Adherence to Procalcitonin Measurement in Inpatient Care: a Guide for Antibiotic Stewardship and High Value Care

Veena Dronamraju, MD¹, Gordon T. Moffat, MD, and Mohamed Nakeshbandi, MD

Department of Internal Medicine, SUNY Downstate Medical Center, Brooklyn, NY, USA.

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INTRODUCTION

Antibiotic overuse is a growing public health epidemic that is associated with increased multidrug resistance (MDR), length of hospitalizations, and healthcare costs. There are approximately two million cases of MDR infections per year, which have resulted in twenty-three thousand deaths.¹ Furthermore, the average cost of an inpatient hospitalization is \$2086 per day.² In efforts to practice high-value care, a rising trend in hospitalist medicine is to use the biomarker procalcitonin to differentiate bacterial etiology in lower respiratory tract infections and sepsis, and thereby promote early cessation of unnecessary antibiotics.^{3–5}

Bacterial infections release specific toxins and cytokines including endotoxin, tumor necrosis factor alpha, interleukin-1-B, and interleukin-6 that induce procalcitonin production and release from almost all tissues. There is a rise in serum procalcitonin levels within 2 to 4 h of the bacterial trigger; this level peaks between 24 and 48h. Many hospitals have developed protocols to guide antibiotic use based on procalcitonin level.

METHODS

A total of 540 cases where providers ordered a procalcitonin level at SUNY Downstate Medical Center from January 2017 to June 2017 were retrospectively reviewed. Inclusion criteria was defined as patients greater than 18 years of age, lab level ordered during inpatient hospitalization, and complete medical evaluation during hospital course excluding patients who left against medical advice, expired during admission, or required transfer to an alternate facility. A total of 348 cases were reviewed for clinical presentation, laboratory studies, microbiology,

radiographic imaging, and outcomes. Procalcitonin cutoff levels of 0.25 ng/ml and 0.5 ng/ml were used for bacterial pneumonia and sepsis respectively (Fig. 1). Data was analyzed for statistical significance. Research was exempt from IRB review.

RESULTS

There was a 68% (119/175) compliance rate with the bacterial pneumonia protocol and a 66% (114/173) compliance rate with the bacterial sepsis protocol. Procalcitonin levels were trended in 4.9% (2) of bacterial pneumonia cases and 11% of sepsis cases (7). There were 72% (78/108) and 57% (50/87) rates of immediate cessation of antibiotics or lack of initiation of antibiotics based on a negative procalcitonin level for cases concerning for a bacterial pneumonia and sepsis respectively. In cases that followed the bacterial pneumonia algorithm where antibiotics were either stopped or not started based on a negative procalcitonin, antibiotic course and hospital stay were 5.52 days ($p < 0.000001$) and 3.03 days ($p = 0.025$) shorter than in cases where antibiotics were continued or started despite a negative procalcitonin. In cases that followed the bacterial sepsis algorithm where antibiotics were either stopped or not started based on a negative procalcitonin, antibiotic course and hospital stay were 3.6 days ($p = 0.029$) and 11.3 days ($p = 0.091$) shorter than in cases where antibiotics were continued or started despite a negative procalcitonin.

DISCUSSION

Procalcitonin should be used in cohesion with other laboratory studies, imaging, cultures, and clinical picture. As suggested from our data, a negative biomarker can possibly decrease unnecessary antibiotic use and length of stay, with potential savings of \$7344–\$27,391 per hospitalization. It is posited that compliance with the procalcitonin protocols likely decreases hospital stay due to quicker diagnosis and subsequent appropriate management. In our underserved population, there are external factors that contribute to length of stay including lack of or limited health insurance, as well as inadequate staffing

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Figure 1 SUNY Downstate procalcitonin management algorithms for cases suspicious for lower respiratory tract infection and sepsis.

delaying rehabilitation evaluation and discharge. Though these social aspects may be possible confounders that affected number of inpatient days, it is less likely given that they affect both the compliant and noncompliant cases uniformly.

It is important to note that in this study cases were not excluded based on comorbidities that may have caused nonbacterial elevations of procalcitonin including massive stress, shock, and compromised renal function. In these cases, our institution's protocols emphasize clinical judgment rather than reliance on the lab value. The inclusion of these cases may have falsely lowered rates of compliance with the protocol and decreased the specificity of the test.

Further studies are required to investigate the utilization and effectiveness of procalcitonin protocols in both bacterial pneumonia and sepsis. Based on our preliminary data, however, we anticipate that procalcitonin could be made a vital tool to reduce antibiotic overuse, antibiotic resistance, and hospital stay, and consequently promote high value care.

Corresponding Author: Veena Dronamraju, MD; Department of Internal Medicine SUNY Downstate Medical Center, 450 Clarkson Ave, MSC-50, Brooklyn, NY 11203-2098, USA (e-mail: Veena.Dronamraju@Downstate.edu).

Contributors None

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