in the blood, vitamin D, and bone metabolism

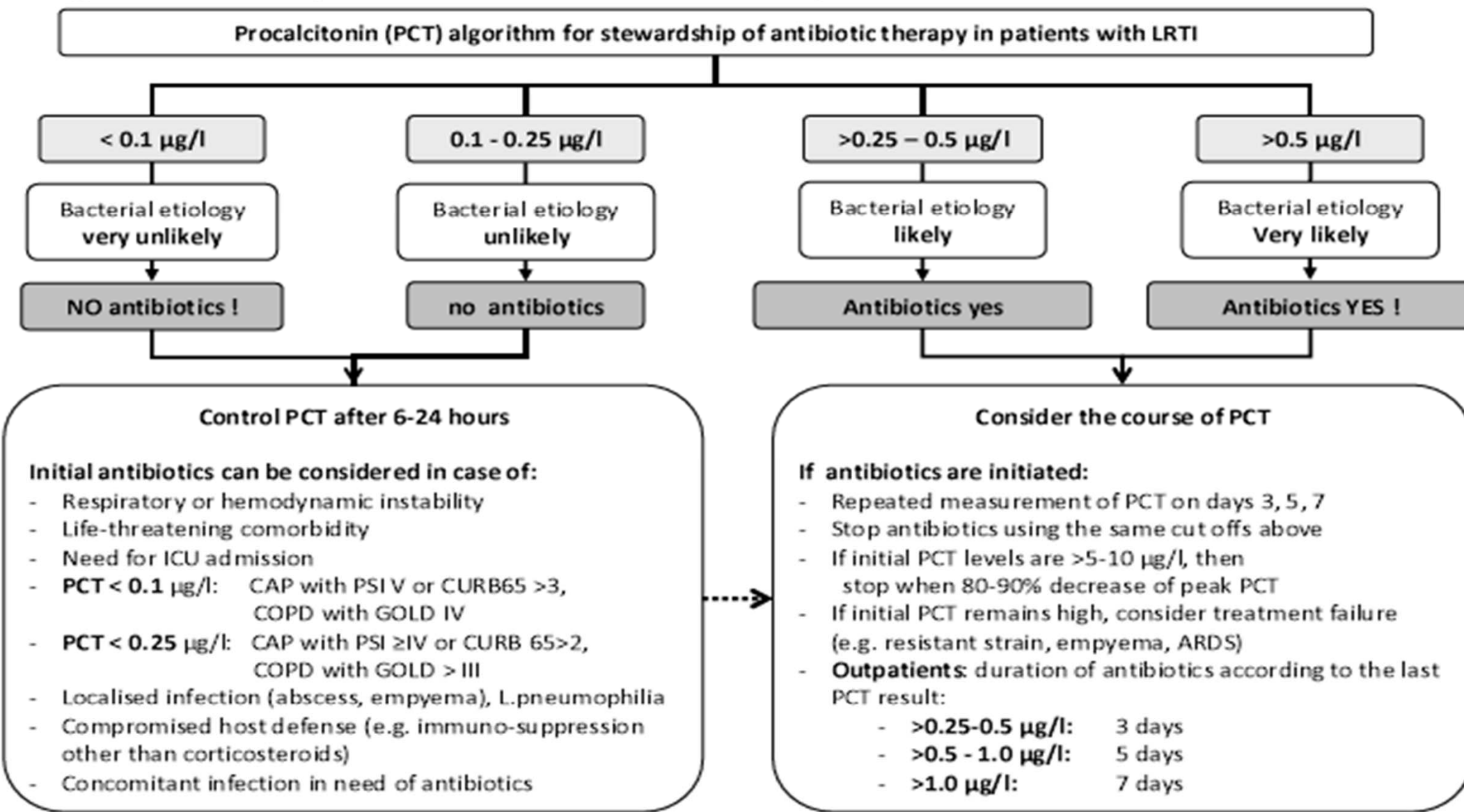
## Produced by the C-cells of the thyroid gland<sup>2</sup>

- The production of PCT is regulated by the CALC-1 gene
- In healthy individuals, PCT is not released into the bloodstream
  - Expression of the CALC-1 gene is restricted to selective expression in the C-cells of the thyroid
    - Normal level is < 0.1 ng/mL
    - Abnormal levels associated with ***infection and inflammation***

<sup>1</sup>Costoff A. Sect. 5, Ch. 6: . [http://www.lib.mcg.edu/edu/eshuphysio/program/section5/5ch6/s5ch6\\_23.htm](http://www.lib.mcg.edu/edu/eshuphysio/program/section5/5ch6/s5ch6_23.htm).

<sup>2</sup>Muller B, et al. *J Clin Endocrin Metab.* 2001.

**eFigure 1. PCT Algorithm for Antibiotic Stewardship**



**Abbreviations:** PCT procalcitonin, CAP community-acquired pneumonia, PSI pneumonia severity index, COPD chronic obstructive pulmonary disease, GOLD global initiative for obstructive lung disease,

# Procalcitonin to assist Antibiotic therapy

- **RCT – PCT vs. Control for the management of respiratory infections on 1359 subjects**

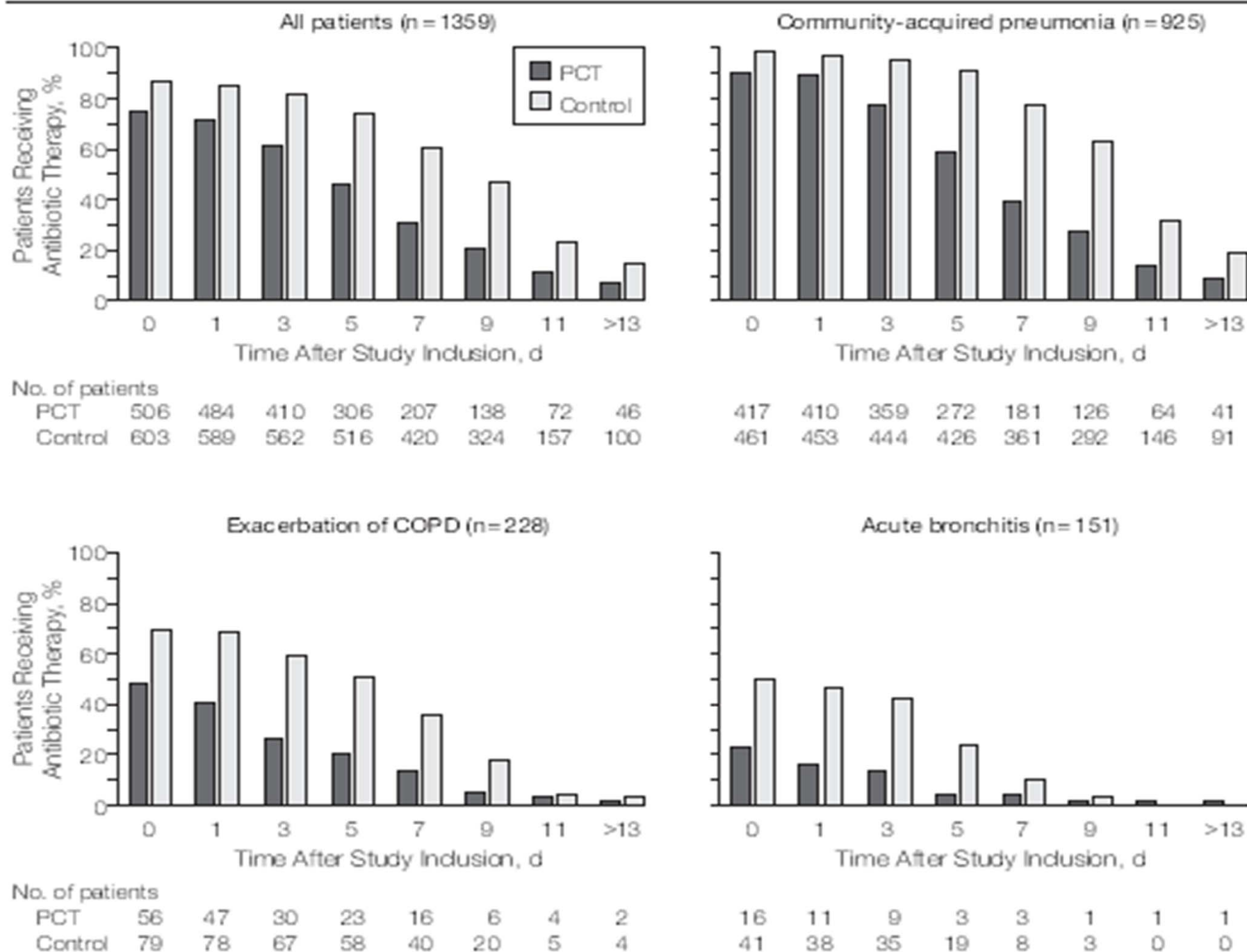
N=925

<b>Outcomes</b>	<b>PCT n=460 - %</b>		<b>Control n=465- %</b>
<b>Abx exposure, mean days</b>	<b>7.2</b>	<b>*</b>	<b>10.7</b>
<b>Abx prescription</b>	<b>91%</b>	<b>*</b>	<b>99%</b>
<b>Adverse events from Abx</b>	<b>23%</b>	<b>*</b>	<b>33%</b>
<b>LOS, mean days</b>	<b>10</b>		<b>9.5</b>

**\* p<0.05**



**Figure 2.** Antibiotic Exposure in Patients Receiving Antibiotic Therapy



# Meta-analysis of PCT-guided algorithms vs. routine practice

N=7 RCT Studies - (n=1131 ICU patients)

Table 5. Meta-analysis of aggregate data<sup>a</sup>: Procalcitonin-guided algorithms versus routine practice

Outcomes	Studies	Participants	Statistical Method	Effect Size
Duration of antibiotic treatment for the first episode of infection	5	938	WMD (FEM), 95% CI	-2.14 (-2.48 to -1.80)
Total duration of antibiotic treatment	3	801	WMD (FEM), 95% CI	-4.19 (-4.98 to -3.39)
Antibiotic-free days	3	801	WMD (FEM), 95% CI	2.94 (1.92 to 3.96)
28-day mortality	6	1,010	OR (FEM), 95% CI	0.93 (0.69 to 1.26)
Hospital mortality	4	317	OR (FEM), 95% CI	0.86 (0.52 to 1.44)
ICU length of stay	6	1,010	WMD (FEM), 95% CI	-0.49 (-1.55 to 0.57)
Hospital length of stay	3	801	WMD (FEM), 95% CI	-0.13 (-1.10 to 0.84)
Days free from mechanical ventilation	2	722	WMD (FEM), 95% CI	0.60 (-0.64 to 1.85)
Superinfection rate	3	790	OR (FEM), 95% CI	1.13 (0.83 to 1.54)
Persistent/relapsed infection rate	3	801	OR (FEM), 95% CI	0.97 (0.56 to 1.69)

Reduction of Antibiotic Prescription and/or duration of Abx

# Procalcitonin Appropriate Indications

- **Pneumonia**
  - CAP
  - HCAP
  - HAP
  - VAP
  - Aspiration
- **Sepsis**
  - SIRS
  - Sepsis (SIRS plus documented or suspected infection)
  - Severe sepsis (one organ failure)
  - Septic shock (on vasopressors)
- **AECOPD**

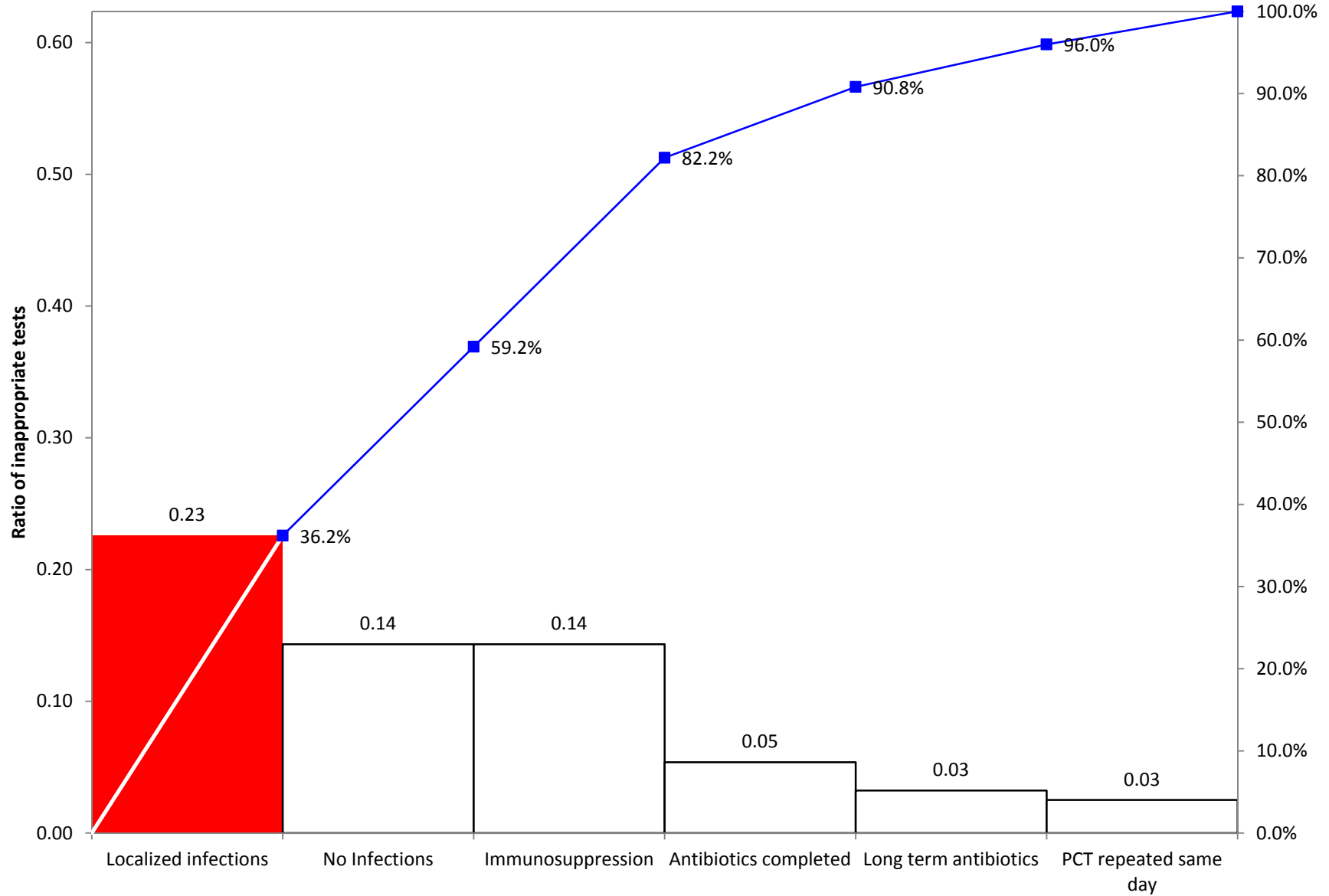
# Procalcitonin Inappropriate Indications

- **Localized infection**
  - Skin and soft tissue (abscess, cellulitis)
  - Empyema
  - Osteomyelitis
  - Meningitis
  - Endocarditis
  - Pancreatitis
- **Immunosuppression disease or therapies**
  - Post-transplantation (bone marrow, solid organ)
  - s/p chemo
- **Other**
  - Trauma/post surgery
  - Invasive fungal infection
- **Diagnosis**
  - No infection
  - Unknown diagnosis
- **Time of testing**
  - 1<sup>st</sup> PCT test value in the middle of an Abx course (no baseline)

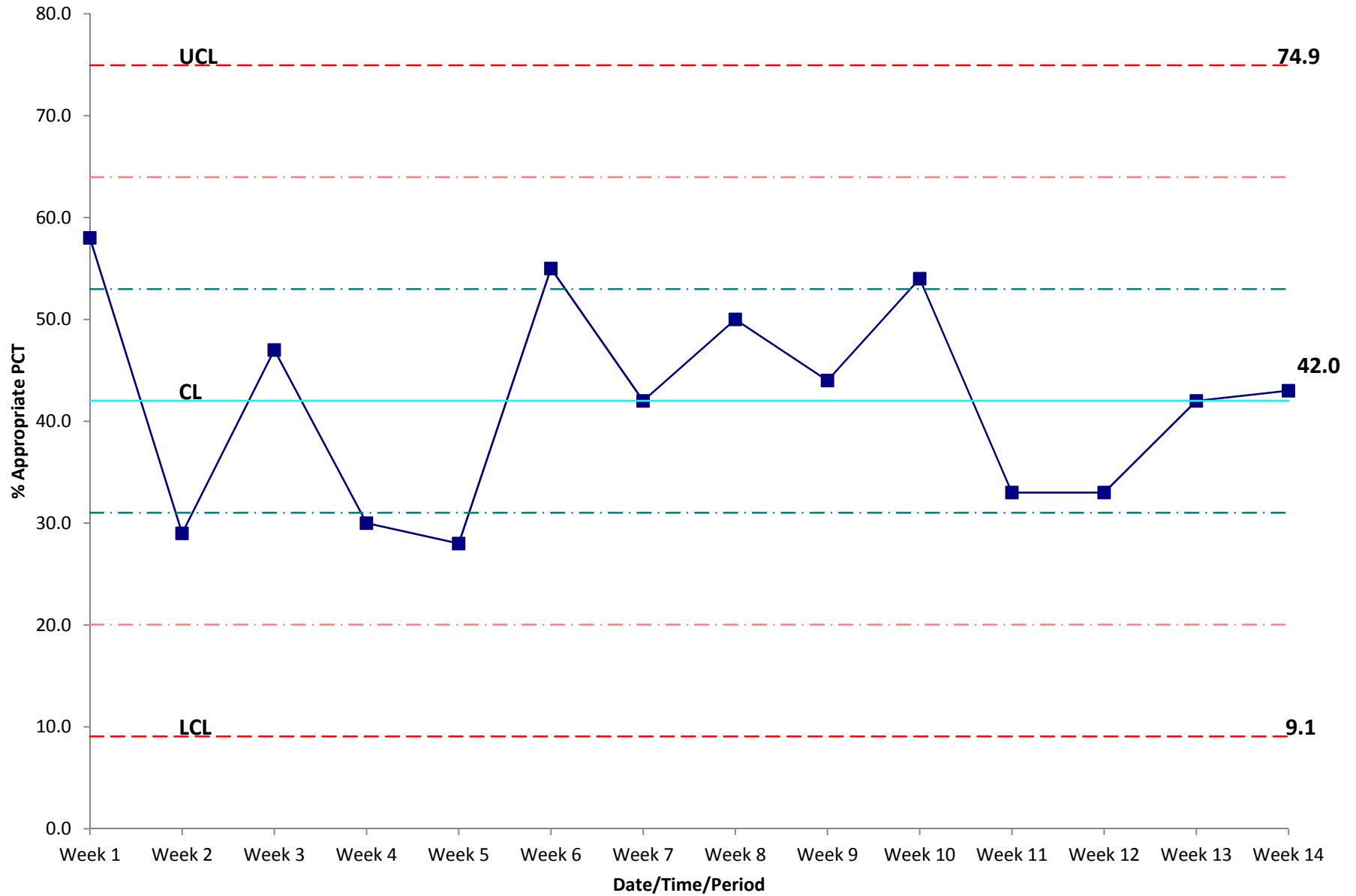
# PCT use at the VA

- **Introduced as a laboratory test**
  - January 2011
    - No restrictions
    - No guidelines
- **Pre-test evaluation (April 1, 2011 – June 30, 2011)**
  - PCT tests n=477
    - 42% Appropriate use
    - **58% Inappropriate use**
      - 96% from two services
        - » ICU /Intermediate care (62%) or Ward service (34%)

# Inappropriate Procalcitonin Order

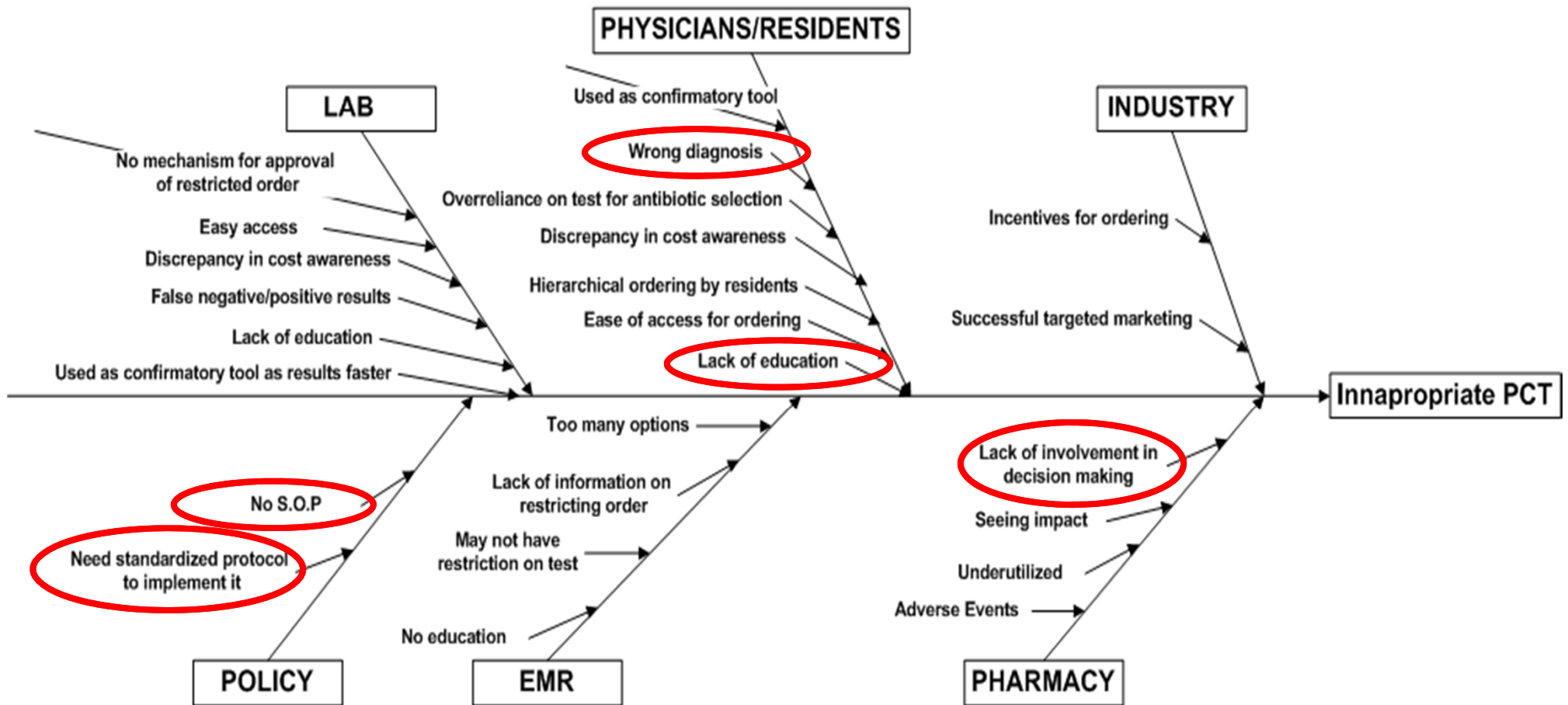


# Appropriate Procalcitonin Order



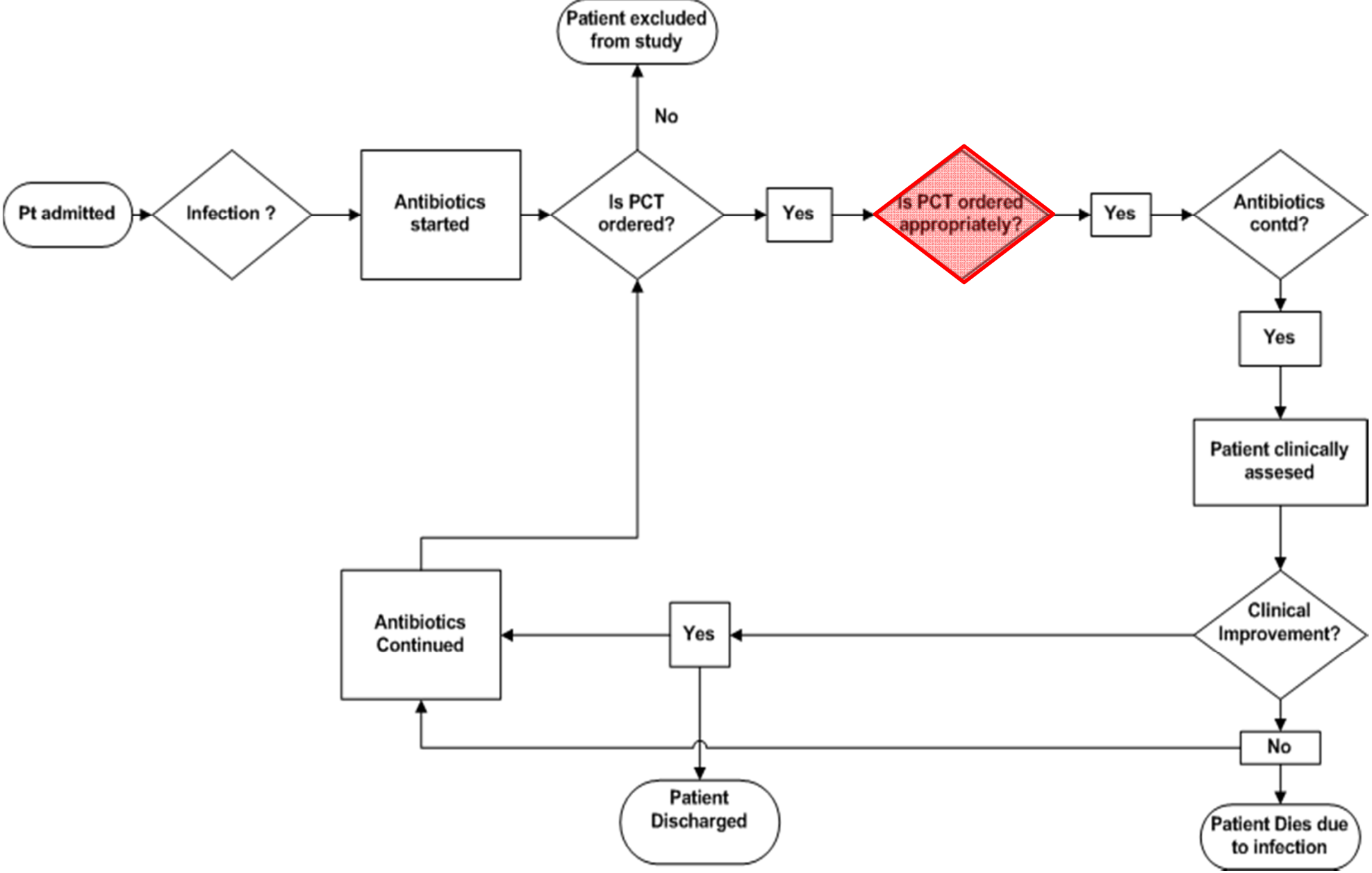
# Cause and Effect Diagram

Cause and effect diagram for Inappropriate use of Procalcitonin





# PCT Use Flowchart



# How Will We Know That a Change is an Improvement?

- **Measure of Success**
  - Knowledge regarding PCT use
  - Appropriate order of PCT
- **Method of measurement**
  - Pre- and post-test evaluation
  - Retrospective chart review of documented appropriateness of the PCT order
- **Specific targets for change**
  - Increase knowledge of appropriate use of PCT usage
  - Increase effectiveness of appropriate PCT order

# Components of the Knowledge Evaluation

- **Numerator**
  - Number of correct answers by health care providers related to the appropriate usage of PCT
- **Denominator**
  - Total number health care providers taking the test regarding the appropriate use of PCT
- **Testing topic**
  - 4 areas of opportunities to appropriate use and order PCT

# Components of the PCT Algorithm Evaluation

- **Numerator**
  - Number of appropriate use of PCT orders according to the indications
- **Denominator**
  - Total number PCT tests performed during the study period
- **Algorithm characteristics for appropriate use**
  - Initial testing
  - Follow-up testing

# Knowledge Evaluation Sample Characteristics

- **Knowledge evaluation**
  - **Sample population (n=49)**
    - Pulmonary and Critical Care fellows (n=12)
    - Medical students (MS 3-4) and internal medicine residents (PGY 1-3) rotating in internal medicine (n=37)
  - **Evaluation date**
    - January 10, 2012 & December 9, 2011 (for PCCM division)
  - **Evaluation characteristics**
    - Pre-test
    - Educational program
    - Post test

# Clinical Evaluation Sample Characteristics

- **Clinical Cohort**

- **Sample population**

- Procalcitonin test performed to hospitalized patients at the STVHCS

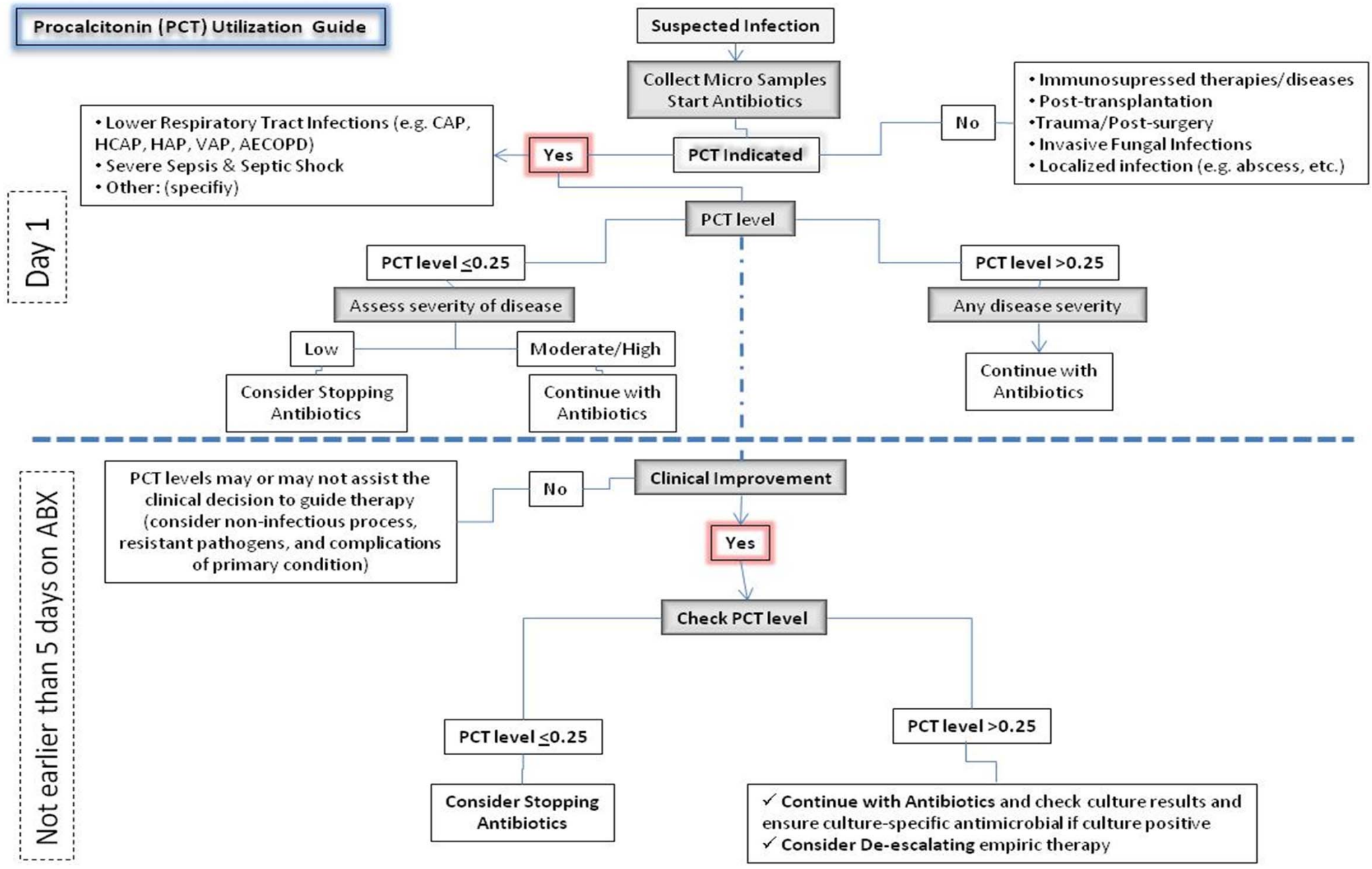
- **Evaluation period**

- Pre-intervention period
      - April 1, 2011 to June 30, 2011 (14 weeks)
    - Intervention
      - Education program – January 10, 2012
    - Post-intervention period
      - January 11, 2012 to February 16, 2012 (6 weeks)

# QI PCT Intervention Implementation

- **Phase I**
  - Team literature review
  - Developed appropriate usage characteristics
  - Developed algorithm for PCT use
    - Appropriate approvals
    - Dissemination protocols
  - Educational program
    - Baseline knowledge evaluation (students, residents, fellows, faculty)
    - Pre-test assessment prior to an educational program
    - Post-test assessment after the education program
  - Clinical data
    - Pre-clinical data collection and analysis
    - Post-intervention – Phase I: Educational program
    - Post-intervention clinical data collection and analysis

**Procalcitonin (PCT) Utilization Guide**



Day 1

Not earlier than 5 days on ABX

- Lower Respiratory Tract Infections (e.g. CAP, HCAP, HAP, VAP, AECOPD)
- Severe Sepsis & Septic Shock
- Other: (specify)

- Immunosuppressed therapies/diseases
- Post-transplantation
- Trauma/Post-surgery
- Invasive Fungal Infections
- Localized infection (e.g. abscess, etc.)

PCT levels may or may not assist the clinical decision to guide therapy (consider non-infectious process, resistant pathogens, and complications of primary condition)

- ✓ Continue with Antibiotics and check culture results and ensure culture-specific antimicrobial if culture positive
- ✓ Consider De-escalating empiric therapy

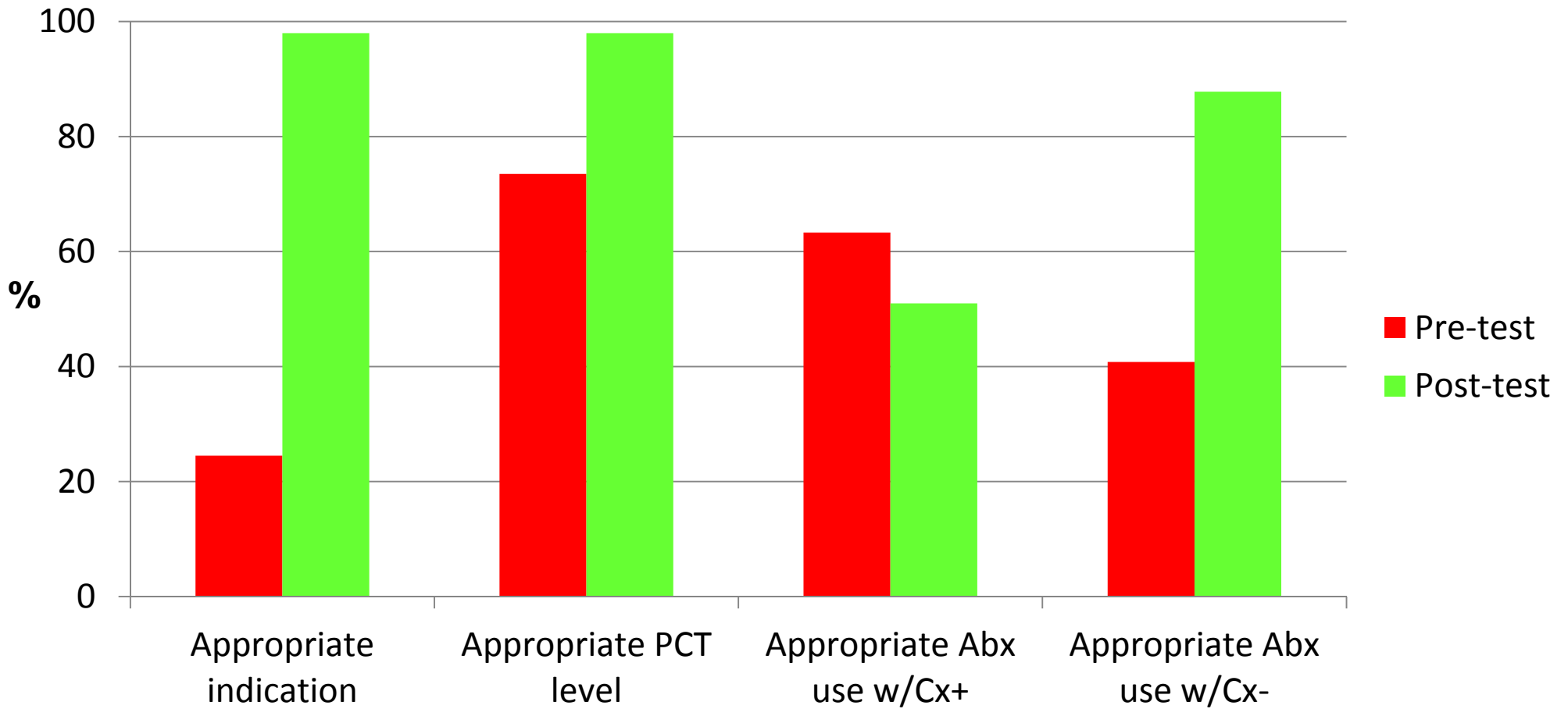


# Knowledge Based Evaluation Results

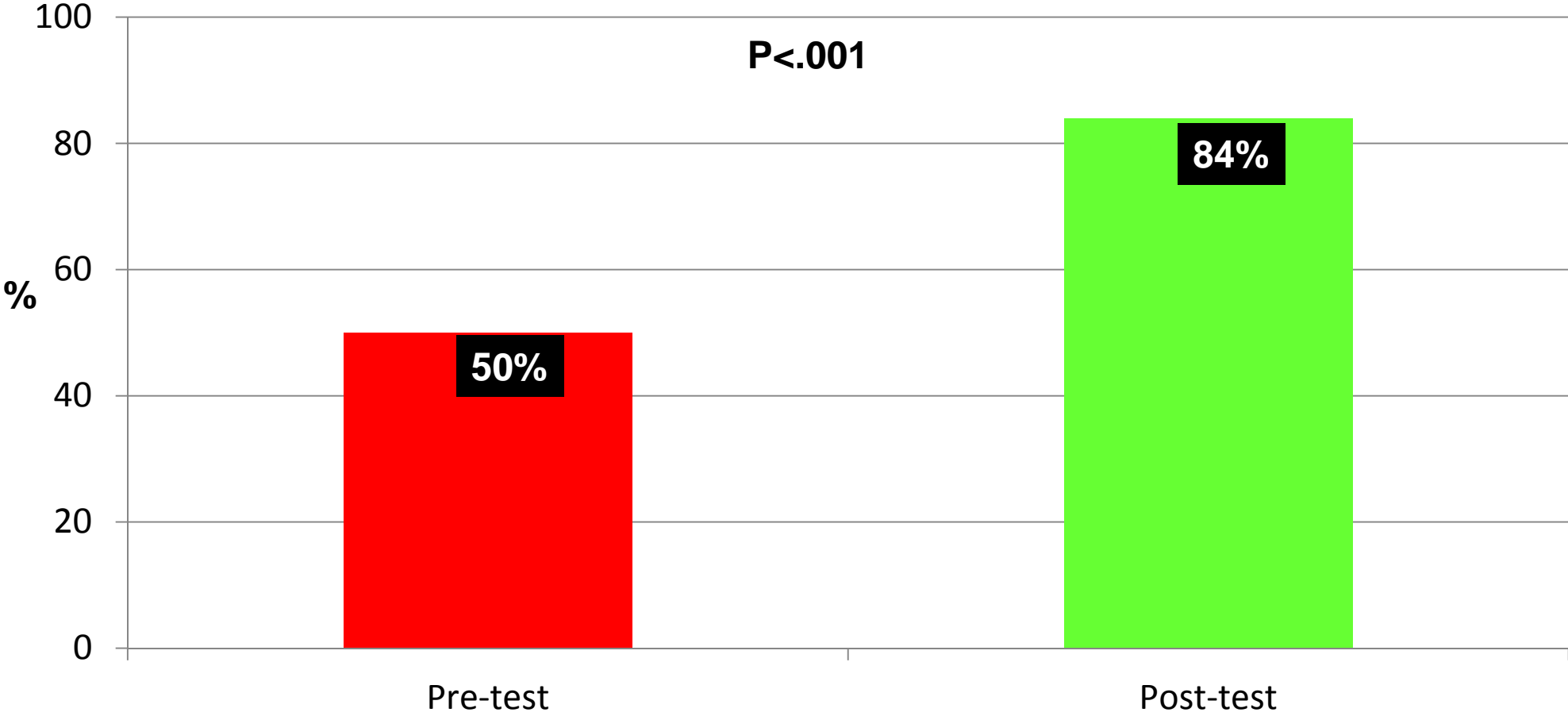
**QI PCT Appropriate use**

# Pre and Post-Tests Answers

## Appropriate PCT utilization



# Overall Pre and Post PCT Assessment



# Clinical Data Evaluation Results

**QI PCT Appropriate use**

# % Appropriate PCT

