

AMERICAN THORACIC SOCIETY DOCUMENTS

Diagnosis and Management of Community-acquired Pneumonia An Official American Thoracic Society Clinical Practice Guideline

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THIS OFFICIAL CLINICAL PRACTICE GUIDELINE OF THE AMERICAN THORACIC SOCIETY WAS APPROVED MAY 2025

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This document was funded by the American Thoracic Society.

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ABSTRACT

Background:

Understanding of the diagnosis and treatment of adults with community-acquired pneumonia (CAP) has evolved thanks to new evidence, experience, and emerging technologies. This document updates evidence-based clinical practice guidelines on four key questions for the diagnosis and management of adult patients with CAP.

Methods:

A multidisciplinary panel integrated systematic reviews of comparative evidence with other relevant research and clinical experience, then applied Grading of Recommendations, Assessment, Development and Evaluation (GRADE) methodology to produce recommendations using the Evidence to Decision Framework.

Results:

The panel formulated clinical recommendations that address questions related to CAP, including lung ultrasound for diagnosis, empiric antibacterial therapy if a test for a respiratory virus is positive, antibiotic duration, and the use of systemic corticosteroids.

Conclusions:

The panel formulated and provided the rationale for recommendations on selected diagnostic and treatment strategies for adult patients with CAP.

Keywords: pneumonia; lower respiratory tract infection; practice guidelines; guideline update

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SUMMARY OF RECOMMENDATIONS

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For adults with suspected CAP, we suggest lung ultrasound is an acceptable diagnostic alternative to chest x-ray in medical centers where appropriate clinical expertise exists (conditional recommendation, low-quality evidence). Vote: 13/15 (87%) of committee members voted in favor of this recommendation.

2. Empiric Antibacterial therapy for CAP with positive respiratory virus testing

For adult outpatients without co-morbidities who have clinical and imaging evidence of CAP and who test positive for a respiratory virus, we suggest not prescribing empiric antibiotics (conditional recommendation, very low-quality evidence). Remark: this is a conditional recommendation because the balance between benefit and harm of empiric antibiotics will vary based on clinical context (see Table 1). Vote: 14/15 (93%) of committee members voted in favor of not prescribing antibiotics.

For adult outpatients with co-morbidities who have clinical and imaging evidence of CAP and who test positive for a respiratory virus, we suggest prescribing empiric antibiotics due to concern for bacterial-viral co-infection (conditional recommendation, very low-quality evidence). Remark: this is a conditional recommendation because the balance between benefit

and harm of empiric antibiotics will vary based on clinical context (**see Table 1**). Vote: 11/15 (73%) of committee members voted in favor of prescribing antibiotics.

For adult inpatients with clinical and imaging evidence of non-severe CAP who test positive for a respiratory virus, we suggest prescribing empiric antibiotics due to concern for bacterial-viral co-infection (conditional recommendation, very low-quality evidence). Remark: this is a conditional recommendation because the balance between benefit and harm of empiric antibiotics will vary based on clinical context (**Table 1**). Vote: 12/15 (80%) of committee members voted in favor of prescribing antibiotics.

For adult inpatients with clinical and imaging evidence of severe CAP who test positive for a respiratory virus, we suggest prescribing empiric antibiotics due to concern for bacterial-viral co-infection (conditional recommendation, very low-quality evidence). Remark: although the committee was unanimous in making this recommendation, this is a conditional recommendation due to the absence of comparative evidence. Vote: 15/15 (100%) of committee members voted in favor of prescribing antibiotics.

3. Antibiotic duration for CAP

For adult outpatients with CAP who reach clinical stability, we suggest less than five days of antibiotics (minimum of 3 days duration), rather than five or more days of antibiotics (conditional recommendation, low-quality evidence). Remark: this is a conditional

recommendation that requires individualization. See **Table 1** for factors that weaken this recommendation. Vote: 15/16 (94%) of committee members voted in favor of less than five days of antibiotics.

For adult inpatients with non-severe CAP who reach clinical stability, we suggest less than five days of antibiotics (minimum of 3 days duration), rather than five or more days of antibiotics (conditional recommendation, low-quality evidence). Remark: this is a conditional recommendation that requires individualization. See **Table 1** for factors that weaken this recommendation. Vote: 11/16 (69%) of committee members voted in favor of less than five days of antibiotics.

For adult inpatients with severe CAP who reach clinical stability, we suggest five or more days of antibiotics, rather than less than five days of antibiotics (strong recommendation, low-quality evidence). Remark: This recommendation is strong despite the low-quality of evidence because insufficient antibiotic therapy can result in serious adverse outcomes or death in patients with severe CAP. Vote: 15/16 (94%) of committee members voted in favor of five or more days of antibiotics.

4. Systemic corticosteroids for CAP

For adult inpatients with non-severe CAP, we recommend NOT administering systemic corticosteroids (strong recommendation, low-quality evidence). Remark: This recommendation is strong because, while the overall quality of evidence was low, the intent is to avoid harmful

side effects like hyperglycemia for which there is robust evidence. Vote: 16/16 (100%) of committee members voted in favor not administering systemic corticosteroids.

For adult inpatients with severe CAP, we suggest systemic corticosteroids (conditional recommendation, low-quality evidence). Remark: This recommendation excludes patients with severe CAP due to influenza pneumonia. Vote: 15/16 (94%) of committee members voted in favor systemic corticosteroids.

INTRODUCTION

In 2019, the American Thoracic Society (ATS) and Infectious Disease Society of America (IDSA) provided evidence-based practice guidelines on the management of adult patients with community-acquired pneumonia (CAP) to provide an update to the previous 2007 guideline.[1, 2] It addressed 16 specific areas for recommendations surrounding diagnostic testing, determination of site of care, selection of empiric antibiotic therapy, and subsequent management decisions. Since publication of the 2019 guidelines, the care of CAP has been impacted by the COVID-19 pandemic, the availability of rapid molecular tests for multiple pathogens including viruses, emerging imaging technology, and new evidence surrounding the host response and the potential role of corticosteroids. Given the dynamic nature of the evidence base for CAP and the need for more rapidly updated guidance, there has been a move toward more rapidly generated, incremental guideline recommendation updates. The first of these updates addressed nucleic acid testing for non-influenza and non-SARS-CoV-2 viruses.[3] The current update addresses four clinically relevant questions, of which two are updates from the 2019 guideline and two are new questions:

1. Should lung ultrasound be considered a reasonable alternative to chest x-ray for diagnosis in adults with suspected community-acquired pneumonia? (New)
2. Should adults with community-acquired pneumonia who test positive for a respiratory virus be treated with empiric antibacterial therapy? (New)
3. Should adults with community-acquired pneumonia who reach clinical stability be treated with less than 5 days of antibiotics? (Update from 2019)
4. Should adults who are hospitalized with community-acquired pneumonia be treated with corticosteroids? (Update from 2019)

This guideline update addresses community-acquired pneumonia (CAP) in immunocompetent adult patients. Pneumonia is a lower respiratory tract infection (LRTI) that causes inflammation in the alveoli. CAP is acquired outside of hospital or healthcare settings, and most commonly presents to emergency department or primary care. Because CAP cannot be clinically distinguished from other LRTI's without chest imaging to confirm alveolar inflammation, the standard diagnosis of CAP requires clinical signs and symptoms plus chest imaging confirmation to visualize alveolar inflammation. This guideline update focuses only on those patients with a standard diagnosis of CAP.

CAP can be caused by bacterial, viral, fungal, or a combination of pathogens. The diagnosis does not require microbiologic confirmation because microbiologic tests have poor sensitivity. This definition includes all viruses, including SARS-CoV-2. However, this guideline update does not address the syndrome of SARS-CoV-2 pneumonia that was seen during the COVID-19 pandemic. Patients who presented with pneumonia due to SARS-CoV-2 during the COVID-19 pandemic exhibited distinct patterns of presentation and responses to therapies due to its novelty, virulence, dominance over other pathogens, and naivety of the host immune system. Evidence and guidelines were generated to support management [4, 5] that are distinct from this guideline and do not apply to CAP. With the exception of the lung ultrasound question, none of the other formal evidence reviews included studies conducted during the pandemic. As we emerge from the pandemic and SARS-CoV-2 becomes integrated into the milieu of respiratory pathogens that cause CAP, we expect the pattern of presentation, epidemiology, and responsiveness to therapy for patients with CAP caused by SARS-CoV-2 to change. At the time of this publication, it is not clear whether today's patient with pneumonia due to SARS-CoV-2

would most benefit from standard CAP management or COVID-19 treatments used during the pandemic.

This guideline update is also not intended for use in immunocompromised hosts (ICHs). Patients classified as ICHs have compromised immune systems due to certain medical conditions including malignancy, advanced HIV infection, and organ transplantation, and treatments that impair the immune system including chronic glucocorticoids, chemotherapy, conventional disease-modifying antirheumatic drugs, and biological agents used to treat various rheumatologic, dermatologic, gastrointestinal, and autoimmune disorders. The clinical presentation, pathogen profile, and host responses to pneumonia in ICHs are markedly different from those in non-immunocompromised individuals. For detailed guidance on the diagnosis and management of pneumonia in ICHs, please consult specific recommendations provided by the ATS and other medical organizations.[6] [7]

The understanding of CAP is evolving. Previously considered a sterile compartment, the lung is now understood as an active ecosystem with organisms that interact with each other and host cells in complex, dynamic ways.[8] Pneumonia is no longer considered a simple matter of invasion of a sterile space by a foreign organism with the simple solution of eliminating offending pathogens. Rather, it is a state that emerges from structural and functional host susceptibility, dysbiosis (an imbalance in microbial populations), inflammation from a dysregulated host response, and tissue damage.[9] This evolving understanding of the microbiology and host response of CAP has important implications on clinical management, particularly surrounding the optimal use of diagnostic tests, antimicrobials, and host modulating therapies. As a result, clinicians need to pursue more individualized, tailored approaches to clinical management.

We have maintained the convention of separate recommendations based on setting and severity of illness similar to prior ATS/IDSA guidelines: outpatient, inpatients with non-severe CAP, and inpatients with severe CAP as defined by previously validated criteria (Table 2). However, decisions about site of care may be based on considerations other than severity and can vary widely between hospitals and practice sites. These guidelines are intended not to impose a standard of care based upon singular categories, but to provide the basis for rational decisions in the management of patients with CAP. The majority of the recommendations in this guideline update are conditional, meaning that a sizable minority of patients may not want the suggested course of action, and clinicians must help patient arrive at a management decision consistent with their values and preferences (Table 3). For each guideline recommendation, the committee generated patient factors to consider that strengthen or weaken the recommendation (Table 1). Clinicians should review these factors and individualize recommendations based upon their assessment of how well the guidelines apply to their patient. Clinicians, patients, third-party payers, institutional review committees, other stakeholders, and courts should never view or use these recommendations as mandates. No guideline or recommendation can account for all the unique individual clinical circumstances that must be considered in medical decision-making. Therefore, no one responsible for evaluating clinicians' actions should attempt to apply the recommendations from these guidelines by rote or in a blanket fashion. Statements about underlying values and preferences, as well as qualifying remarks, accompanying each recommendation are integral parts that serve to facilitate nuanced interpretation. They should never be omitted when quoting or translating recommendations from these guidelines.

METHODS

A multidisciplinary (pulmonology, infectious disease, internal medicine, critical care, hospital medicine, emergency medicine, and evidence synthesis) panel of 9 experts from the ATS and 9 from IDSA was composed to identify clinically important interventions for CAP that warrant review of the evidence. In accordance with Institute of Medicine (now the National Academy of Medicine) Standards, clinical questions were posed, and systematic reviews of comparative effectiveness studies published January 1 1946-March 31 2023 were performed by four members of the methodology team to inform recommendations.[10, 11] The literature search was updated on November 27, 2024 and February 20, 2025 with an additional 60 articles reviewed by the methodology team and co-chairs. No studies were identified that required insertion into the completed systematic reviews. When the comparative evidence alone was deemed insufficient to inform a recommendation, it was supplemented with epidemiological evidence, clinical observations, and disease pathophysiology. The Grading of Recommendations, Assessment, Development, and Evaluation (GRADE) approach was employed to formulate and rate the recommendations[12]. The Convergence of Opinion on Recommendations and Evidence (CORE) process was used to help generate consensus [13]. To integrate patient feedback, the document was reviewed independently by two patient representatives, MP and CH, who were identified and recruited by committee members through non-therapeutic relationships for their experiences having CAP. Each patient representative provided feedback surrounding each recommendation via a virtual meeting facilitated by the ATS senior director of documents and patient education, Judy Corn. Targeted questions for each recommendation prepared by co-chairs were also answered. Feedback was then incorporated throughout the document by chairs and patient representatives and summarized in the patient input statement .

The guideline underwent anonymous peer review by 16 content experts (4 from ATS; 11 from IDSA). Following multiple cycles of review and revision, the guideline was reviewed and approved by a multi-disciplinary Board of Directors from ATS. However, it was not approved by the IDSA. The guideline update will be reviewed by the ATS three years after publication and it will be determined if updating is necessary. A detailed description of the methods is provided in the online supplement. Implications of the strengths of the recommendations (i.e., strong versus conditional) are described in Table 3.

QUESTION 1: Should lung ultrasound be considered a reasonable diagnostic alternative to chest x-ray in adults with suspected community-acquired pneumonia?

Rationale:

The diagnosis of pneumonia carries substantial uncertainty.[14] Since signs and symptoms are neither sensitive nor specific, it is essential to confirm the clinical suspicion of pneumonia with visualization of alveolar inflammation on imaging. Confirming pneumonia through chest imaging is thus a standard in settings where it is available, as the remainder of evidence-based practice hinges upon diagnosis.

Chest x-ray, which is the most common way of documenting a diagnosis, is less accurate than chest computerized tomography (CT). However, chest CT is more costly and time-consuming. Both of these modalities require a radiology department. An estimated two-thirds of the world's population has limited or no access to radiographic imaging [15], and past clinical trials on pneumonia have been limited to use of chest x-ray or CT [16, 17], effectively excluding much of the world from clinical research, the evidence base, and high-quality diagnosis.

Since the 1990's, studies of lung ultrasound (LUS) have shown that this technique can accurately detect common lung pathologies when performed by clinicians competent in its use [16, 17]. In recent years, more clinicians have begun using LUS to diagnose and manage patients with pulmonary disease thanks to advancements in ultrasound technology, increased availability of portable ultrasound machines, and integration of training in LUS in undergraduate and graduate medical education.[18, 19] Although our historical standard of diagnosis in CAP has been chest radiograph (x-ray or CT), there are currently few studies and guideline

recommendations in this area. Due to the emerging evidence and availability of LUS, we pursued a review of the evidence surrounding LUS for the diagnosis of CAP.

Evidence synthesis:

The guideline committee *a priori* defined three outcomes as “critical”: time to appropriate diagnosis, treatment, and disposition; repeat visits to emergency department, clinic, or hospital; and test accuracy. The committee also *a priori* defined four outcomes as “important”: use of advanced imaging, cost, and provider and patient experience (ie, satisfaction).

We identified no studies that measured any outcomes besides accuracy when comparing LUS to chest x-ray in patients with suspected CAP. No studies directly compared the effects of LUS and chest x-ray on clinical outcomes in patients with suspicion for CAP. However, twelve studies of patients who underwent LUS and chest x-ray and then proceeded to chest CT for clinical reasons (including discordance between LUS and X-ray) were identified, which examined the test characteristics of LUS and chest x-ray using chest CT as the reference standard [20-31] (Table S1). These studies provided indirect evidence, since they included only a subset of patients with suspected CAP, specifically those who also required a chest CT scan.

One study was judged to be an outlier due to near 100% discordance between US and chest x-ray and was excluded [31]. Thus, eleven studies with 939 patients were included [20-30]. When the data were aggregated by meta-analysis, LUS had a median sensitivity of 95% (range 68-100%), while chest x-ray had a median sensitivity of 70% (range 16-94%). The median specificity of ultrasound was 75% (range 0-100%), while the median specificity of chest x-ray was 55% (range 0-94%) (Figure S2, Table S2).

Overall, the committee's certainty in the accuracy of the test characteristics (the quality of evidence) for both LUS and chest x-rays was judged to be low due to inconsistency (wide range of estimates across studies) and imprecision (confidence intervals were wide with the ends leading to different clinical actions). The committee acknowledged the indirectness of the population described above but did not downgrade for it because the committee concluded that it did not further diminish confidence in the estimated effects (Table S2).

Committee's discussion:

Because the existing studies were indirect, inconsistent, imprecise, and lacked clinical outcome evaluations, the true clinical performance of LUS for the diagnosis of CAP is uncertain. There remains substantial uncertainty surrounding whether LUS is equivalent to chest x-ray for management, or which diagnostic approach for pneumonia results in the best outcomes for patients. However, our evidence synthesis suggests that LUS is likely to be at least as accurate as chest x-ray in confirming a clinical suspicion of pneumonia. Thus, while we acknowledge the evidence is of low quality, we conditionally suggest that LUS is an acceptable diagnostic alternative to chest x-ray when performed by clinicians and in settings with adequate expertise.

The studies included in the meta-analysis were limited to an indirect population – patients with indications for chest CT rather than all patients with clinical suspicion for CAP. One of the indications for chest CT is a negative chest x-ray in a patient with high clinical suspicion of pneumonia. Interpreting the performance characteristics found in these studies should be done with extreme caution because they are likely not generalizable to the broader population of patients with clinical suspicion of CAP. In practice, we might expect more similar performance

characteristics between the two diagnostic tests, since a larger proportion of cases would have concordant findings between chest x-ray and LUS. Thus, the accuracy of LUS compared to chest x-ray in the population of patients with clinical suspicion for CAP is yet to be determined.

The skill of the ecographer and the quality of the ultrasound image are paramount to ensuring an accurate diagnosis. In contrast to traditional imaging studies performed by technicians and interpreted by radiologists, LUS can be performed as a point-of-care ultrasound application by bedside clinicians to answer a focused set of clinical questions. Clinicians must demonstrate the skills to identify the most common sonographic features of pneumonia, including consolidation (irregular marginal contour, air bronchogram, the air trapping sign), vertical artifacts (B-lines), and the presence of pleural effusion. Other important factors impacting LUS accuracy include the protocol followed, region of focus, and patient factors, such as obesity, drains, scars, wounds, and movement. While full recommendations surrounding training are beyond the scope of this guideline, clinician skill level must be formally assessed to ensure that the quality of the images acquired matches the quality in published studies. Standard protocols must be followed and documented. LUS results should also be stored and reported within the medical record with the same standards as those of radiographic images and reports to allow for others to review and for longitudinal comparisons. Table 4 summarizes important criteria to ensure high quality LUS in practice.

This recommendation has different implications for different settings and patients. See Table 1 for additional patient factors to consider that strengthen or weaken this recommendation. For settings and patients for whom chest x-ray is available, LUS may serve as an alternative diagnostic tool if clinical suspicion of pneumonia is high, a chest x-ray is negative, and there are barriers or contraindications to a timely diagnosis with CT such as patient safety or cost. For

settings and patients for whom chest x-ray is not an option (due to either lack of radiology services, cost, or other patient concerns including radiation exposure and convenience), LUS is an important advance to clinical diagnosis, enabling the clinician to diagnose CAP more accurately. LUS also has distinct strengths and weaknesses relative to chest x-ray. Compared to radiography, the smaller size, lack of technician and supplies, and ability to visualize the pleural space are important advantages of LUS. However, LUS may not be appropriate for patients in whom it is important to visualize the entire lung or rule out additional processes that can only be visualized by radiography (Table 1).

Recommendation:

For adults with suspected community-acquired pneumonia, we suggest that LUS is an acceptable diagnostic alternative to chest x-ray in settings where the appropriate expertise exists (conditional recommendation, low-quality evidence). Vote: 13/15 (87%) of committee members voted in favor of a conditional recommendation for considering lung ultrasound as an acceptable diagnostic alternative to chest x-ray.

What others are saying:

Several professional and specialty societies have published clinical practice guidelines and recommendations to standardize the use of LUS for multiple conditions [32-40]. International evidence-based recommendations for point-of-care lung ultrasound published in 2012 suggested the use of LUS for the diagnosis of pneumonia based on an evidence synthesis of diagnostic accuracy compared to chest x-ray. [32].

Research needs:

Our recommendation is conditional based upon low quality evidence due to a lack of studies that have 1) included the entire population of patients with suspected CAP, and 2) assessed the performance of LUS in clinical practice and its impact on outcomes compared to chest x-ray diagnosis. There are several unanswered questions surrounding the clinical approach to pneumonia diagnosis, particular surrounding choice of imaging or how to interpret discordant results. Two types of studies are needed to improve the evidence supporting this recommendation: 1) well-performed, multi-site diagnostic accuracy studies that include all patients with clinical suspicion of pneumonia, ideally at diverse settings in patients with a broad range of illness severity; and 2) randomized clinical trials that directly compare the impact of different imaging approaches to the diagnosis of pneumonia – including LUS, chest x-ray, and chest CT – on management and clinical outcomes, cost, and patient and provider experience.

QUESTION 2: Should adults with community-acquired pneumonia who test positive for a respiratory virus be treated with empiric antibacterial therapy?**Rationale:**

The decision whether to administer empiric antibacterial therapy to a patient with pneumonia who tests positive for a virus is difficult. The question should not be interpreted as whether to treat viruses with antibiotics (which have no effect on viral infections), but when to consider the risks and consequences of viral-bacterial co-infection. The lung compartment is difficult to sample directly, and microbiology cultures take time to grow and can be inaccurate. The important role of bacteria in deaths from influenza was established by Morens et al[41] who found evidence for coinfecting bacteria in lung tissue from more than 90% of persons who died in the 1918-9 influenza epidemic. *Streptococcus pneumoniae*, *Streptococcus pyogenes* and *Staphylococcus aureus* and *Haemophilus influenzae* are the most common bacterial pathogens identified in patients with influenza virus co-infection.[42] In the 1957-8 Asian influenza outbreak, co-infection with *S. aureus* was the major cause of death.[43] While the mechanisms leading to bacterial-viral co-infection are unclear, proposed theories include viral infection first causing epithelial barrier compromise, impaired immunity, and inflammation producing enriched nutrients, providing an opportunity for bacterial overgrowth.[44, 45] Because of poor sensitivity of microbiology and concern for co-infection, empiric antibiotics have historically been given regardless of whether or not a pathogen is identified. However, the widespread availability of rapid molecular assays have unearthed more viral pathogens, as well as co-detection of viral with bacterial pathogens, than previously documented. Prospective studies with intensive diagnostic efforts during the initial workup have failed to identify any etiologic agent in more than one-half of patients hospitalized for CAP.[46, 47] No presently available combination of clinical,

radiologic or laboratory characteristics reliably distinguishes among patients who have viral, bacterial or viral-bacterial co-infections, making it difficult to ascertain the need for antibacterial therapy in addition to antiviral therapy if such is available.[47] In deciding whether to treat a patient with CAP who tests positive for a respiratory virus for a possible bacterial co-infection, we must weigh 2 important risks:

- 1) Risks of missed or delayed antibiotic treatment to patients with concomitant bacterial pneumonia (adverse outcomes and death).[42, 48-52]
- 2) Risks of antibiotic use to individual patients (side effects, disruption of microbiome, costs) and public health (antimicrobial resistance)[53]

Evidence synthesis:

Our systematic review sought studies that enrolled patients with CAP and compared antibiotics versus no antibiotics following the identification of a viral respiratory pathogen by PCR. The literature search identified 3,895 articles but, upon full-text review of 27 articles, none met our pre-specified study selection criteria (lack of comparison or outcomes- see Supplement for details). The search was then broadened to seek indirect evidence. Again, no studies met our pre-specified study selection criteria. Therefore, no published studies were identified to inform the guideline committee's recommendations and the guideline committee had to make clinical recommendations based upon non-comparative evidence and their non-systematic clinical observations, which constitutes very low-quality evidence.

Committee's discussion:

Given the lack of studies to inform the impact of antibiotics on outcomes for patients with CAP who test positive for a respiratory virus, the committee addressed the question by combining epidemiologic evidence, pathophysiologic understanding, and clinical experience. We emphasize the following recommendations are conditional and should be individualized based upon clinical judgment. Individual patient factors that strengthen or weaken each recommendation are provided in Table 1.

For outpatients, we recommend not offering empiric antibacterial therapy to every outpatient with CAP who tests positive for viral pathogen based on 1) the lack of epidemiologic studies that enrolled outpatients and evaluated the prevalence and outcomes of viral-bacterial co-detection [56], and 2) the committee's judgment that the low risk for an undesirable outcome if antibiotics are withheld or delayed means the potential benefits of early antibacterial therapy may not exceed the risks of harmful consequences of antibiotics to individual and public health. In contrast, we recommend administering empiric antibacterial therapy to adult outpatients who have co-morbidities that might place them at risk for a serious outcome if antibiotics are withheld or delayed. There was disagreement among committee members regarding which comorbidities pose sufficient risk to warrant administering antibiotics to ambulatory patients with a detected viral pathogen. Factors discussed included those that increase risk of either bacterial infection (decreased pulmonary clearance, impaired immunity) or poor outcomes from untreated bacterial co-infection.[42] Table 5 depicts the results of the committee members' votes concerning comorbidities that support antibiotic therapy for outpatients with CAP who test positive for a respiratory virus.

For inpatients hospitalized for CAP who test positive for a respiratory virus, we suggest prescribing empiric antibiotics based upon 1) ample medical literature documenting the co-

existence of bacteria in patients who have pneumonia and test positive for a respiratory virus, especially influenza virus and, to a lesser extent, respiratory syncytial and other respiratory viruses;[47, 54, 55] and 2) high risk of poor outcomes with viral-bacterial co-infection [43,48], which likely increases if antibiotics are withheld or delayed in the event of bacterial infection.[56] The committee recommendation for severe CAP was strong and unanimous despite very low-quality of evidence because insufficient antibiotic therapy can result in serious adverse outcomes or death in patients with severe CAP [1,47,49,50][57]. A systematic review of epidemiologic studies evaluating the etiology of pneumonia among predominantly hospitalized patients reported that in studies in which viral PCR was performed, a respiratory virus was identified in 30 to 40% of patients, and bacteria were detected in 25–35% of these cases.[58] The studies demonstrated that co-detection of viral and bacterial pathogens in CAP due to viruses other than SARS-CoV-2 occurred in about 25-30% of patients. [47, 54, 59] A separate study that evaluated all patients hospitalized for CAP found to have a viral illness reported an 18-39% rate of bacterial detection.[60] Prospective studies of CAP have shown the co-incidence of viral and bacterial pathogens to vary from 3% to 19%. [47, 59, 61] However, in these studies, there was widespread variation in sampling rates, and investigators failed to identify any etiologic agent in 37% to 62% of pneumonia. Using specialized techniques, a study limited to the small proportion of patients who could provide a high-quality purulent sputum at admission showed that, in addition to detection of usual bacterial pathogens, commensal bacteria, so-called ‘normal respiratory flora’ were present in an additional 8% of cases.[58] The role of bacterial co-infection with commensal respiratory flora will not be recognized using currently available techniques.

The burden and consequences of bacterial co-infection may vary by viral pathogen.

Recent studies of adults hospitalized for respiratory syncytial virus pneumonia show that 12% to 29%[62] have bacterial co-infection. Among patients hospitalized with SARS-CoV-2 virus during the pandemic, a systematic review of 24 studies indicated a low rate of bacterial coinfection (3.5%),[63] although a critical analysis has questioned the results of this review.[64] A European cooperative study reported a 10% rate of bacterial detection in patients intubated with COVID-19, compared to 30% among patients with influenza [65] Whether this low rate of co-detection in SARS-CoV-2 will remain in the future is uncertain.

Individual patient factors that strengthen or weaken the recommendation are provided in Table 1. The committee discussed whether features from the history or laboratory studies could reliably predict the presence of bacterial infection and thus the utility of antibiotics. However, we lack any clinical or laboratory parameters that individually or collectively reduce the probability of bacterial superinfection to a level that would allow safely withholding antibiotics. Although a high white blood cell count with the presence of band forms, an elevated procalcitonin level, or a delayed presentation could support a potential role for bacterial co-infection, the absence of these findings is not sufficiently reliable to exclude it for two reasons. First, the ability to predict microbiology based upon biomarkers is poor. For example, sensitivity and specificity of procalcitonin is, at best, around 75-80%, [66, 67] and this performance may be worse in the setting of viral infection.[68] Attempts to distinguish bacterial from viral causes of pneumonia based on clinical criteria have also not been successful.[47, 59] Second, even if these biomarkers were predictive of microbiology results, given that microbiology tests themselves are poor at identifying true bacterial infection in the lung, they are still insufficient to predict benefit or harm of antibiotics.

Since it is currently difficult to exclude the possibility of bacterial infection, the majority of the committee advised initiating antibacterial therapy in patients whose illness severity from pneumonia is sufficient to require hospitalization. However, the patient's presentation (Table 1) including comorbid conditions, clinical features, radiographic findings, virus identified, laboratory/microbiologic results, and clinical response should be considered when reassessing the indication for continued antibiotics versus early discontinuation. We recommend that when empiric antibacterial therapy is initiated, clinicians should perform daily evaluations of clinical stability and review of microbiological results to inform de-escalation or early discontinuation of antibacterial therapy. For specific recommendations regarding antimicrobial therapy including specific antibiotic regimens and antivirals, please refer to prior 2019 ATS/IDSA guidelines.

Recommendations:

1. For adult outpatients without co-morbidities who have clinical and imaging evidence of CAP and who test positive for a respiratory virus, we suggest not prescribing empiric antibiotics due to concern for bacterial-viral co-infection (conditional recommendation, very low-quality evidence). Remark: this is a conditional recommendation because the balance between benefit and harm of empiric antibiotics will vary based on clinical context (**see Table 1**). Vote: 14/15 (93%) of committee members voted in favor of NOT prescribing antibiotics.
2. For adult outpatients with co-morbidities who have clinical and imaging evidence of CAP and who test positive for a respiratory virus, we suggest prescribing empiric antibiotics

due to concern for bacterial-viral co-infection (conditional recommendation, very low-quality evidence). Remark: this is a conditional recommendation because the balance between benefit and harm of empiric antibiotics will vary based on clinical context (see **Table 1**). Vote: 11/15 (73%) of committee members voted in favor of prescribing antibiotics.

3. For adult inpatients with clinical and imaging evidence of non-severe CAP who test positive for a respiratory virus, we suggest prescribing empiric antibiotics (conditional recommendation, very low-quality evidence). Remark: this is a conditional recommendation because the balance between benefit and harm of empiric antibiotics will vary based on clinical context (**Table 1**). Vote: 12/15 (80%) of committee members voted in favor of prescribing antibiotics.
4. For adult inpatients with clinical and imaging evidence of severe CAP who test positive for a respiratory virus, we recommend prescribing empiric antibiotics (conditional recommendation, very low-quality evidence). Remark: although the committee was unanimous in making this recommendation, this is a conditional recommendation due to the absence of comparative evidence. Vote: 15/15 (100%) of committee members voted in favor of prescribing antibiotics.

What others are saying:

Prior 2019 ATS/IDSA clinical practice guidelines recommended that standard antibacterial treatment be initially prescribed for adults with clinical and radiographic evidence of CAP who test positive for influenza in both the inpatient and outpatient settings, based upon multiple epidemiologic studies that reported high rates of detection of bacteria. The current update

diverges from this recommendation for outpatients with CAP and influenza without comorbidities based upon the lack of epidemiologic evidence in outpatients, low risk of harm of withholding antibacterials in this population, and risks of antibiotic overuse to public health. The ATS guideline update addressing non-influenza respiratory viral tests recommended against routine testing of viruses.[3] Given the pandemic experience, the dynamic nature of viral epidemics, increasing availability of lower-cost tests, and potential for positive viral tests to change management, this recommendation may require future review. The decision when to obtain viral tests should be left to clinical judgment informed by both individual patient factors and local epidemiology. Guidelines for managing COVID-19 during the pandemic [4] [5] recommended that antibiotics not be given unless there is evidence for bacterial coinfection based upon lower rates of bacterial detection observed during the pandemic. No guidelines have addressed whether to administer antibacterial therapy in patients with CAP who test positive for other respiratory virus, such as respiratory syncytial virus, due to the concern of bacterial co-infection.[1, 69-71] Recent ERS/ESICM/ESCMID/ALAT guidelines for severe CAP recommend the use of molecular diagnostic PCR to detect both bacteria and virus when available, continue to recommend empiric antimicrobial for all patients, and highlight the need for studies that elucidate the safety of discontinuing antibiotics if bacterial tests are negative.[72]

Research needs:

There is an immediate need to improve the quality of evidence through comparative effectiveness research, including 1) randomized controlled studies to determine which patients with CAP benefit or are harmed from antibiotics when a virus is detected; 2) studies that evaluate patients based upon the virus identified, illness severity, patient comorbidities, and for outcomes

that impact patients beyond 30-day mortality (such as return to function and antibiotic-associated side effects); 3) studies that compare the withholding of empiric antibiotics versus initiating and discontinuing them early (within the first 24-48 hours of initiation) versus standard approaches; and 4) studies of tailored approaches based upon patient factors including severity of illness presentation, patient- and virus-related risk of bacterial infection, and microbiological and biomarker information, including novel tests such as bacterial multiplex PCR, inflammatory markers, or host transcriptional signals.[73] [74] Additional research is also needed to support appropriate use and interpretation of these tests, including which patient and environmental factors should be used to consider when to obtain viral testing.

QUESTION 3: Should adults with community-acquired pneumonia who reach clinical stability be treated with less than 5 days of antibiotics?

Rationale:

The optimal duration of antibiotic treatment in CAP is unknown. Due to concerns that pathogens may develop resistance if undertreated[75], prior CAP guidelines from the 1990s recommended antibiotic durations as long as 14 days, well beyond clinical stability.[76, 77] However, as our model of lung infection advances, the goals of antibiotics may no longer be to completely eradicate causative pathogens[78] but rather to reduce bacterial load with as little disruption to the microbiome as possible.[79] Harms from longer antibiotic durations are increasingly observed, including side effects,[80, 81] *Clostridioides difficile* infection,[82, 83] acute kidney injury,[83] disruption of normal flora[84] and emergence of antibacterial

resistance.[85, 86] Over the past 2 decades, several studies have demonstrated noninferior clinical outcomes with shorter durations of antibiotic therapy compared to longer durations. [87-91] ATS/IDSA CAP guidelines in both 2007 and 2019 recommended a duration of therapy no more than 5 days of antibiotics if the patient reaches clinical stability. Since these recommendations, additional clinical trials suggested durations shorter than 5 days could be adequate for selected patients reaching clinical stability.

Evidence synthesis:

The initial evidence synthesis included 13 studies of immunocompetent patients with clinical and imaging evidence of CAP that evaluated any antibiotic as long as it was less than 5 days of treatment. This was changed to only include studies evaluating less than 5 days effective duration so that studies of azithromycin were only included if it was given for less than 3 days, due to the pharmacokinetics of azithromycin (1 day of high-dose 2g azithromycin microspheres are effectively 4 days duration, and 3 days of 500mg or 1g azithromycin are effectively 5 days or slightly longer antibiotic duration).[92] [93] Several studies that gave azithromycin for 3 days were thus removed. Our systematic review identified four relevant randomized controlled trials that compared <5 effective days duration of antimicrobial therapy to ≥ 5 days duration [87, 89, 94, 95]. Two of the trials evaluated azithromycin in outpatients: D'Ignacio et al. compared 1 day of 2g extended-release azithromycin to 7 days of 500mg levofloxacin, and Drehobl compared 1 day of 2g extended-release azithromycin to 7 days of 1g extended-release clarithromycin. [94, 95] These were considered an assessment of effectively 3 days duration of antimicrobial therapy, given the pharmacokinetics of azithromycin; 4 studies evaluating 3 days of azithromycin were not included. The other two trials used beta-lactams and enrolled hospitalized patients: in

immunocompetent nonpregnant inpatients with mild or moderate pneumonia admitted to hospital wards who had clinical improvement after a 3-day course of high-dose IV amoxicillin, Moussaoui et al compared placebo to 5 additional days of 750mg PO amoxicillin three times daily. Among immunocompetent hospitalized patients without a history of respiratory insufficiency, severe, or complicated pneumonia who reached clinical stability after a 3-day course of a beta-lactam antibiotic, Dinh et al compared placebo to 5 additional days of 1g/125mg PO amoxicillin-clavulanate [87, 89] (Table S4 and Table S5). The studies used different definitions of clinical cure and had variable follow-up time periods, although the follow-up periods could be classified as either one to two weeks or three to four weeks after treatment initiation.

The guideline committee *a priori* defined three outcomes as “critical”, which included mortality, treatment success/failure, and CAP complications. Out of these outcomes, only mortality and treatment success (defined by studies as clinical cure) could be estimated from the included studies. The committee also *a prior* defined five outcomes as “important”, including duration of hospitalization, antibiotic-free days, patient experience, cost, and antibiotic resistance. Out of these outcomes, only one study evaluated duration of hospitalization.

The data were aggregated by meta-analysis for each outcome (Figure S5). Mortality was evaluated in only one study (Dinh et al), which showed no statistically significant difference when fewer than 5 days of antibiotics were compared to five or more days (2.0% versus 1.3%, risk ratio 1.49, 95% CI 0.25 to 8.79). One death occurred among patients treated with fewer than 5 days; the patient had bacteremia due to *Staphylococcus aureus*. One death occurred among patients treated with more than 5 days; the patient had recurrent pneumonia. The clinical cure rate one to two weeks after treatment was similar among patients who received less than five

days of antibiotics versus those who received five or more days (85.6% versus 87.6%, risk ratio 0.98, 95% CI 0.91 to 1.05) (Figure S5 and Table S6.1).

Subgroup analyses for clinical cure rate one to two weeks after treatment were based upon the setting and antibiotic. For the subgroup of outpatients treated with azithromycin, the clinical cure rate one to two weeks after treatment was similar among patients treated with less than five days of antibiotics compared to five or more days of antibiotics (87.4% versus 91.9%, risk ratio 0.96, 95% CI 0.91 to 1.01) (Figure S5 and Table S6.2). Likewise, for the subgroup of inpatients treated with beta-lactams, the clinical cure rate one to two weeks after treatment was similar among patients treated with less than five days of antibiotics versus those treated for five or more days (81.9% versus 75.7%, risk ratio 1.06, 95% CI 0.90 to 1.24) (Figure S5 and Table S6.3).

Clinical cure rate three to four weeks after treatment was similar among patients who received less than five days of antibiotics versus those who received five or more days (81.0% versus 82.5%, risk ratio 0.99, 95% CI 0.92 to 1.07) (Figure S5 and Table S6.1). For the studies evaluating azithromycin in outpatients, the clinical cure rate three to four weeks after treatment was similar among patients treated with less than five days of antibiotics versus those treated with five or more days (82.1% versus 84.1%, risk ratio 0.98, 95% CI 0.84 to 1.13) (Figure S5 and Table S6.2). For the studies evaluating beta-lactams among inpatients, the clinical cure rate three to four weeks after treatment was also similar among patients treated with less than five days of antibiotics versus those treated with five or more days (78.7% versus 79.2%; risk ratio 1.01, 95% CI 0.92 to 1.11) (Figure S5 and Table S6.3).

Hospital length of stay was not impacted by whether subjects were treated with less than five or five or more days of antibiotics (mean of 6 days \pm 3.7 versus 6.3 \pm 3.7 days; mean difference of -0.35 days, 95% CI -1.17 to 0.47 days) (Figure S5 and Table S6.3).

Overall, the committee's certainty in the accuracy of the estimated effects (the quality of evidence) was low (Table S6).

Committee's discussion:

Our recommendation for antibiotic duration in adults with CAP who reach clinical stability varies based on CAP severity and treatment setting. Table 6 defines clinical stability according to the study definitions.

For immunocompetent adult outpatients and inpatients with non-severe CAP who reach clinical stability, we suggest treating with <5 days effective duration of antibiotics (minimum of 3 days) rather than \geq 5 days of antibiotics due to the four recent trials that suggested similar clinical outcomes in these groups. The pharmacokinetics of the antibiotic and the patient's renal and hepatic function must be considered to establish the number of days of treatment that are equivalent to the suggested therapeutic duration (the effective number of days), particularly for macrolides (which have a half-life of 3 days) and for patients with renal insufficiency.

We recognize that the existing studies a) established non-inferiority but not clinical benefit of shorter durations in a select group of patients, excluding many patients with comorbidities; b) did not evaluate important outcomes such as CAP-related complications or return to baseline function; and c) examined antibiotic selection and doses that are not considered appropriate treatment by the IDSA/ATS (azithromycin and clarithromycin are not considered

adequate treatment for outpatients due to the high rate of macrolide-resistant *Streptococcus pneumoniae* in the United States; combination therapy of beta-lactam plus macrolide or fluoroquinolone is strongly recommended for inpatients; fluoroquinolone dosing for CAP is 750mg levofloxacin or 400mg moxifloxacin).

For outpatients, many meet clinical stability criteria upon presentation, but individual patient factors (listed in Table 1) should be considered for appropriateness, and all patients should be monitored for clinical recovery or recurrent infection. Assessing the safety of discontinuing antibiotics on day 3 requires close follow-up, which may be difficult for some settings and patients. If prescribing short courses of antibiotics, clinicians and patients should develop an optimal plan based upon individual patient preferences, discuss signs and symptoms of recovery or recurrence of infection (elevated temperature or heart rate, shortness of breath, altered mental status), and establish communication lines and contingency plans.

For inpatients with non-severe CAP, this recommendation should only be applied to those patients who do not have additional contraindications to short courses of antibiotics and who reach clinical stability, including resolution of new oxygen needs. Table 1 lists additional patient factors to consider, such as patient comorbidities and results of inflammatory markers. Antibiotic courses should not be implemented as set duration for all patients determined at presentation, since many patients have contraindications to shorter durations, and time to clinical stability is difficult to predict on presentation. The duration of antibiotics should be determined day by day based upon clinical responses. A sizable proportion (over 50%) of hospitalized patients with non-severe CAP would not be eligible for short courses.[96] [97] [98] [99] Patients discharged home should also establish clear follow-up plans for symptoms of recurrence.

Adults with severe CAP were not evaluated in the trials we reviewed. We thus maintain our prior strong recommendation of 5 days or greater due to these patients' higher risk of disseminated infection, necrotizing or resistant organisms, and higher risk and consequences of treatment failure.

Regardless of illness severity, patients with contraindications to shorter courses including severe chronic lung disease such as bronchiectasis, evidence of necrotizing pneumonia such as lung abscesses or empyema, or confirmed infection with a necrotizing or resistant organism such as *Staphylococcus aureus* or *Pseudomonas aeruginosa* require tailored antimicrobials according to guidance specific to these complications. In patients with low certainty of a CAP diagnosis who have an alternative diagnosis that better explains their illness, antibiotics should be discontinued. This is not a short course for pneumonia, but an individualized treatment based on refined diagnosis.

Recommendations:

1. For adult outpatients with CAP who reach clinical stability, we suggest less than five days of antibiotics (minimum of 3 days duration), rather than five or more days of antibiotics (conditional recommendation, low-quality evidence). Remark: this is a conditional recommendation that requires individualization. **See Table 1** for factors that weaken this recommendation. Vote: 15/16 (94%) of committee members voted in favor of less than five days of antibiotics.
2. For adults inpatients with non-severe CAP who reach clinical stability, we suggest less than five days of antibiotics (minimum of 3 days duration), rather than five or more days of

antibiotics (conditional recommendation, low-quality evidence). Remark: this is a conditional recommendation that requires individualization. See **Table 1** for factors that weaken this recommendation. Vote: 11/16 (69%) of committee members voted in favor of less than five days of antibiotics.

3. For adult inpatients with severe CAP who reach clinical stability, we suggest five or more days of antibiotics, rather than less than five of antibiotics (strong recommendation, low-quality evidence). Remark: This recommendation is strong despite the low quality of evidence because robust evidence indicates that insufficient antibiotic therapy can result in serious adverse outcomes or death in patients with severe CAP. Note: 15/16 (94%) of committee members voted for five days or greater of antibiotics.

What others are saying:

British Thoracic Society Guidelines (2009) and NICE guidelines (2015) for the management of CAP recommended 5-day course of a single antibiotic for patients with low severity CAP, and 7-10 days duration for patients with moderate or severe CAP.[100] [101] However, it should be noted that these society guidelines do not endorse the same empiric strategy of antibiotics recommended by IDSA/ATS. European Respiratory Society (ERS) and European Society for Clinical Microbiology and Infectious Diseases guidelines for the management of lower respiratory tract infections (2011) recommended antibiotics for 7 days among inpatients with non-severe CAP.[102] Consensus guidelines for the management of severe CAP by ERS/ESICM/ESCMID/ALAT [103] (2023) conditionally recommend that procalcitonin may be used to reduce the duration of antibiotic treatment in patients with severe CAP when duration of

antibiotic therapy was over 7 days. In the case of durations less than 5 days, the utility of inflammatory markers has not been addressed.

Research needs:

Our recommendations are conditional based upon low quality of evidence, and the optimal duration of therapy for patients with CAP once they reach clinical stability is still unknown. Research needed to better inform this recommendation includes clinical trials that evaluate 1) first-line therapies; 2) outcomes that are important to patients, such as development of complications (whether from the infection or the antibiotic treatment), long-term outcomes, antibiotic effects, length of hospitalizations, and return to function; 3) tailored strategies based upon pathogen identification, illness severity (non-severe versus severe CAP), clinical response, and serial inflammatory markers.

QUESTION 4: Should adults who are hospitalized with community-acquired pneumonia be treated with corticosteroids?

Rationale:

The host immune response to infection is an increasingly recognized factor influencing mortality and morbidity in patients with CAP. Treatments that target immunomodulation such as corticosteroids have historically had mixed results. The 2019 ATS-IDSA guideline for the management of adults with CAP previously reviewed the question of whether corticosteroids should be included as part of the treatment regimen for adults with CAP. The guideline committee recommended against routine use of corticosteroids in adults with non-severe CAP (strong recommendation, high quality of evidence) and suggested against their routine use in adults with severe CAP (conditional recommendation, moderate quality of evidence). These recommendations were based on the review of four meta-analyses of published trials, two of which reported a mortality benefit in patients with severe CAP [104, 105], and two of which did not find a benefit [106, 107]. Since the publication of those guidelines, several additional trials have been published evaluating the effect of corticosteroids on mortality and other CAP outcomes, including one trial that demonstrated a significant mortality benefit when steroids were prescribed in severe CAP [108]. In addition, the 2021 publication of the RECOVERY trial demonstrated a strong benefit of corticosteroids in patients with moderate to severe COVID-19 during the pandemic, particularly in patients who required oxygen by high flow nasal cannula or invasive mechanical ventilation [109]. These new studies and experience add weight to a pathophysiologic mechanism of benefit of immunomodulation for select patients with

pneumonia, led others to update their recommendations[103] [110], and support the need to reassess the evidence around use of corticosteroids in adults with CAP.

Evidence synthesis:

Our literature search identified 16 relevant randomized controlled trials [111-126]. One relevant trial was excluded because full text was not available [112], leaving 15 randomized controlled trials for analysis [111, 113-126]. All trials enrolled inpatients but used varying definitions of CAP. Six trials evaluated hydrocortisone therapy [113, 114, 117, 121, 122, 125] while the remaining trials examined methylprednisolone (3 trials) [115, 118, 124], dexamethasone (3 trials) [116, 119, 126], and prednisone/prednisolone (3 trials) [111, 120, 123]. The duration of corticosteroids varied among trials but included seven days (five trials) [111, 113, 121-123], five days or fewer (seven trials) [116, 117, 119, 120, 124-126], and longer durations (three trials) [114, 115, 118] (Table S7).

The guideline committee *a priori* defined four outcomes as “critical”: mortality, treatment/clinical failure, clinical stability, and adverse drug events. The committee also *a priori* defined four outcomes as “important”: symptoms, disability or return to independence/function, length of stay, and antibiotic days. Given a lack of consistent measurement of symptomatic improvement, return to function/independence, or disability across the selected trials, these outcomes were not evaluated.

When the data were aggregated by meta-analysis, corticosteroids decreased mortality (6.1% versus 9.1%; risk ratio 0.68, 95% CI 0.53 to 0.86), which means that if applied to a similar population to that enrolled in the trials, it is estimated that one death is prevented for every 34

(range 23-78) patients who receive corticosteroids (Figure S8 and Table S8.1). In patients with non-severe CAP,[119, 126] the decrease in mortality was not statistically significant (4.4% versus 6.7%; risk ratio 0.88, 96% CI 0.55 to 1.41) (Figure S8 and Table S8.3). When the meta-analysis was restricted to patients with severe CAP ,[113, 114, 117, 118, 122, 124] the decrease in mortality was significant (9.8% versus 15.1%; risk ratio 0.62, 95% CI 0.41 to 0.94), meaning that one death could be prevented for every 17 (CI 11-110) patients with severe CAP who receive corticosteroids (Figure S8 and Table S8.2).

Corticosteroids also decreased the length of stay (mean difference -1.53 days, 95% CI -2.14 to -0.91 days) (Figure S8 and Table S8.1).[111, 113, 115-121, 123, 124, 126] The decrease in the length was not statistically significant in patients with non-severe CAP (mean difference -0.52 days, 95% CI -1.33 to 0.28) (Figure S8 and Table S8.3) but was for patients with severe CAP (mean difference -1.06 days, 95% CI -2.01 to -0.12) (Figure S8 and Table S8.2).

There was no significant effect on adverse events (risk ratio 1.2, 95% CI 0.89-1.63) (Figure S8 and Table S8.1), including the subgroups of patients with non-severe CAP (risk ratio 1.37, 95% CI 0.73 to 2.43) and severe CAP (risk ratio 1.12, 95% CI 0.69 to 1.82) (Figure S8 and Table S8.2). Corticosteroid therapy did not demonstrate an effect on treatment failure (risk ratio 0.83, 95% CI 0.25 to 2.80) or time to clinical stability (mean difference -0.45 days, 95% CI -1.77 to 0.86 days). There was no effect on antibiotic duration (mean difference -2.01 days, 95% CI -4.46 to 0.45 days), including the subgroup of patients with non-severe CAP (mean difference -0.99, 95% CI -3.93 to 1.96) (Table S8.1).

Overall, the committee's certainty in the accuracy of the estimated effects (the quality of evidence) was low for both severe and non-severe CAP due to inconsistency of results (Table S8).

Committee's discussion:

The committee evaluated the evidence for corticosteroids in inpatient adults with non-severe CAP and severe CAP (as defined by ATS criteria) separately. For adult inpatients with non-severe CAP, the committee judged that since no significant difference was observed in mortality or other critical outcomes in pooled analyses, the undesirable effects of corticosteroids outweighed desirable effects. However, this recommendation does not obviate the need to give corticosteroids for other indications in this group, such as chronic obstructive pulmonary disease or asthma exacerbations or suspicion for pneumocystis pneumonia.

In severe CAP, the committee judged that the desirable effects of steroids on critical outcomes, particularly mortality, outweighed the undesirable effects, predominantly hyperglycemia, and the intervention is feasible and likely to be acceptable to most patients when considering patient preferences and values. The recommendation in favor of corticosteroids is conditional because our confidence in the quality of the evidence was low, in large part due to inconsistency of results across studies. Notably, the study by Dequin et al.[114] found a significant reduction in mortality whereas the study by Meduri et al.[118] did not. Important differences in the Dequin study that may have contributed to the positive findings include: 1) earlier exposure to corticosteroids from the diagnosis of severe CAP; 2) criteria for severe CAP that focused on respiratory failure (and did not include patients with septic shock); 3) exclusion of patients with influenza, and 4) inclusion of more women. While the committee endorses the ATS/IDSA definition of severe CAP as including either need for mechanical ventilation or vasopressor support (major criteria) or 3 or more minor criteria, [1] we recognize heterogeneity within this group, and note that the aggregate meta-analysis approach is limited in its ability to

identify specific subgroups of patients that benefit most from corticosteroids. For example, an individual patient data meta-analysis of 8 clinical trials identified elevated C-reactive protein as a predictor of corticosteroid benefit.[127] Since the completion of our evidence review, the REMAP-CAP platform trial reported results for fixed-dose hydrocortisone, which demonstrated no benefit on short-term mortality, although the shock-dependent arm and both dexamethasone arms are still ongoing.[128] Additionally, a pre-planned subgroup analysis of the APROCCHSS trial evaluating corticosteroids in septic shock was also published after our evidence review, finding a significant benefit of hydrocortisone with fludrocortisone in those with septic shock due to CAP but not due to non-CAP causes[129] in contrast to the earlier ADRENAL study published in 2018.[130] A subsequent meta-analysis that included these trials reported a continued overall favorable effect of corticosteroids.[131] The inconsistency of results further highlights the uncertainty of benefit for many patients and the need to individualize the decision to treat with corticosteroids. We eagerly await additional evidence surrounding different patient phenotypes to improve precision with CAP treatment and anticipate that this recommendation will be further refined based upon new evidence in the future. See Table 1 for additional patient characteristics that would strengthen or weaken this recommendation, including clinically available markers of inflammation that may be useful to predict benefit versus harm.

While the exact mechanism of the benefit of corticosteroids in these patients is unclear, the timing (early administration) and pattern of inflammatory response (elevated inflammatory markers, particularly C-reactive protein) may be important factors to consider when deciding which patients are most likely to benefit.[127] This suggestion should not be applied to patients with CAP and influenza because observational data suggests potential harm,[132] and there is a lack of prospective, randomized data in this population because they were excluded from most of

the trials. Currently available evidence precludes a recommendation on the type of corticosteroid and duration of exposure, although the trial with most compelling results assigned patients to hydrocortisone 200 mg continuous IV infusion daily for either 4 or 7 days as determined by clinical improvement followed by tapering for a total of 8 or 14 days, or discontinuation of corticosteroids at ICU discharge among those patients with rapid clinical improvement.[114]

Recommendations:

1. For adult inpatients with non-severe CAP, we recommend not administering systemic corticosteroids (strong recommendation, low quality of evidence). Remark: This recommendation is strong because, while the overall quality of evidence is low, the intent is to avoid harmful side effects like hyperglycemia for which there is robust evidence. Vote: 16/16 (100%) of committee members voted in favor of not administering systemic corticosteroids.
2. For adult inpatients with severe CAP, we suggest administering systemic corticosteroids (conditional recommendation, low quality of evidence). Remark: This recommendation excludes patients with severe CAP due to influenza pneumonia. Vote: 15/16 (94%) of committee members voted for administering systemic corticosteroids.

What others are saying:

The ERS/ESICM/ESCMID/ALAT guidelines published in 2023 suggest using systemic corticosteroids in severe CAP only if shock is present (conditional recommendation, very low quality of evidence).[103] This guideline did not include the study by Dequin et al.[108] The SCCM focused guideline update on corticosteroids recommends administering corticosteroids to

adult patients hospitalized with severe bacterial CAP (strong recommendation, moderate certainty; “bacterial CAP” defined as probable or suspected bacteria) and make no recommendation for administering corticosteroids for adult patients hospitalized with non-severe CAP.[110] The Surviving Sepsis Campaign recommends use of corticosteroids in patients with septic shock refractory to adequate fluid resuscitation and vasopressor support [133], as well as the recent update on management of adult patients with acute respiratory distress syndrome suggesting using corticosteroids in these patients.[134] The NIH COVID-19 Treatment Guidelines[5], also recommended corticosteroids (specifically, dexamethasone) for the treatment of COVID-19 pneumonia in hospitalized patients who required supplemental oxygen, particularly high-flow nasal cannula, non-invasive ventilation, or invasive mechanical ventilation, although the certainty of benefit in patients with CAP due to SARS-CoV-2 outside of the pandemic may be lower. In addition, clinicians should use corticosteroids when deemed clinically appropriate for comorbid conditions, such as chronic obstructive pulmonary disease, asthma, and autoimmune diseases, where corticosteroids are supported as a component of treatment. Multiple systematic reviews have also been published which, like the systematic review that informed our recommendations, reported benefits from systemic corticosteroids in patients with severe CAP [135-137] .

Research needs:

Three types of research are needed to help strengthen the evidence base informing the use of corticosteroids in CAP: trials that evaluate 1) which patient features are associated with benefit, including those adequately designed to evaluate patient subgroups or tailored strategies based upon sex, severity of respiratory failure/ARDS, inflammatory biomarkers, pathogen

identification, or other key features subgroups yet to be identified; 2) optimal dose, duration, type and timing of corticosteroid treatment relative to onset of CAP; and 3) outcomes in addition to mortality, such as time to clinical stability, treatment failure, impact on non-pulmonary complications of CAP (e.g., cardiovascular events), and long-term outcomes (e.g. symptom burden, functional status, and health-related quality of life). Patients with influenza should be included in this research, as data supporting their exclusion are limited to very low-quality observational studies in this population.

PATIENT INPUT

For all CAP recommendations, high-quality communication with patients should cover: (1) the rationale for the clinical recommendation; (2) the degree of certainty for the recommendation; (3) the advantages and disadvantages of treatment options including side effects, cost, and convenience, (4) what to expect over the course of treatment, including clear access to follow-up and contingency plans, and 5) a pathway for communication and follow-up. Recommendations with less certainty should be accompanied by greater engagement with patients about their preferences and values.

When deciding whether to pursue LUS or chest x-ray for diagnosis, discussions with patients should include convenience, accuracy, cost, and radiation exposure, as well as clinician expertise and facility ability to conduct, interpret, and document ultrasound results. The potential for each test to identify incidental findings should be considered. When weighing the decision regarding antibiotic use when a viral test is positive, patients should be informed that antibiotics do not treat viruses and may have side effects, but bacteria and viruses can co-exist. Less

aggressive antibiotic therapy (no treatment or short courses) should be coupled with more aggressive monitoring and follow-up, including a clear and feasible contingency plan if a patient does not get better or experiences side effects. Clear definitions of clinical stability and antibiotic side effects should be communicated to patients. When considering corticosteroids, clinicians should provide realistic expectations including uncertainty about treatment effects for any individual patient and risks of short-term versus chronic use.

Clinicians should use common language and patient information documents to explain medical concepts and adopt a tailored approach to communication based upon the patient's severity of illness, ability or preference to engage in communication or shared decision-making, and level of certainty of the benefit of recommendations. Documents that provide patient-friendly explanations of pneumonia should be used to support communication and are available through the ATS.[138, 139]

CONCLUSIONS

This document addresses four practice areas pertaining to the management of patients with CAP. These areas were selected by the committee due to their clinical relevance and the potential influence of recent literature on the existing standard of care.

For the purpose of diagnosing pneumonia, the use of lung ultrasound is regarded as equivalent to chest x-ray, provided there is sufficient clinical expertise and infrastructure available. Concerning the usage of antibacterial therapy for patients diagnosed with a respiratory virus, the suggestion is to withhold antibacterial therapy only in outpatients who do not have co-existing medical conditions that put them in risk of severe outcomes. Addressing the optimal

duration of antibiotic therapy, <5 days of treatment is regarded as acceptable (minimum of 3 days duration) except in case of severe CAP or pneumonia caused by necrotizing or resistant organisms, such as *S. aureus* or *P. aeruginosa*. Lastly, the use of systemic corticosteroids is endorsed solely for a subgroup of patients experiencing severe CAP without influenza virus infection.

However, practitioners must acknowledge that most recommendations presented in this document are based on low-quality evidence or have low or very low certainty of effects. This implies that new studies are likely to have an important influence on the estimate of the effect and the true effect might be substantially different from the estimated effect. We encourage research efforts to improve the evidence surrounding pneumonia care, particularly by conducting studies that: evaluate patient-oriented outcomes in the areas of diagnosis, individualizing antimicrobial treatments, and host-directed therapies, and also evaluate the relationships between CAP management of individual patients and public health outcomes such as antimicrobial resistance and infection transmission.

Given the potential impact of future research on our current recommendations, it is crucial for physicians to thoroughly assess patients when implementing a clinical approach based on these recommendations and to individualize their management according to patients' risks and clinical response. We encourage a nuanced clinical approach to pneumonia care that acknowledges the complexity of lung disease and uncertainty in the evidence base.

Acknowledgment: The authors thank Judy Corn, ATS Senior Director of Documents and Patient Education, for guidance and facilitation of patient input, and Rachel Kaye, Senior Coordinator of the ATS Documents Development and Implementation Committee, for administrative support.

This official clinical practice guideline was prepared by an *ad hoc* subcommittee of content experts who were appointed by the American Thoracic Society (ATS) and the Infectious Diseases Society of America (IDSA).

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Subcommittee Disclosures: B.E.J. received research support from the CDC, the Gordon and Betty Moore Foundation, and the Veterans Health Administration. J.A.R. served as a consultant for Dompe; and served on a data and safety monitoring board for Paratek. M.I.R. is an employee of the U.S. Department of Veterans Affairs at the South Texas Veterans Health Care System. C.P. received research support from Diasorin. V.M.V. received research support from the Agency for Healthcare Research and Quality, the CDC, the Patient-Centered Outcomes Research Institute, and the U.S. Department of Veterans Affairs. B.B. is an employee of Wolters Kluwer Health. J.D.C. served as a consultant for Antabio, AstraZeneca, Boehringer Ingelheim, Chiesi, GlaxoSmithKline, Grifols, Insmed, Janssen, Novartis, Pfizer, and Zambon; and received research support from AstraZeneca, Boehringer Ingelheim, Chiesi, Genentech, Gilead, Grifols, Insmed, Novartis, and Trudell. K.W. is an employee of Boston University; and served on a data and safety monitoring board for the NIH. E.O., N.J.S., L.R.S., D.M.M., B.L.E., S.A.H., K.C., J.P.M., B.C., C.S.D.C., I.G., L.S.H., M.L.V., S.Y.L., G.W.W., M.P., and C.H. reported no commercial or relevant non-commercial interests from ineligible companies.

REFERENCES

1. Metlay, J.P., et al., *Diagnosis and Treatment of Adults with Community-acquired Pneumonia. An Official Clinical Practice Guideline of the American Thoracic Society and Infectious Diseases Society of America*. Am J Respir Crit Care Med, 2019. **200**(7): p. e45-e67.
2. Mandell, L.A., et al., *Infectious Diseases Society of America/American Thoracic Society consensus guidelines on the management of community-acquired pneumonia in adults*. Clin Infect Dis, 2007. **44 Suppl 2**(Suppl 2): p. S27-72.
3. Evans, S.E., et al., *Nucleic Acid-based Testing for Noninfluenza Viral Pathogens in Adults with Suspected Community-acquired Pneumonia. An Official American Thoracic Society Clinical Practice Guideline*. Am J Respir Crit Care Med, 2021. **203**(9): p. 1070-1087.
4. Panel., C.-T.G. COVID-19 Treatment Guidelines Panel. *Coronavirus Disease 2019 (COVID-19) Treatment Guidelines*. National Institutes of Health. [cited 2023 October 23]; Available from: <https://www.covid19treatmentguidelines.nih.gov/>.
5. (NICE), T.N.I.f.H.a.C.E. COVID-19 rapid guideline: Managing COVID-19; Available from: <https://www.nice.org.uk/guidance/ng191>.
6. Cheng, G.-S., et al., *Immunocompromised Host Pneumonia: Definitions and Diagnostic Criteria: An Official American Thoracic Society Workshop Report*. Annals of the American Thoracic Society, 2023. **20**(3): p. 341-353.
7. Ramirez, J.A., et al., *Treatment of Community-Acquired Pneumonia in Immunocompromised Adults: A Consensus Statement Regarding Initial Strategies*. Chest, 2020. **158**(5): p. 1896-1911.
8. Dickson, R.P., J.R. Erb-Downward, and G.B. Huffnagle, *Towards an ecology of the lung: new conceptual models of pulmonary microbiology and pneumonia pathogenesis*. Lancet Respir Med, 2014. **2**(3): p. 238-46.
9. Wu, B.G. and L.N. Segal, *The Lung Microbiome and Its Role in Pneumonia*. Clin Chest Med, 2018. **39**(4): p. 677-689.
10. Institute of Medicine Committee on Standards for Developing Trustworthy Clinical Practice, G., in *Clinical Practice Guidelines We Can Trust*, R. Graham, et al., Editors. 2011, National Academies Press (US)

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11. Institute of Medicine Committee on Standards for Systematic Reviews of Comparative Effectiveness, R., in *Finding What Works in Health Care: Standards for Systematic Reviews*, J. Eden, et al., Editors. 2011, National Academies Press (US)

Copyright 2011 by the National Academy of Sciences. All rights reserved.: Washington (DC).

12. Schünemann, H.J., et al., *An official ATS statement: grading the quality of evidence and strength of recommendations in ATS guidelines and recommendations*. Am J Respir Crit Care Med, 2006. **174**(5): p. 605-14.
13. Schoenberg, N.C., et al., *A Comparative Analysis of Pulmonary and Critical Care Medicine Guideline Development Methodologies*. Am J Respir Crit Care Med, 2017. **196**(5): p. 621-627.
14. *Diagnostic Discordance, Uncertainty, and Treatment Ambiguity in Community-Acquired Pneumonia*. Annals of Internal Medicine. **0**(0): p. null.
15. Organization, P.A.H.O.W.H.; Available from: https://www3.paho.org/hq/index.php?option=com_content&view=article&id=7410:2012-dia-radiografia-dos-tercios-poblacion-mundial-no-tiene-acceso-diagnostico-imagen&Itemid=0&lang=en#gsc.tab=0.

16. Llamas-Alvarez, A.M., E.M. Tenza-Lozano, and J. Latour-Perez, *Accuracy of Lung Ultrasonography in the Diagnosis of Pneumonia in Adults: Systematic Review and Meta-Analysis*. Chest, 2017. **151**(2): p. 374-382.
17. Strøm, J.J., et al., *Accuracy of lung ultrasonography in the hands of non-imaging specialists to diagnose and assess the severity of community-acquired pneumonia in adults: a systematic review*. BMJ Open, 2020. **10**(6): p. e036067.
18. Schott, C.K., et al., *Current Use, Training, and Barriers to Point-of-Care Ultrasound Use in ICUs in the Department of Veterans Affairs*. CHEST Critical Care, 2023. **1**(2): p. 100012.
19. LoPresti, C.M., et al., *Current Point of Care Ultrasound Use and Training Among Internal Medicine Residency Programs from the 2020 APDIM Program Director's Survey*. The American Journal of Medicine, 2022. **135**(3): p. 397-404.
20. Amatya, Y., et al., *Diagnostic use of lung ultrasound compared to chest radiograph for suspected pneumonia in a resource-limited setting*. Int J Emerg Med, 2018. **11**(1): p. 8.
21. Bitar, Z.I., et al., *Diagnostic accuracy of chest ultrasound in patients with pneumonia in the intensive care unit: A single-hospital study*. Health Sci Rep, 2019. **2**(1): p. e102.
22. Bourcier, J.E., et al., *Performance comparison of lung ultrasound and chest x-ray for the diagnosis of pneumonia in the ED*. Am J Emerg Med, 2014. **32**(2): p. 115-8.
23. Corradi, F., et al., *Quantitative analysis of lung ultrasonography for the detection of community-acquired pneumonia: a pilot study*. Biomed Res Int, 2015. **2015**: p. 868707.
24. Cortellaro, F., et al., *Lung ultrasound is an accurate diagnostic tool for the diagnosis of pneumonia in the emergency department*. Emerg Med J, 2012. **29**(1): p. 19-23.
25. Dhawan, J. and G. Singh, *Bedside Lung Ultrasound as an Independent Tool to Diagnose Pneumonia in Comparison to Chest X-ray: An Observational Prospective Study from Intensive Care Units*. Indian J Crit Care Med, 2022. **26**(8): p. 920-929.
26. Gibbons, R.C., et al., *Lung Ultrasound vs. Chest X-Ray Study for the Radiographic Diagnosis of COVID-19 Pneumonia in a High-Prevalence Population*. J Emerg Med, 2021. **60**(5): p. 615-625.
27. Karimi, E., *Comparing Sensitivity of Ultrasonography and Plain Chest Radiography in Detection of Pneumonia; a Diagnostic Value Study*. Arch Acad Emerg Med, 2019. **7**(1): p. e8.
28. Liu, X.L., et al., *Lung ultrasonography: an effective way to diagnose community-acquired pneumonia*. Emerg Med J, 2015. **32**(6): p. 433-8.
29. M-N., F.A., *Role of transthoracic ultrasound in detection of pneumonia in ICU patients*. Med J Cairo Univ, 2015. **83**: p. 307-314.
30. Taghizadieh, A., et al., *Diagnostic Accuracy of Chest x-Ray and Ultrasonography in Detection of Community Acquired Pneumonia; a Brief Report*. Emerg (Tehran), 2015. **3**(3): p. 114-6.
31. Testa, A., et al., *Early recognition of the 2009 pandemic influenza A (H1N1) pneumonia by chest ultrasound*. Crit Care, 2012. **16**(1): p. R30.
32. Volpicelli, G., et al., *International evidence-based recommendations for point-of-care lung ultrasound*. Intensive Care Med, 2012. **38**(4): p. 577-91.
33. Qaseem, A., et al., *Appropriate Use of Point-of-Care Ultrasonography in Patients With Acute Dyspnea in Emergency Department or Inpatient Settings: A Clinical Guideline From the American College of Physicians*. Ann Intern Med, 2021. **174**(7): p. 985-993.
34. American College of Emergency Physicians Policy Statement: Emergency Ultrasound Guidelines. 2016. February 6, 2018]; Available from: <https://www.acep.org/Clinical--Practice-Management/Ultrasound/#sm.0000hik85dq1rfbcvr01redkh6eyd>.
35. Mayo, P.H., et al., *American College of Chest Physicians/La Societe de Reanimation de Langue Francaise statement on competence in critical care ultrasonography*. Chest, 2009. **135**(4): p. 1050-60.

36. Frankel, H.L., et al., *Guidelines for the Appropriate Use of Bedside General and Cardiac Ultrasonography in the Evaluation of Critically Ill Patients-Part I: General Ultrasonography*. Crit Care Med, 2015. **43**(11): p. 2479-502.
37. Demi, L., et al., *New International Guidelines and Consensus on the Use of Lung Ultrasound*. J Ultrasound Med, 2022.
38. Soni, N.J., et al., *Point-of-Care Ultrasound for Hospitalists: A Position Statement of the Society of Hospital Medicine*. J Hosp Med, 2019. **14**: p. E1-E6.
39. Laursen, C.B., et al., *European Respiratory Society statement on thoracic ultrasound*. European Respiratory Journal, 2021. **57**(3): p. 2001519.
40. Bronshteyn, Y.S., et al., *Diagnostic Point-of-Care Ultrasound: Recommendations From an Expert Panel*. J Cardiothorac Vasc Anesth, 2022. **36**(1): p. 22-29.
41. Morens, D.M., J.K. Taubenberger, and A.S. Fauci, *Predominant role of bacterial pneumonia as a cause of death in pandemic influenza: implications for pandemic influenza preparedness*. J Infect Dis, 2008. **198**(7): p. 962-70.
42. Arranz-Herrero, J., et al., *Determinants of poor clinical outcome in patients with influenza pneumonia: A systematic review and meta-analysis*. Int J Infect Dis, 2023. **131**: p. 173-179.
43. Martin, C.M., et al., *Asian influenza A in Boston, 1957-1958. II. Severe staphylococcal pneumonia complicating influenza*. AMA Arch Intern Med, 1959. **103**(4): p. 532-42.
44. Metzger, D.W. and K. Sun, *Immune dysfunction and bacterial coinfections following influenza*. J Immunol, 2013. **191**(5): p. 2047-52.
45. Lane, S., Y. Hilliam, and M. Bomberger Jennifer, *Microbial and Immune Regulation of the Gut-Lung Axis during Viral-Bacterial Coinfection*. Journal of Bacteriology, 2022. **205**(1): p. e00295-22.
46. Jain, S., et al., *Community-Acquired Pneumonia Requiring Hospitalization among U.S. Adults*. N Engl J Med, 2015. **373**(5): p. 415-27.
47. Musher, D.M., et al., *Can an etiologic agent be identified in adults who are hospitalized for community-acquired pneumonia: results of a one-year study*. J Infect, 2013. **67**(1): p. 11-8.
48. Bogdan, I., et al., *The Assessment of Multiplex PCR in Identifying Bacterial Infections in Patients Hospitalized with SARS-CoV-2 Infection: A Systematic Review*. Antibiotics (Basel), 2023. **12**(3).
49. Qiao, M., et al., *The prevalence of influenza bacterial co-infection and its role in disease severity: A systematic review and meta-analysis*. J Glob Health, 2023. **13**: p. 04063.
50. Beumer, M.C., et al., *Influenza virus and factors that are associated with ICU admission, pulmonary co-infections and ICU mortality*. J Crit Care, 2019. **50**: p. 59-65.
51. Abelenda-Alonso, G., et al., *Influenza and Bacterial Coinfection in Adults With Community-Acquired Pneumonia Admitted to Conventional Wards: Risk Factors, Clinical Features, and Outcomes*. Open Forum Infect Dis, 2020. **7**(3): p. ofaa066.
52. Shah, M.M., et al., *Bacterial and viral infections among adults hospitalized with COVID-19, COVID-NET, 14 states, March 2020-April 2022*. Influenza Other Respir Viruses, 2023. **17**(3): p. e13107.
53. Pickens, C.I. and R.G. Wunderink, *Principles and Practice of Antibiotic Stewardship in the ICU*. Chest, 2019. **156**(1): p. 163-171.
54. Hedberg, P., et al., *Bacterial co-infections in community-acquired pneumonia caused by SARS-CoV-2, influenza virus and respiratory syncytial virus*. BMC Infect Dis, 2022. **22**(1): p. 108.
55. Smith, C.M., et al., *Respiratory syncytial virus increases the virulence of Streptococcus pneumoniae by binding to penicillin binding protein 1a. A new paradigm in respiratory infection*. Am J Respir Crit Care Med, 2014. **190**(2): p. 196-207.
56. Houck, P.M., et al., *Timing of antibiotic administration and outcomes for Medicare patients hospitalized with community-acquired pneumonia*. Arch Intern Med, 2004. **164**(6): p. 637-44.

57. Austrian, R. and J. Gold, *PNEUMOCOCCAL BACTEREMIA WITH ESPECIAL REFERENCE TO BACTEREMIC PNEUMOCOCCAL PNEUMONIA*. Ann Intern Med, 1964. **60**: p. 759-76.

58. Shoar, S. and D.M. Musher, *Etiology of community-acquired pneumonia in adults: a systematic review*. Pneumonia (Nathan), 2020. **12**: p. 11.

59. Huijskens, E.G.W., et al., *The value of signs and symptoms in differentiating between bacterial, viral and mixed aetiology in patients with community-acquired pneumonia*. J Med Microbiol, 2014. **63**(Pt 3): p. 441-452.

60. Falsey, A.R., et al., *Bacterial complications of respiratory tract viral illness: a comprehensive evaluation*. J Infect Dis, 2013. **208**(3): p. 432-41.

61. Holter, J.C., et al., *Etiology of community-acquired pneumonia and diagnostic yields of microbiological methods: a 3-year prospective study in Norway*. BMC Infect Dis, 2015. **15**: p. 64.

62. Godefroy, R., et al., *Respiratory Syncytial Virus Infection: Its Propensity for Bacterial Coinfection and Related Mortality in Elderly Adults*. Open Forum Infect Dis, 2020. **7**(12): p. ofaa546.

63. Langford, B.J., et al., *Bacterial co-infection and secondary infection in patients with COVID-19: a living rapid review and meta-analysis*. Clin Microbiol Infect, 2020. **26**(12): p. 1622-1629.

64. Musher, D.M., *Bacterial Coinfection in COVID-19 and Influenza Pneumonia*. Am J Respir Crit Care Med, 2021. **204**(5): p. 498-500.

65. Rouzé, A., et al., *Early Bacterial Identification among Intubated Patients with COVID-19 or Influenza Pneumonia: A European Multicenter Comparative Clinical Trial*. American Journal of Respiratory and Critical Care Medicine, 2021. **204**(5): p. 546-556.

66. Self, W.H., et al., *Procalcitonin as a Marker of Etiology in Adults Hospitalized With Community-Acquired Pneumonia*. Clin Infect Dis, 2017. **65**(2): p. 183-190.

67. Kamat, I.S., et al., *Procalcitonin to Distinguish Viral From Bacterial Pneumonia: A Systematic Review and Meta-analysis*. Clin Infect Dis, 2020. **70**(3): p. 538-542.

68. Cohen, A.J., et al. *Nonutility of procalcitonin for diagnosing bacterial pneumonia in patients with severe COVID-19*. European clinical respiratory journal, 2023. **10**, 2174640 DOI: 10.1080/20018525.2023.2174640.

69. Wiersinga, W.J., et al., *Management of community-acquired pneumonia in adults: 2016 guideline update from the Dutch Working Party on Antibiotic Policy (SWAB) and Dutch Association of Chest Physicians (NVALT)*. Neth J Med, 2018. **76**(1): p. 4-13.

70. Athlin, S., et al., *Management of community-acquired pneumonia in immunocompetent adults: updated Swedish guidelines 2017*. Infect Dis (Lond), 2018. **50**(4): p. 247-272.

71. Woodhead, M., et al., *Guidelines for the management of adult lower respiratory tract infections -full version*. Clin Microbiol Infect, 2011. **17 Suppl 6**(Suppl 6): p. E1-59.

72. Martin-Loeches, I., et al., *ERS/ESICM/ESCMID/ALAT guidelines for the management of severe community-acquired pneumonia*. European Respiratory Journal, 2023. **61**(4): p. 2200735.

73. Timbrook, T.T., K.D. Hueth, and C.C. Ginocchio, *Identification of bacterial co-detections in COVID-19 critically ill patients by BioFire(R) FilmArray(R) pneumonia panel: a systematic review and meta-analysis*. Diagn Microbiol Infect Dis, 2021. **101**(3): p. 115476.

74. Siljan, W.W., et al., *Host Transcriptional Signatures Predict Etiology in Community-Acquired Pneumonia: Potential Antibiotic Stewardship Tools*. Biomark Insights, 2022. **17**: p. 11772719221099130.

75. Fleming, A. *Nobel Lecture*. Nobel Prize Outreach AB 2023 1945 [cited 2023 Dec 1]; Available from: <https://www.nobelprize.org/prizes/medicine/1945/fleming/lecture/>.

76. Bartlett, J.G., et al., *Practice guidelines for the management of community-acquired pneumonia in adults*. Infectious Diseases Society of America. Clin Infect Dis, 2000. **31**(2): p. 347-82.

77. Niederman, M.S., et al., *Guidelines for the management of adults with community-acquired pneumonia. Diagnosis, assessment of severity, antimicrobial therapy, and prevention*. Am J Respir Crit Care Med, 2001. **163**(7): p. 1730-54.

78. File, T.M., Jr. and M.S. Niederman, *Antimicrobial therapy of community-acquired pneumonia*. Infect Dis Clin North Am, 2004. **18**(4): p. 993-1016, xi.

79. Ramirez, J., et al., *Antibiotics as Major Disruptors of Gut Microbiota*. Frontiers in Cellular and Infection Microbiology, 2020. **10**.

80. Vaughn, V.M., et al., *Excess Antibiotic Treatment Duration and Adverse Events in Patients Hospitalized with Pneumonia: A Multihospital Cohort Study*. Ann Intern Med, 2019. **171**(3): p. 153-163.

81. Tammaro, P.D., et al., *Association of Adverse Events With Antibiotic Use in Hospitalized Patients*. JAMA Internal Medicine, 2017.

82. Kazakova, S.V., et al., *Association Between Antibiotic Use and Hospital-onset Clostridioides difficile Infection in US Acute Care Hospitals, 2006-2012: An Ecologic Analysis*. Clin Infect Dis, 2020. **70**(1): p. 11-18.

83. Branch-Elliman, W., et al., *Association of Duration and Type of Surgical Prophylaxis With Antimicrobial-Associated Adverse Events*. JAMA Surg, 2019. **154**(7): p. 590-598.

84. Russo, T.A., B. Spellberg, and J.R. Johnson, *Important Complexities of the Antivirulence Target Paradigm: A Novel Ostensibly Resistance-Avoiding Approach for Treating Infections*. J Infect Dis, 2016. **213**(6): p. 901-3.

85. Curran, J., et al., *Estimating daily antibiotic harms: an umbrella review with individual study meta-analysis*. Clin Microbiol Infect, 2022. **28**(4): p. 479-490.

86. Poku, E., et al., *Systematic review of time lag between antibiotic use and rise of resistant pathogens among hospitalized adults in Europe*. JAC Antimicrob Resist, 2023. **5**(1): p. dlad001.

87. el Moussaoui, R., et al., *Effectiveness of discontinuing antibiotic treatment after three days versus eight days in mild to moderate-severe community acquired pneumonia: randomised, double blind study*. BMJ, 2006. **332**(7554): p. 1355.

88. Uranga, A., et al., *Duration of Antibiotic Treatment in Community-Acquired Pneumonia: A Multicenter Randomized Clinical Trial*. JAMA Intern Med, 2016. **176**(9): p. 1257-65.

89. Dinh, A., et al., *Discontinuing β -lactam treatment after 3 days for patients with community-acquired pneumonia in non-critical care wards (PTC): a double-blind, randomised, placebo-controlled, non-inferiority trial*. Lancet, 2021. **397**(10280): p. 1195-1203.

90. Spellberg, B., *The new antibiotic mantra—"shorter is better"*. JAMA internal medicine, 2016. **176**(9): p. 1254-1255.

91. Madaras-Kelly, K.J., et al., *Total duration of antimicrobial therapy in veterans hospitalized with uncomplicated pneumonia: Results of a national medication utilization evaluation*. J Hosp Med, 2016. **11**(12): p. 832-839.

92. Di Paolo, A., et al., *PHARMACOKINETICS OF AZITHROMYCIN IN LUNG TISSUE, BRONCHIAL WASHING, AND PLASMA IN PATIENTS GIVEN MULTIPLE ORAL DOSES OF 500 AND 1000 MG DAILY*. Pharmacological Research, 2002. **46**(6): p. 545-550.

93. administration, F.D., *ZMAX (AZITHROMYCIN) | NDA #050797 | FOR SUSPENSION, EXTENDED RELEASE;ORAL*. 2021.

94. D'Ignazio, J., et al., *Novel, single-dose microsphere formulation of azithromycin versus 7-day levofloxacin therapy for treatment of mild to moderate community-acquired Pneumonia in adults*. Antimicrob Agents Chemother, 2005. **49**(10): p. 4035-41.

95. Drehobl, M.A., et al., *Single-dose azithromycin microspheres vs clarithromycin extended release for the treatment of mild-to-moderate community-acquired pneumonia in adults*. Chest, 2005. **128**(4): p. 2230-7.

96. Halm, E.A., et al., *Time to clinical stability in patients hospitalized with community-acquired pneumonia: implications for practice guidelines*. Jama, 1998. **279**(18): p. 1452-7.

97. Garin, N., et al., *Predictors and Implications of Early Clinical Stability in Patients Hospitalized for Moderately Severe Community-Acquired Pneumonia*. PLoS One, 2016. **11**(6): p. e0157350.

98. Menéndez, R., et al., *Risk factors of treatment failure in community acquired pneumonia: implications for disease outcome*. Thorax, 2004. **59**(11): p. 960-5.

99. Vaughn, V., et al., *Three-day antibiotic duration in patients with pneumonia: A sixty-eight-hospital cohort*. Antimicrobial Stewardship & Healthcare Epidemiology, 2023. **3**(S2): p. s22-s22.

100. Lim, W.S., et al., *BTS guidelines for the management of community acquired pneumonia in adults: update 2009*. Thorax, 2009. **64 Suppl 3**: p. iii1-55.

101. Excellence., N.N.I.f.H.a.C. *Pneumonia (including community acquired pneumonia)*. 2014. 2014; Available from: <http://www.nice.org.uk/guidance/cg191>.

102. Woodhead, M., et al., *Guidelines for the management of adult lower respiratory tract infections - full version*. Clin Microbiol Infect, 2011. **17 Suppl 6**(Suppl 6): p. E1-59.

103. Martin-Loeches, I., et al., *ERS/ESICM/ESCMID/ALAT guidelines for the management of severe community-acquired pneumonia*. Intensive Care Med, 2023. **49**(6): p. 615-632.

104. Horita, N., et al., *Adjunctive Systemic Corticosteroids for Hospitalized Community-Acquired Pneumonia: Systematic Review and Meta-Analysis 2015 Update*. Sci Rep, 2015. **5**: p. 14061.

105. Siemieniuk, R.A., et al., *Corticosteroid Therapy for Patients Hospitalized With Community-Acquired Pneumonia: A Systematic Review and Meta-analysis*. Ann Intern Med, 2015. **163**(7): p. 519-28.

106. Briel, M., et al., *Corticosteroids in Patients Hospitalized With Community-Acquired Pneumonia: Systematic Review and Individual Patient Data Metaanalysis*. Clin Infect Dis, 2018. **66**(3): p. 346-354.

107. Chen, L.P., et al., *Efficacy and safety of glucocorticoids in the treatment of community-acquired pneumonia: A meta-analysis of randomized controlled trials*. World J Emerg Med, 2015. **6**(3): p. 172-8.

108. Dequin, P.-F., et al., *Hydroxortisone in Severe Community-Acquired Pneumonia*. N Engl J Med, 2023.

109. Group, R.C., et al., *Dexamethasone in Hospitalized Patients with Covid-19*. N Engl J Med, 2021. **384**(8): p. 693-704.

110. Chaudhuri, D., et al., *2024 Focused Update: Guidelines on Use of Corticosteroids in Sepsis, Acute Respiratory Distress Syndrome, and Community-Acquired Pneumonia*. Critical Care Medicine, 2024. **52**(5).

111. Blum, C.A., et al., *Adjunct prednisone therapy for patients with community-acquired pneumonia: a multicentre, double-blind, randomised, placebo-controlled trial*. Lancet, 2015. **385**(9977): p. 1511-8.

112. Cangemi, R., et al., *Corticosteroid Use and Incident Myocardial Infarction in Adults Hospitalized for Community-acquired Pneumonia*. Ann Am Thorac Soc, 2019. **16**(1): p. 91-98.

113. Confalonieri, M., et al., *Hydrocortisone infusion for severe community-acquired pneumonia: a preliminary randomized study*. Am J Respir Crit Care Med, 2005. **171**(3): p. 242-8.

114. Dequin, P.F., et al., *Hydrocortisone in Severe Community-Acquired Pneumonia*. N Engl J Med, 2023. **388**(21): p. 1931-1941.

115. Fernández-Serrano, S., et al., *Effect of corticosteroids on the clinical course of community-acquired pneumonia: a randomized controlled trial*. Crit Care, 2011. **15**(2): p. R96.

116. Fitzgerald, D.B., et al., *Steroid Therapy and Outcome of Parapneumonic Pleural Effusions (STOPPE): A Pilot Randomized Clinical Trial*. Am J Respir Crit Care Med, 2022. **205**(9): p. 1093-1101.

117. Marik, P., et al., *Hydrocortisone and tumor necrosis factor in severe community-acquired pneumonia. A randomized controlled study*. Chest, 1993. **104**(2): p. 389-92.
118. Meduri, G.U., et al., *Low-dose methylprednisolone treatment in critically ill patients with severe community-acquired pneumonia*. Intensive Care Med, 2022. **48**(8): p. 1009-1023.
119. Meijvis, S.C., et al., *Dexamethasone and length of hospital stay in patients with community-acquired pneumonia: a randomised, double-blind, placebo-controlled trial*. Lancet, 2011. **377**(9782): p. 2023-30.
120. Mikami, K., et al., *Efficacy of corticosteroids in the treatment of community-acquired pneumonia requiring hospitalization*. Lung, 2007. **185**(5): p. 249-255.
121. Nafae RM, R.M., Amany FM, Rashed SB., *Adjuvant role of corticosteroids in the treatment of community-acquired pneumonia*. Egyptian Journal of Chest Diseases and Tuberculosis., 2013. **62**(3): p. 439-445.
122. Sabry N, O.E., *Corticosteroids and ICU Course of Community Acquired Pneumonia in Egyptian Settings*. . Pharmacology & Pharmacy., 2011. **2**(2): p. 73-81.
123. Snijders, D., et al., *Efficacy of corticosteroids in community-acquired pneumonia: a randomized double-blinded clinical trial*. Am J Respir Crit Care Med, 2010. **181**(9): p. 975-82.
124. Torres, A., et al., *Effect of corticosteroids on treatment failure among hospitalized patients with severe community-acquired pneumonia and high inflammatory response: a randomized clinical trial*. Jama, 2015. **313**(7): p. 677-86.
125. Wagner, H.N., Jr., et al., *The effect of hydrocortisone upon the course of pneumococcal pneumonia treated with penicillin*. Bull Johns Hopkins Hosp, 1956. **98**(3): p. 197-215.
126. Wittermans, E., et al., *Adjunctive treatment with oral dexamethasone in non-ICU patients hospitalised with community-acquired pneumonia: a randomised clinical trial*. Eur Respir J, 2021. **58**(2).
127. Smit, J.M., et al., *Predicting benefit from adjuvant therapy with corticosteroids in community-acquired pneumonia: a data-driven analysis of randomised trials*. The Lancet Respiratory Medicine.
128. Angus, D.C., *Effect of hydrocortisone on mortality in patients with severe community-acquired pneumonia : The REMAP-CAP Corticosteroid Domain Randomized Clinical Trial*. Intensive Care Med, 2025. **51**(4): p. 665-680.
129. Heming, N., et al., *Hydrocortisone plus fludrocortisone for community acquired pneumonia-related septic shock: a subgroup analysis of the APROCCHSS phase 3 randomised trial*. Lancet Respir Med, 2024. **12**(5): p. 366-374.
130. Venkatesh, B., et al., *Adjunctive Glucocorticoid Therapy in Patients with Septic Shock*. N Engl J Med, 2018. **378**(9): p. 797-808.
131. Pitre, T., et al., *Corticosteroids for adult patients hospitalised with non-viral community-acquired pneumonia: a systematic review and meta-analysis*. Intensive Care Med, 2025.
132. Martin-Loeches, I., et al., *Use of early corticosteroid therapy on ICU admission in patients affected by severe pandemic (H1N1)v influenza A infection*. Intensive Care Med, 2011. **37**(2): p. 272-83.
133. Rhodes, A., et al., *Surviving Sepsis Campaign: International Guidelines for Management of Sepsis and Septic Shock: 2016*. Intensive Care Med, 2017. **43**(3): p. 304-377.
134. Qadir, N., et al., *An Update on Management of Adult Patients with Acute Respiratory Distress Syndrome: An Official American Thoracic Society Clinical Practice Guideline*. Am J Respir Crit Care Med, 2024. **209**(1): p. 24-36.
135. Bergmann, F., et al., *Efficacy and Safety of Corticosteroid Therapy for Community-Acquired Pneumonia: A Meta-Analysis and Meta-Regression of Randomized, Controlled Trials*. Clinical

infectious diseases : an official publication of the Infectious Diseases Society of America, 2023. **77**(12): p. 1704-1713.

136. Saleem, N., et al., *Effect of Corticosteroids on Mortality and Clinical Cure in Community-Acquired Pneumonia: A Systematic Review, Meta-analysis, and Meta-regression of Randomized Control Trials*. Chest, 2023. **163**(3): p. 484-497.

137. Stern, A., et al., *Corticosteroids for pneumonia*. Cochrane Database Syst Rev, 2017. **12**(12): p. Cd007720.

138. Society, A.T. *Patient Education Information Series: What is Pneumonia?* American Thoracic Society Patient Education Information Series 2020; Available from: <https://www.thoracic.org/patients/patient-resources/resources/what-is-pneumonia-1pg.pdf>.

139. Society, A.T. *American Thoracic Society Patient information Series: Pneumococcal (Pneumonia) Vaccines*. American Thoracic Society Patient information Series: 2020 [cited 2024 March 1]; Available from: <https://www.thoracic.org/patients/patient-resources/resources/pneumonia-vaccines.pdf>.

140. *ACCP - Point-of-Care Ultrasound Certificate of Completion*. Available from: <https://www.chestnet.org/learning-and-events/learning/certificate-of-completion/pocus>.

141. *ACP - Point of Care Ultrasound (POCUS) Pathway for Internal Medicine*. Available from: https://www.acponline.org/meetings-courses/focused-topics/point-of-care-ultrasound-pocus-for-internal-medicine?gad=1&gclid=Cj0KCQiAjMKqBhCgARIsAPDgWIwBEMOzhuOoddAEfCeZhrCO38x3Cg5jb1BkZq1L-Wp2-VnnzdT0eYAaAjuXEALw_wcB&gclsrc=aw.ds.

142. *ERS - The Thoracic Ultrasound Certified Training Programme*. Available from: <https://www.ersnet.org/education-and-professional-development/ers-certified-training-programmes/thoracic-ultrasound-certified-training-programme/>.

143. *SHM - POCUS Certificate of Completion*. Available from: <https://www.hospitalmedicine.org/clinical-topics/ultrasound/pocus-certificate-of-completion/>.

Table 1. Individual patient factors to consider that may strengthen or weaken recommendations.

Factors listed in this table were generated from clinical experience, observational studies, and pathophysiologic rationale, but are not supported by high-quality comparative evidence and should be integrated with clinical judgment for individual patient care.

Recommendations are not for patients with immunocompromise. See other guidelines focused on this patient population.

Recommendation	Strength & Evidence Quality	Factors that <u>strengthen</u> the recommendation	Factors that <u>weaken</u> the recommendation
1. Lung ultrasound versus chest x-ray to diagnose CAP.			
For adults with suspected CAP, we suggest lung ultrasound is an acceptable diagnostic alternative to chest x-ray in medical centers where appropriate clinical expertise exists	Conditional Low-quality evidence	All criteria for establishing expertise met (Table 4) No availability of chest X-Ray (LUS as alternative to X-Ray) High patient risks or cost of CT scan (LUS as alternative to CT) Patient convenience and radiation exposure compared to chest x-ray & CT.	Not all criteria for establishing expertise met (Table 4) Suspicion of alternative/additional diagnoses (pulmonary embolism, malignancy) Barriers to high-quality LUS (Obesity, drains, scars, wounds, difficulty holding position)
2. Empiric antibacterial therapy for CAP with positive respiratory virus testing			
For adult outpatients without co-morbidities who have clinical and imaging evidence of CAP and who test positive for a respiratory virus, we suggest not prescribing empiric antibiotics	Conditional Very low-quality evidence	Low suspicion for bacterial co-infection (clinical history, low/normal inflammatory markers, clinical history, radiologic findings suggestive of viral etiology, viral pathogen with low prevalence of bacterial co-detection) Higher risk of harm from antibiotic exposure (History of <i>C. difficile</i> , severe antibiotic allergy or adverse event) Patient preference to avoid antibiotic exposure	Suspicion of bacterial co-infection (long symptom onset, "double sickening", purulent sputum, elevated inflammatory markers, radiologic findings such as consolidative infiltrate, viral pathogen with high prevalence of bacterial co-detection, exposure to <i>Mycoplasma pneumoniae</i>) High risk of harm if missed bacterial infection (elderly, pregnant, signs/symptoms suggestive of more severe illness) Barriers to follow-up or communication

<p>For adult outpatients with co-morbidities who have clinical and imaging evidence of CAP and who test positive for a respiratory virus, we suggest prescribing empiric antibiotics due to concern for bacterial-viral co-infection</p>	<p>Conditional Very low-quality evidence</p>	<p>Suspicion of bacterial co-infection (long symptom onset, "double sickening", purulent sputum, elevated or increasing inflammatory markers, radiologic findings such as consolidative infiltrate)</p> <p>Low likelihood that virus identified explains etiology and severity of pneumonia (ie, virus with low virulence or high-risk of co-infection)</p> <p>High risk of harm if missed bacterial infection</p> <p>-High illness severity, severe symptoms</p> <p>-Higher number, severe, or poorly controlled comorbidities</p>	<p>Low suspicion of bacterial infection (clinical history, normal inflammatory markers, radiologic findings suggestive of viral etiology)</p> <p>High likelihood that virus identified explains etiology and severity of pneumonia (virus with high virulence, low risk of co-infection)</p> <p>Lower risk of harm if missed bacterial infection</p> <p>-Lower illness severity</p> <p>-Single, mild, or well controlled comorbidities</p> <p>Higher risk of harm from antibiotic exposure (History of <i>C. difficile</i>, antibiotic allergy/adverse event)</p> <p>- Patient preference to avoid antibiotic exposure</p>
		Same as above	**Same as above**
		Sepsis, severe respiratory failure, elevated or increasing inflammatory markers, Chest radiograph showing consolidation infiltrates.	Higher risk of harm from antibiotic exposure (History of <i>C. difficile</i> , antibiotic allergy, or antibiotic adverse event)
3. Antibiotic duration for CAP			
<p>For adult outpatients with CAP <u>who reach clinical stability*</u>, we suggest less than five days of antibiotics (minimum of 3 days duration), rather than five or more days of antibiotics.</p> <p>The duration of antibiotics should be determined based upon daily assessment of clinical stability.</p>	<p>Conditional Low-quality evidence</p>	<p>Higher risk of harm from prolonged antibiotic exposure (History of <i>C. difficile</i>, or an antibiotic adverse event)</p> <p>Patient preference to minimize antibiotic exposure</p>	<p>Barriers to self assessment, follow-up, or communication to ensure recovery</p> <p>Organism requiring longer duration (i.e., <i>Staphylococcus aureus</i>, <i>Pseudomonas aeruginosa</i>, suspected <i>Legionella pneumophila</i> or other intracellular microorganisms)**</p>

			<p>Radiographic findings (high burden of disease, necrotizing process, dense consolidations)</p> <p>Underlying lung disease (e.g., bronchiectasis, post-obstructive pneumonia, chronic respiratory insufficiency**)</p> <p>Recent Hospitalization or resident in Long-term care**</p>
<p>For adult inpatients with non-severe CAP <u>who reach clinical stability*</u>, we suggest less than five days of antibiotics (minimum of 3 days duration), rather than five or more days of antibiotics.</p> <p>*The duration of antibiotics should be determined based upon daily assessment of clinical stability.</p>	<p>Conditional Low-quality evidence</p>	<p>Patient preference to minimize antibiotic exposure</p> <p>Resolution of inflammatory markers</p>	<p>Organism requiring longer duration (i.e., <i>Staphylococcus aureus</i>, <i>Pseudomonas aeruginosa</i>, suspected <i>Legionella pneumophila</i> or other intracellular microorganisms)**</p> <p>Pneumonia complication (e.g., empyema/parapneumonic effusion, abscess/necrotizing process, bacteremia, extrapulmonary infection)</p> <p>Underlying lung disease (e.g., bronchiectasis, post-obstructive pneumonia, chronic hypoxemia**)</p> <p>Pregnancy, recent antibiotics**</p> <p>Recent Hospitalization or resident in Long-term care**</p>
<p>For adult inpatients with severe CAP who reach clinical stability, we suggest five or more days of antibiotics, rather than less than five days of antibiotics</p>	<p>Strong Low-quality evidence</p>		
<p>4. Corticosteroids</p>			
<p>For adult inpatients with non-severe CAP, we recommend NOT administering systemic corticosteroids ***</p>	<p>Strong Low-quality evidence</p>		
<p>For adult inpatients with severe CAP, we suggest systemic corticosteroids</p>	<p>Conditional Low-quality evidence</p>	<p>Short time interval between symptom onset and presentation.</p>	<p>Longer time between symptom onset and presentation</p>

		<p>Ability to administer corticosteroids early after meeting criteria for severe CAP (within 24 hours)</p> <p>ICU-admitted</p> <p>Respiratory failure (P:F<300)</p> <p>Elevated inflammatory markers (ie, CRP, IL-6)</p>	<p>Longer time since onset of severe CAP (e.g. >72 hours)</p> <p>Lack of respiratory failure</p> <p>Normal or low inflammatory markers</p> <p>Contraindications to corticosteroids (ie, influenza, Aspergillus, uncontrolled diabetes, recent gastrointestinal bleeding)</p> <p>Pregnancy**</p>
<p>**Exclusion criteria from key studies</p> <p>***Recommendation and factors listed are for patients without another established indication of corticosteroids.</p>			

Table 2. 2007 and 2019 Infectious Diseases Society of America/American Thoracic Society Criteria for Defining Severe Community-acquired Pneumonia

Validated definition includes either one major criterion or three or more minor criteria.

Major criteria

- Septic shock with need for vasopressors**
- Respiratory failure requiring mechanical ventilation**

Minor criteria

- Respiratory rate \geq 30 breaths/min**
- $\text{Pa}_{\text{O}_2}/\text{Fi}_{\text{O}_2}$ ratio \leq 250**
- Multilobar infiltrates**
- Confusion/disorientation**
- Uremia (blood urea nitrogen level \geq 20 mg/dl)**
- Leukopenia (white blood cell count $<$ 4,000 cells/ μl)**
- Thrombocytopenia (platelet count $<$ 100,000/ μl)**
- Hypothermia (core temperature $<$ 36°C)**
- Hypotension requiring aggressive fluid resuscitation**

Table 3. Strengths of Recommendation

	Strong Recommendation ("We recommend . . .")	Conditional Recommendation ("We suggest . . .")
For patients	The overwhelming majority of individuals in this situation would want the recommended course of action and only a small minority would not.	The majority individuals in this situation would want the suggested course of action, but a sizeable minority would not.
For clinicians	The overwhelming majority of individuals should receive the recommended course of action. Adherence to this recommendation according to the guideline could be used as a quality criterion or performance indicator. Formal decision aids are not likely to be needed to help individuals make decisions consistent with patient values and preferences.	Different choices will be appropriate for different patients, and you must help each patient arrive at a management decision consistent with her or his values and preferences. Decision aids may be useful to help individuals make decisions consistent with their values and preferences. Clinicians should expect to spend more time with patients when working towards a decision.
For policy makers	The recommendation can be adapted as policy in most situations including for the use as performance indicators if supported by high- or moderate-quality evidence.	Policymaking will require substantial debates and involvement of many stakeholders. Policies are also more likely to vary between regions. Performance indicators would have to focus on the fact that adequate deliberation about the management options has taken place.

Table 4. Key Criteria for Establishing Expertise in Lung Ultrasound Exams

Factor	Requirements
Ultrasound Equipment	Either a cart-based or handheld ultrasound device with a low-frequency ultrasound probe that provides adequate penetration, typically 14-16cm in adults, is needed to assess for pneumonia.
Training	Requisite training in LUS must provide background knowledge; practice in image acquisition, optimization, and interpretation; and knowledge in clinical integration. Mastery of LUS knowledge and skills through formal assessments should be demonstrated prior to use in clinical practice as recommended by specialty guidelines. [140-143]
Imaging Protocol	A standardized protocol evaluating the superior and inferior portions of the anterior, lateral, and posterior chest wall should be utilized.[32]
Image Archival	Dynamic ultrasound images, typically 2-4 second video loops, should be recorded, labelled per local convention, and saved in a retrievable image archival.
Documentation	Documentation of the operator, indications, exam performed, and ultrasound findings of the pleura and lung parenchyma – including location of abnormalities using standard terminology -- should be included as a report within the patient's medical record.
	Findings from different imaging modalities shall be compared and periodic quality assurance checks of clinicians using LUS should be performed at the same level of radiology images. Discrepancies of imaging findings associated with negative outcomes should be reviewed for quality improvement.
Patient	Patient factors that limit LUS imaging including obesity, drains, scars, wounds, and uncooperativeness, should be considered when choosing imaging modality.

Table 5. Comorbidities that may warrant antibiotic therapy for outpatients with CAP who test positive for a respiratory virus. Conditions are ranked by % of committee members who would prescribe antibiotics for patients with each condition, in descending order.

Comorbidity (see footnotes for further definitions and examples)	% committee members who voted this condition that may warrant antibiotics
Greater than 50% agreement	
Chronic pulmonary disease other than asthma	82%
End-stage liver disease	71%
End-stage renal disease	65%
Cardiovascular disease	53%
Alcoholism	53%
Neoplastic disease	53%
Less than 50% agreement	
Neurological disease	47%
Chronic liver disease	35%
Malnutrition	35%
Current smoker	35%
Corticosteroid therapy* (<20mg daily or <4 weeks)	30%
Diabetes mellitus	29%
Chronic kidney disease	24%
Human immunodeficiency virus* (CD4>200)	24%
Asthma	21%
Rheumatological diseases* (not on immunosuppressants)	18%
Obesity (BMI>30)	12%

*Patients with solid organ transplant on anti-rejection medications, corticosteroid therapy more than 20mg/day for 4wks, human insufficiency virus with CD4 count <200, or rheumatological diseases on immunocompromising medication should be considered immunocompromised hosts, to whom the CAP guidelines do not apply. Refer to References 6 and 7 for guidance on diagnosis and management of these patients.

Chronic pulmonary diseases other than asthma= chronic obstructive pulmonary disease [COPD], bronchiectasis or interstitial lung disease. End-stage liver disease = ascites, variceal hemorrhage, hepatic encephalopathy, or renal impairment. End-stage renal disease=GFR <15 mL/min lasting >3 months. Solid organ transplant recipient=not taking immunosuppressive anti-rejection medication. Cardiovascular disease=congestive heart failure, coronary artery disease, or poorly controlled hypertension. Alcoholism = recurrent or ongoing alcohol use despite inability to fulfill obligations, or despite social or interpersonal problems exacerbated by alcohol use. Neoplastic disease = not taking immunosuppressive chemotherapy. Neurological disease such as Parkinson's Disease, dementia, myasthenia gravis or amyotrophic lateral sclerosis. Chronic liver disease defined as abnormal liver function tests, coagulopathy, or other evidence of chronic liver damage lasting >3 months. Malnutrition = weight loss, BMI <18.5, reduced muscle mass, or reduced food intake or assimilation. Current smoker, including cigarettes and marijuana. Corticosteroid therapy not at immunosuppressive doses such as a cumulative dose >600 mg of prednisone. Chronic kidney disease defined as GFR 15-60 mL/min, albuminuria >30 mg / 24 hours, or other markers of kidney damage lasting >3 months. Human immunodeficiency virus (HIV) with CD4 >200 and no AIDS defining illness. Rheumatological diseases such as rheumatoid arthritis or systemic lupus erythematosus, not taking immunosuppressive medication. Obesity defined as BMI >30.

Table 6. Clinical Stability Definitions*

The duration of antibiotics should be determined based upon daily assessment of clinical responses.

Temperature	≤37.8° C
Heart rate	<100 beats per minute*
Respiratory rate	<24 breaths per minute*
Arterial oxygen saturation or partial pressure	SpO ₂ ≥90% or PaO ₂ ≥60 mmHg on room air* or baseline oxygen requirement*
Systolic blood pressure	≥90 mmHg
Mental status	Normal

*All criteria were needed to be met to be considered “stable” in the Dinh study [89]. Prior 2007 guidelines and Uranga study [88] required afebrile plus no more than one sign of instability and used heart rate of ≤100 beats per minute, and respiratory rate of ≤24 breaths per minute. For el Moussaoui et al study, eligibility for 3-day duration was determined by improvement of 2 or more points on a respiratory symptom scale, temperature < 38°C and ability to take oral intake.

**Neither Dinh nor Mooussaoi studies included patients with chronic respiratory insufficiency. Thus this factor weakens this recommendation (See Table 1)

Online Supplement

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An Official American Thoracic Society Clinical Practice Guideline

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... on behalf of the American Thoracic Society Assembly on Pulmonary Infections and Tuberculosis.

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METHODS

Panel Composition

The project was proposed by one of the co-chairs (BJ) through an application to the American Thoracic Society (ATS), which subsequently invited the Infectious Diseases Society of America (IDSA) to collaborate. The project began January 1, 2022. Co-chairs BJ and JR proposed panelists based upon their expertise in the diagnosis and management of community-acquired pneumonia (CAP) and KCW assembled a methodology team from the ATS' Guideline Methodology Training Program (EO, BB, SL, BE). The committee was diverse with respect to gender, specialties (pulmonology, infectious disease, internal medicine, critical care, hospital medicine, emergency medicine, and evidence synthesis), level of seniority, and geographical locations. The appointed representatives from ATS and IDSA were approved by the leadership of those societies. All panelists disclosed their conflicts of interest, which were vetted and managed according to the policies and procedures of the ATS and IDSA.

Questions

The co-chairs drafted key questions pertaining to treatment interventions in a PICO (Population, Intervention, Comparator, and Outcome) format. The questions were discussed, revised, and finally approved by the full committee at a virtual meeting Fall 2022. Four PICO questions were agreed upon. For each PICO question, critical and important outcomes were predetermined. An overview document was created to clarify inclusion and exclusion criteria, participants, and *a priori* subgroup analyses.

Literature search

The published literature was searched by a health librarian (MH) as well as reviewed by the lead methodologist (EO) in a number of databases, including Medline/PubMed, Excerpta Medica Database (EMBASE), and Cochrane Database of Systematic Reviews. Searching was conducted Winter and Spring 2023. The methodology team reviewed all publications retrieved from the literature searches, initially screening based on title and/or abstract and then reviewing the full text of potentially relevant publications. Bibliographies of selected studies, relevant systematic reviews, and articles suggested by committee members were also reviewed. All screened article meta-fields were input into Rayyan.AI, which was used to document and track included and excluded articles for full-text review. Randomized trials that compared performing the treatment of interest to not performing the treatment were sought first. If randomized trials were not identified, non-randomized studies that compared performing a treatment to not performing the treatment were sought. If such studies were not found, non-randomized studies without a control group were sought. If no direct evidence was found, indirect evidence (e.g. population, intervention) was sought based on initial expert discussion. For one of the PICO questions, this resulted in a shift to diagnostic interventions, with inclusion of accuracy studies that determined sensitivity and specificity of the diagnostic test.

Evidence synthesis

Findings from selected publications were extracted into an Excel spreadsheet created specifically for the project. When data were amenable to weighted pooling (i.e., meta-analysis), a random effects model was implemented in the Cochrane Collaboration Review Manager (RevMan), version 5.4. For controlled studies, relative risk (RR) was used to report dichotomous outcomes and the mean difference (MD) was used to report continuous outcomes. The accompanying 95% confidence interval (CI) was determined.

Statistical heterogeneity was measured using the I^2 test; an $I^2 \geq 75\%$, $50\%-75\%$, and $25\%-50\%$ was considered severe, moderate, and mild, respectively. Whenever heterogeneity was encountered, sensitivity analyses were performed to identify contributing studies, reasons for the heterogeneity sought, and subgroups analyzed. If no cause was found, we eliminated outliers and the estimates before and after elimination of outliers were both presented to the committee to inform their discussion and judgements. Results are provided in the evidence tables. For diagnostic comparisons, a summary receiver operator curve was constructed. The area under the curve was calculated and a bivariate model was used to find a single best estimate of sensitivity and specificity.

The Grading, Recommendations, Assessment, Development, and Evaluation (GRADE) approach was used to assess certainty in the estimated effects (i.e., the quality of evidence) for each intervention on each outcome of interest. The methodology team created evidence profiles, which categorized the overall certainty in the evidence into one of four levels: high, moderate, low, or very low. Each level represents the certainty in the accuracy of the estimated effects for a specific intervention. The full guideline panel reviewed the evidence profiles and provided input and feedback.

Recommendations

The methodology team distributed the completed evidence syntheses to the guideline committee by email two weeks prior to the face-to-face meeting at the ATS conference in Washington DC, May 2023. The methodology team presented the evidence syntheses at the meeting, which were then discussed by the committee and recommendations were formulated. Decisions about whether to recommend for or against an intervention were based on the balance of desirable consequences (benefits) and undesirable consequences (burdens, adverse effects, and costs), quality of evidence, feasibility, and acceptability to patients (i.e., patient values and preferences). Guideline committee members were encouraged to consider their non-systematic clinical observations (i.e., clinical experience) when the quality of empirical evidence was very low.

To facilitate consensus, each recommendation was voted on using the Convergence of Opinion on Recommendations and Evidence (CORE) approach, a modified Delphi process. Voting percentages were calculated and rounded to the nearest multiple of five. It was decided a priori that 1) 80% committee participation was necessary, 2) 70% agreement was necessary to make a recommendation, 3) the strength of the recommendation would be determined by the majority among those in agreement, and 4) only those who were present for the evidence presentation could vote on the recommendation. The methodology team and patient representatives were not voting members of guideline committee.

Evidence to Data (EtD) tables were constructed for each PICO question summarizing recommendations and providing an overview of the process.

Implications of the strength of recommendations

The strength of recommendations can be conceptualized in several ways. First, “we recommend” conveys that the recommended course of action is the appropriate in >95% of patients, whereas a “we suggest” conveys that the recommended course of action is appropriate in >50% of patients but may not be appropriate in a sizeable minority. Second, “we recommend” conveys “just do it”, whereas “we suggest” conveys “slow down, think about it, discuss it”. Third, a “we recommend” conveys that

criticism may be warranted if the recommended course of action is not followed, whereas "we suggest" conveys that a decision to not follow the recommended course of action may be a matter of style or equipoise. Finally, "we recommend" is often the basis of a performance measure, whereas "we suggest" seldom make reasonable performance measures.

Manuscript preparation

The introduction and outline were written by the co-chairs (BJ, JR). Guideline committee members were assigned to subcommittees to create sections of the manuscript. The sections were collated and edited into a single manuscript by BJ and JR. All members of the guideline committee reviewed the manuscript; comments were addressed by the co-chairs and then incorporated into the revised manuscript. The manuscript was redistributed to the full committee for further review. The final product was the result of collective work from the co-chairs, committee members, methodologists, and health librarian. Once the manuscript was approved by the full guideline committee, it was submitted for external peer review.

Peer review and approval

Peer review was overseen by the ATS Associate Documents Editor. The guideline was reviewed independently by each co-sponsoring society. This included anonymous peer review by both content experts and guideline methodology experts. Following multiple cycles of review and revision, the guideline was reviewed and approved by the ATS Board of Directors. The IDSA chose to withdraw rather than approve the final version of the guideline.

Updating

The guideline will be reviewed by the ATS' Pulmonary Infections and Tuberculosis Assembly within five years. If one or more questions are deemed in need of an update, or related new questions need answered, a new task force may be approved to develop an updated guideline.

Funding

Funding was provided by both the American Thoracic Society.

PICO question #1: Lung ultrasound versus chest x-ray to diagnose CAP

Population: Adults with suspected community-acquired pneumonia

Intervention: Ultrasound, in addition to clinical judgment

Comparator: Chest x-ray, along with clinical judgment

Outcomes:

Critical

Time to appropriate diagnosis, treatment, and disposition (including emergency department length of stay)

Accuracy/Performance characteristics (sensitivity, specificity,)

Repeat visit to emergency department, clinic, or hospital/re-admission

Important

Provider experience (e.g. clinician confidence in decision-making, usability, etc.)

Use of advanced imaging

Cost

Patient satisfaction

Search strategy

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((("Community-Acquired Infections"[MeSH Terms] OR ("community acquired"[All Fields] AND "infections"[All Fields]) OR "Community-Acquired Infections"[All Fields] OR ("community"[All Fields] AND "acquired"[All Fields] AND "infection"[All Fields]) OR "community acquired infection"[All Fields] OR "Community-Acquired Infections"[MeSH Terms]) AND ("pneumonia"[MeSH Terms] OR "pneumonia"[All Fields] OR "pneumonias"[All Fields] OR "pneumoniae"[All Fields] OR "pneumoniae s"[All Fields])) AND ((("respiratory tract infections"[MeSH Terms] OR ("respiratory"[All Fields] AND "tract"[All Fields] AND "infections"[All Fields]) OR "respiratory tract infections"[All Fields] ))) AND ((english[Filter] AND (alladult[Filter]))) AND (((("doppler ultrasound"[All Fields] OR ("chest x ray"[All Fields])) OR ("chest radiograph"[All Fields])) OR ((("Ultrasonography, Doppler"[Mesh]) OR ("Radiography, Thoracic"[Mesh]) OR ("diagnostic imaging, lung"[Mesh]))) Filters: English, Adult: 19+ years
```

Figure S1: Flow of information diagram

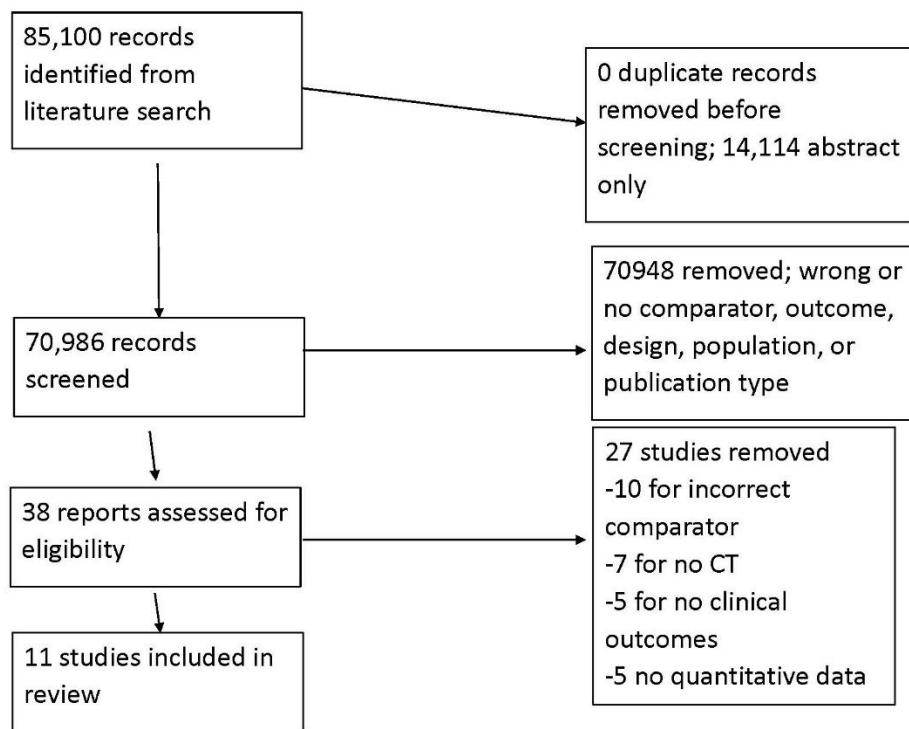


Table S1: Studies selected

Study	Type of Study	Location	Number of Subjects	Population	Intervention	Outcomes	Risk of Bias
Amatya 2018	Observational	Nepal	62	Patients with suspected CAP and CT scan in ED ^a	Lung Ultrasound, CXR	Sensitivity, Specificity **	None
Bourcier 2014	Observational	France	144	Patients with suspected CAP and CT scan in ED ^b	Lung Ultrasound, CXR	Sensitivity, Specificity**	None
Cortallero 2012	Observational	Italy	120	Patients with suspected CAP and CT scan in ED ^c	Lung Ultrasound, CXR	Sensitivity, Specificity **	None
Dhawan 2022	Observational	India	85	Patients with suspected CAP and CT scan in tertiary care hospital ICUs ^d	Lung Ultrasound, CXR	Sensitivity, Specificity **	None
Gibbons 2021	Observational	USA	110	Patients with suspected CAP and CT scan in ED ^e	Lung Ultrasound, CXR	Sensitivity, Specificity **	None
Liu 2014	Observational	China	179	Patients with suspected CAP and CT scan in ED ^f	Lung Ultrasound, CXR	Sensitivity, Specificity **	None

Corradi 2015	Observational	Italy	54	Patients with suspected CAP and CT scan in ED ^g	Lung Ultrasound, CXR	Sensitivity, Specificity **	None
Fares 2015	Observational	Egypt	38	Patients with suspected CAP and CT scan in a hospital ICU ^h	Lung Ultrasound, CXR	Sensitivity, Specificity **	None
Karimi 2019	Observational	Iran	280	Patients with suspected CAP and CT scan in ED ⁱ	Lung Ultrasound, CXR	Sensitivity, Specificity **	None
Taghizadieh 2015	Observational	Iran	30	Patients with suspected CAP and CT scan in ED ^j	Lung Ultrasound, CXR	Sensitivity, Specificity **	None
Bitar 2018	Observational	Kuwait	82	Patients with suspected CAP and CT scan in a hospital medical-surgical ICU ^k	Lung Ultrasound, CXR	Sensitivity, Specificity **	None

^aAmatya Y, et al. Int J Emerg Med. 2018 Mar 12;11(1):8. Patients had at least three of the following signs or symptoms: temperature greater than 38 °C or history of fever, cough, dyspnea, tachypnea (respiratory rate greater than 20), or oxygen saturation lower than 92%.

^bBourcier JE, et al. Am J Emerg Med. 2014 Feb;32(2):115-8. At least three of the following items: tympanic temperature equal or higher than 38°C, cough, dyspnea, heart rate higher than 100 beats per minute, saturation of oxygen lower or equal to 92% in ambient air.

^cCortellaro F, et al. Emerg Med J. 2012 Jan;29(1):19-23wig S, Ruiz M, Mensa J, et al. Severe community-acquired pneumonia: assessment of severity criteria. Am J Respir Crit Care Med 1998;158:1102–1108. Signs and symptoms considered as suggestive of CAP were: cough; pleuritic pain; sputum production; fever; dyspnea.

^dDhawan J, et al. Indian J Crit Care Med. 2022 Aug;26(8):920-929. Clinical suspicion of pneumonia was considered when the following criteria was met: Symptoms suggestive of pneumonia (fever, cough, purulent sputum, and pleuritic chest pain), fulfilled minor criteria with at least three of the following symptoms: Respiratory rate >30 breaths/minute, PaO₂/FiO₂ <250, multilobar infiltrates, confusion/ disorientation, uremia [blood urea nitrogen (BUN) >20 mg/dL], leukopenia (WBC count <4,000 cells/mm³), thrombocytopenia (platelet count <100,000 cells/mm³),

hypothermia (core temperature $<36^{\circ}\text{C}$), and hypotension requiring aggressive fluid resuscitation; fulfilled major criteria with a requirement of at least one of the following factors: Invasive mechanical ventilation and septic shock with need for vasopressors.

^eGibbons RC, et al. J Emerg Med. 2021 May;60(5):615-625. Patients with one or more of the predefined signs and symptoms of COVID-19 were eligible for enrollment. Predefined signs and symptoms included: cough, fever, dyspnea, myalgia, malaise, ageusia, anosmia, increased work of breathing, temperature $\geq 38^{\circ}\text{C}$ (100.4°F), heartrate ≥ 100 beats/ min, respiratory rate ≥ 16 breaths/min, and SpO₂ $< 94\%$.

^fLiu XL, et al. Emerg Med J. 2015 Jun;32(6):433-8. Signs and symptoms considered as suggestive of CAP included: cough, pleuritic pain, sputum production, fever, dyspnea.

^gCorradi F, et al. Biomed Res Int 2015;1-8. Pneumonia was clinically suspected on the basis of cough, dyspnea, body temperature $>38^{\circ}\text{C}$ or $<35^{\circ}\text{C}$, heart rate >90 beats/min, tachypnea >20 breaths/min, rales or crackles on auscultation, and abnormal oxygen saturation.

^hFares Auf M-N. Med J Cairo Univ 2015;83:307-14. Pneumonia diagnosis based on suggestive history (fever, cough, sputum production, dyspnea).General and local physical signs suggestive of pneumonia.

ⁱKarimi E. Arch Acad Emerg Med 2019;7:e8. clinical symptoms of pneumonia such as cough, phlegm, shortness of breath, hemoptysis, and temperature higher than 38°C .

^jTaghizadieh A, et al.. Emerg 2015;3:114-6. Presence of fever, cough, pleuritic pain, sputum production, and dyspnea were considered as signs and symptoms of CAP.

^kBitar ZI, et al.. Health Sci Rep 2019;2:e102. The diagnosis of pneumonia was confirmed by a set of clinical features (clinical history and physical examination), microbiological testing for admitted patients (blood and sputum culture, legionella and pneumococcal urinary antigen testing, and multiplex polymerase chain reaction assay for detecting *Chlamydia pneumoniae*, *Mycoplasma pneumoniae*, and respiratory tract viruses), inflammatory markers (c-reactive protein >10 mg/L and procalcitonin ≥ 0.25 ng/mL), along with the presence of consolidation or opacification on a CXR or chest CT.

** - performance characteristics for CXR and LUS were calculated using CT scan results as reference standard.

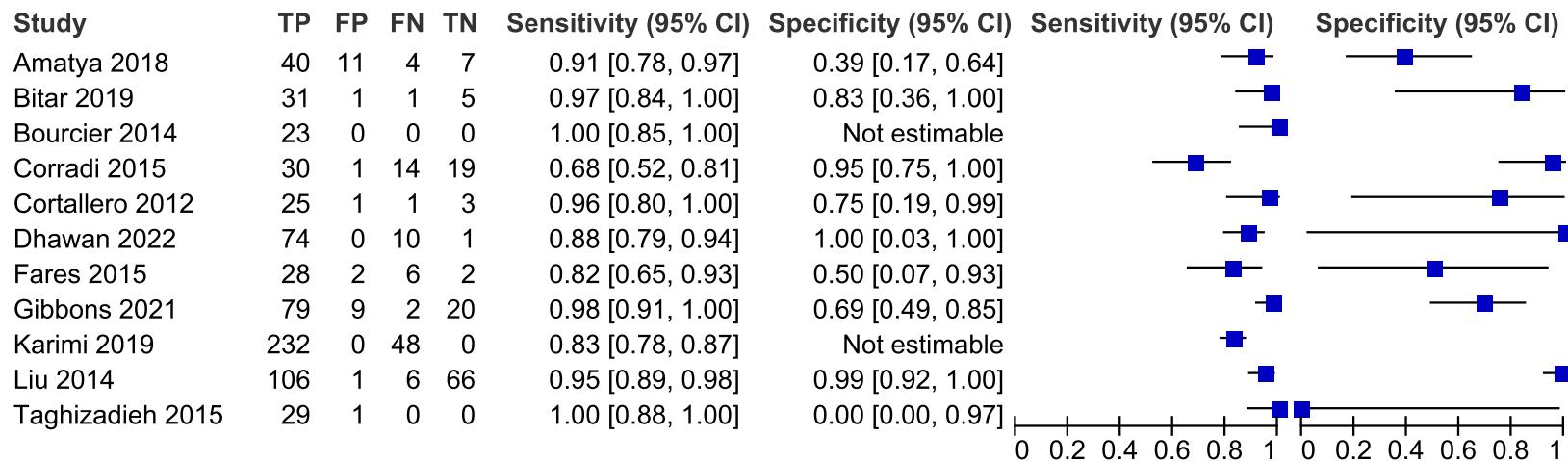
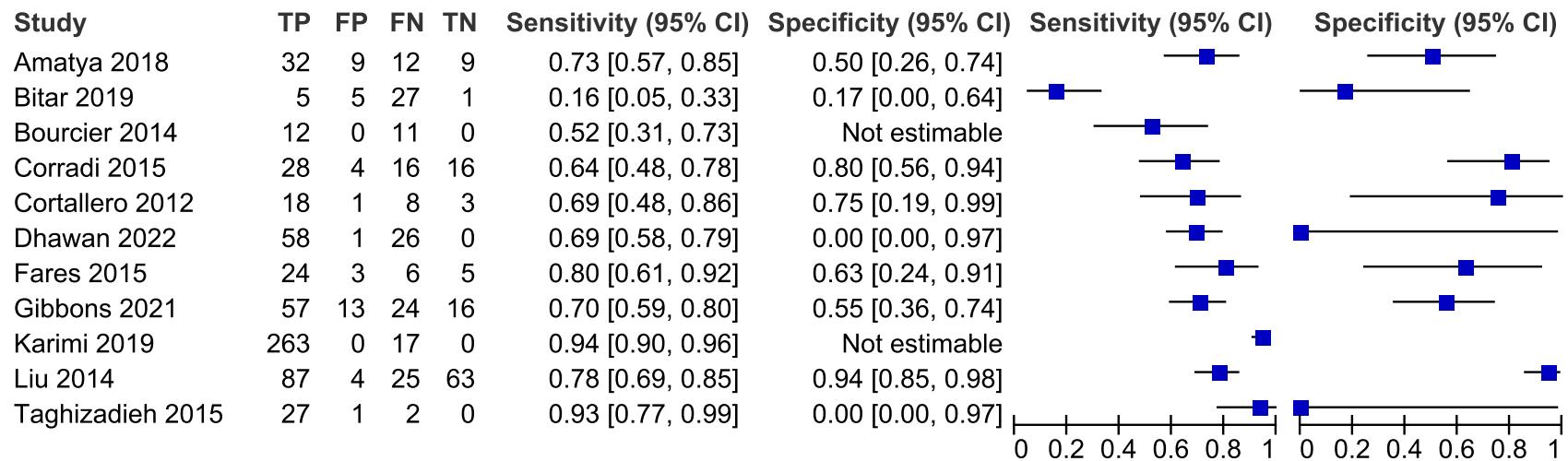
Figure S2: Forest plots**A) Analysis #1: Ultrasound (using chest CT scan as the reference standard)****B) Analysis #2: Chest X-Ray (using chest CT scan as the reference standard)**

Table S2: Evidence profile

Population: Adults with suspected CAP
 Comparison: Chest x-ray versus lung ultrasound
 Setting: Inpatients and outpatients

Quality assessment							Summary of Findings		Quality	Importance
No of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other	# patients	Effect (range)		
Sensitivity and specificity: Ultrasound (using chest CT scan as the reference standard)										
11 ^{1,2}	Accuracy	Not Serious	Serious ³	Not serious ^{4,5}	Serious ⁶	None	939	Sensitivity= median 95% (range 68-100%) Specificity= median 75% ⁶ (range 0-100%)	⊕⊕○○ LOW	CRITICAL
Sensitivity and specificity: Chest X-Ray (using chest CT scan as the reference standard)										
11 ^{1,2}	Accuracy	Not Serious	Serious ⁵	Not serious ^{4,5}	Serious ⁶	None	939	Sensitivity= median 70% (range 16-94%) Specificity= median 55% ⁶ (range 0-94%)	⊕⊕○○ LOW	CRITICAL

Footnotes:

1. Amatya Y, et al. Int J Emerg Med. 2018 Mar 12;11(1):8.; Bitar ZI, et al. Health Sci Rep 2019;2:e102; Bourcier JE, et al. Am J Emerg Med. 2014 Feb;32(2):115-8.; Corradi F, et al. Biomed Res Int 2015;1-8; Cortellaro F, et al. Emerg Med J. 2012 Jan;29(1):19-23; Dhawan J, et al. Indian J Crit Care Med. 2022 Aug;26(8):920-929; Fares Auf M-N. Med J Cairo Univ 2015;83:307-14; Gibbons RC, et al. J Emerg Med. 2021 May;60(5):615-625; Karimi E. Arch Acad Emerg Med 2019;7:e8; Liu XL, et al. Emerg Med J. 2015 Jun;32(6):433-8; Taghizadieh A, et al. Emerg 2015;3:114-6.
2. Testa A, et al. Crit Care. 2012 Feb 17;16(1):R30 was excluded due to being judged an outlier.
3. Inconsistency: Wide range of sensitivity and specificity estimates across studies as seen in the Forest plots.
4. Indirectness of the comparison: The question asks about ultrasound compared to chest x-ray. However, the studies are accuracy studies that compared ultrasound to a reference standard and compared chest x-ray to a reference standard (i.e., chest CT). Therefore, answering the question requires an indirect comparison with an assumption of transitivity. The committee recognized the indirect nature of the comparison but judged that it did not further reduce its certainty in the estimates beyond the inconsistency and the imprecision.
5. Indirectness of the population: The question asks about patients with suspected CAP, but most of the studies enrolled patients with suspected CAP who also required a chest CT scan (usually due to discordant results between the chest x-ray and lung ultrasound). The committee recognized the indirectness of the population but judged that it did not further reduce its certainty in the estimates beyond the inconsistency and the imprecision.
6. Imprecision: Wide confidence intervals for individual studies as seen in the Forest plots.

Table S3: EtD framework**QUESTION**

Should lung ultrasound be considered a reasonable alternative to chest x-ray in patients with suspected community-acquired pneumonia?

POPULATION:	Patients with suspected community-acquired pneumonia
INTERVENTION:	Lung ultrasound
COMPARATOR:	Chest x-ray
SETTING:	Inpatients and outpatients

ASSESSMENT**Test accuracy**

How accurate are the tests?

JUDGEMENT	RESEARCH EVIDENCE
<ul style="list-style-type: none"> <input type="radio"/> CXR is a lot more accurate <input type="radio"/> CXR is slightly more accurate <input type="radio"/> Lung US is a lot more accurate <input type="radio"/> Lung US is slightly more accurate <input checked="" type="radio"/> Chest x-ray and US are comparably accurate 	<p>TEST CHARACTERISTICS</p> <p>The guideline committee judged the sensitivities and specificities of lung ultrasound and chest x-ray as comparable. The estimated medians might seem quite different but, when one considers that the lung ultrasound studies were likely performed by experienced operators, the committee concluded that the accuracy of lung ultrasound is likely overestimated in the studies compared with routine clinical practice. When one accounts for this likelihood, the committee concluded that the accuracy of lung ultrasound and chest x-ray are likely comparable.</p> <p><u>Lung ultrasound</u> Sensitivity = median 95% (range 68-100%) Specificity = median 75% (range 0-100%)</p> <p><u>Chest x-ray</u> Sensitivity = median 70% (range 16-94%) Specificity = median 55% (range 0-94%)</p>

Desirable Effects

How substantial are the desirable effects of making a diagnosis? "Substantial" refers to both the importance and magnitude of the desirable effects. As an example, a small improvement in a critical outcome might be considered more substantial than a large improvement in an unimportant outcome.

JUDGEMENT	RESEARCH EVIDENCE
<ul style="list-style-type: none"> <input type="radio"/> CXR is a lot more likely to lead to desirable effects <input type="radio"/> CXR is slightly more likely to lead to desirable effects <input type="radio"/> Lung US is a lot more likely to lead to desirable effects <input type="radio"/> Lung US is slightly more likely to lead to desirable effects <input checked="" type="radio"/> Chest x-ray and US will lead to similar desirable effects 	<p>DESIRABLE PATIENT-IMPORTANT OUTCOMES</p> <p>Desirable effects derive from true positive and true negative results. They include the initiation or continuation of appropriate antibiotic therapy in those you have pneumonia, the elimination of the burdens and costs of seeking alternative diagnoses in those you have pneumonia, avoiding unnecessary antibiotic therapy in those who do not have pneumonia, and promoting ongoing pursuit of the correct diagnosis in those who do not have pneumonia.</p> <p>For both lung ultrasound and chest x-ray, a positive test result will result in the same intervention, antibiotics, and therefore eventually the same outcomes. Thus, the committee concluded that if test accuracy is comparable (see above), downstream desirable outcomes must also be comparable.</p> <p>Sensitivity = <u>true positive rate</u>:</p>

	<p>Lung ultrasound = 95% Chest x-ray = 70%</p> <p>Specificity = <u>true negative rate</u>: Lung ultrasound = 75% Chest x-ray = 55%</p>
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Undesirable Effects

How substantial are the undesirable effects of making a diagnosis? "Substantial" refers to both the importance and magnitude of the undesirable effects. As an example, a small but important complication of diagnostic testing might be considered more substantial than a large but unimportant complication.

JUDGEMENT	RESEARCH EVIDENCE
<ul style="list-style-type: none"> ○ CXR is a lot more likely to lead to undesirable effects ○ CXR is slightly more likely to lead to undesirable effects ○ Lung US is a lot more likely to lead to undesirable effects ○ Lung US is slightly more likely to lead to undesirable effects ● Chest x-ray and US will lead to similar undesirable effects 	<p>UNDESIRABLE PATIENT-IMPORTANT OUTCOMES</p> <p>Undesirable effects of diagnostic studies derive from false positive and false negative results. In this case, they include the initiation or continuation of inappropriate antibiotic therapy in those who test positive but do not have pneumonia, cessation of the pursuit of the correct diagnosis in those who test positive but do not have pneumonia, unnecessary additional diagnostic testing in those who test negative but have pneumonia, and delays in antibiotic therapy in those who test negative but have pneumonia.</p> <p>For both lung ultrasound and chest x-ray, a negative test result will result in the same actions (foregoing or discontinuing antibiotics, additional diagnostic testing to either confirm the negative result or seek an alternative diagnosis). Thus, the committee concluded that if test accuracy is comparable (see above), downstream undesirable outcomes must also be comparable.</p> <p>1 - sensitivity = <u>false negative rate</u>: Lung ultrasound = 5% Chest x-ray = 30%</p> <p>1 - specificity = <u>false positive rate</u>: Lung ultrasound = 25% Chest x-ray = 45%</p>

Balance of desirable and undesirable effects

Does the balance between desirable and undesirable effects favor the intervention or the comparison?

JUDGEMENT	RESEARCH EVIDENCE
<ul style="list-style-type: none"> ○ Favors chest x-ray ○ Probably favors chest x-ray ● Does not favor either chest x-ray or lung ultrasound ○ Favors lung ultrasound ○ Probably favors lung ultrasound ○ Varies ○ Don't know 	<p>The guideline committee noted that chest x-ray and lung ultrasound probably lead to similar desirable and undesirable effects (see above). Therefore, they concluded that the balance of effects does not favor either chest x-ray or lung ultrasound.</p>

Quality of evidence of test accuracy

What is the committee's confidence in the above listed estimates of test accuracy (i.e., what is the quality of evidence)?

JUDGEMENT	RESEARCH EVIDENCE
-----------	-------------------

<ul style="list-style-type: none"> <input type="radio"/> Very low <input checked="" type="radio"/> Low <input type="radio"/> Moderate <input type="radio"/> High <input type="radio"/> No included studies 	QUALITY OF EVIDENCE <p>The quality of evidence for both lung ultrasound and chest x-rays was low because there are accuracy studies that were downgraded due to inconsistency (there were a wide range of estimates across studies) and imprecision (the confidence intervals were wide for most studies).</p>
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Quality of evidence of test result/management

What is the committee's confidence that the test results will lead to certain clinical actions?

JUDGEMENT	RESEARCH EVIDENCE
<ul style="list-style-type: none"> <input type="radio"/> Very low <input type="radio"/> Low <input type="radio"/> Moderate <input type="radio"/> High <input checked="" type="radio"/> No included studies 	The committee did not evaluate published evidence regarding clinical actions that follow lung ultrasound and chest x-ray results. The committee concluded that the frequency of clinical actions following lung ultrasound and chest x-ray must be comparable if accuracy of studies is comparable (see above) since the tests lead to the same clinical actions. Clinical actions include the initiation/continuation antibiotic therapy or foregoing/discontinuing antibiotic therapy.

Quality of evidence of management/clinical outcomes

What is the committee's confidence that the clinical actions prompted by the test results will lead to certain outcomes?

JUDGEMENT	RESEARCH EVIDENCE
<ul style="list-style-type: none"> <input type="radio"/> Very low <input type="radio"/> Low <input type="radio"/> Moderate <input type="radio"/> High <input checked="" type="radio"/> No included studies 	The committee did not evaluate published evidence regarding the clinical outcomes of antibiotic therapy in patients with CAP. However, the committee was confident that antibiotic therapy improves clinical outcomes in patients with CAP. The committee therefore concluded that clinical outcomes following lung ultrasound and chest x-ray must be comparable if the accuracy of studies is comparable (see above), since the tests lead to the same clinical actions which create those outcomes.

Quality of evidence

What is the overall certainty of the effects of the tests? This is defined as the lowest quality of evidence among the qualities of evidence of test accuracy, result/management, and management/clinical outcomes

JUDGEMENT	RESEARCH EVIDENCE
<ul style="list-style-type: none"> <input checked="" type="radio"/> Very low <input type="radio"/> Low <input type="radio"/> Moderate <input type="radio"/> High <input type="radio"/> No included studies 	The overall quality of evidence is very low because, even if there exists good evidence that test results effect clinical actions that improve outcomes, there is very low quality of evidence for test accuracy for both lung ultrasound and chest x-ray.

Acceptability

Is the intervention acceptable to key stakeholders?

JUDGEMENT	RESEARCH EVIDENCE
<ul style="list-style-type: none"> <input type="radio"/> No <input type="radio"/> Probably no <input type="radio"/> Probably yes <input checked="" type="radio"/> Yes <input type="radio"/> Varies <input type="radio"/> Don't know 	Lung ultrasound and chest x-ray are non-invasive, painless, and not burdensome. Therefore, both are acceptable to most patients. This conclusion is based on the committee's non-systematic clinical observations.

Feasibility

Is the intervention feasible to implement?

JUDGEMENT	RESEARCH EVIDENCE
<input type="radio"/> No <input type="radio"/> Probably no <input checked="" type="radio"/> Probably yes <input type="radio"/> Yes <input type="radio"/> Varies <input type="radio"/> Don't know	Both chest x-ray and lung ultrasound are available in most clinical settings. The primary limiting factor is the availability of experience operators and interpreters of lung ultrasound. This conclusion is based on the committee's non-systematic clinical observations.

SUMMARY OF JUDGMENTS

	JUDGEMENT						
TEST ACCURACY	CXR a lot more	CXR slightly more	CXR and lung US are comparable	Lung US slightly more	Lung US a lot more	-	-
DESIRABLE EFFECTS	CXR a lot more	CXR slightly more	CXR and lung US are comparable	Lung US slightly more	Lung US a lot more	-	-
UNDESIRABLE EFFECTS	CXR a lot more	CXR slightly more	CXR and lung US are comparable	Lung US slightly more	Lung US a lot more	-	-
BALANCE OF EFFECTS	Favors CXR	Probably favors CXR	Does not favor either CXR or lung US	Probably favors lung US	Favors lung US	Varies	Don't know
QUALITY OF EVIDENCE OF TEST ACCURACY	Very low	Low	Moderate	High	No included studies	-	-
QUALITY OF EVIDENCE OF TEST RESULT/MANAGEMENT	Very low	Low	Moderate	High	No included studies	-	-
QUALITY OF EVIDENCE OF MANAGEMENT/OUTCOMES	Very low	Low	Moderate	High	No included studies	-	-
QUALITY OF EVIDENCE	Very low	Low	Moderate	High	No included studies	-	-
ACCEPTABILITY	No	Probably no	Probably yes	Yes	Varies	Don't know	-
FEASIBILITY	No	Probably no	Probably yes	Yes	Varies	Don't know	-

TYPE OF RECOMMENDATION

Strong recommendation for chest x-ray <input type="radio"/>	Conditional recommendation for chest x-ray <input type="radio"/>	Conditional recommendation for either chest x-ray or lung ultrasound <input checked="" type="radio"/>	Conditional recommendation for lung ultrasound <input type="radio"/>	Strong recommendation for lung ultrasound <input type="radio"/>
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CONCLUSIONS

Recommendation

For patients with suspected community-acquired pneumonia, we suggest that lung ultrasound be considered an acceptable alternative to chest x-rays in medical centers where the appropriate expertise exists (conditional recommendation, low quality of evidence).

Participation = 15/18 (83%)

Strong recommendation for chest x-ray = 0/15 (0%).

Conditional recommendation for chest x-ray = 1/15 (6.67%).

Strong recommendation for lung ultrasound = 0/15 (0%).

Condition recommendation for lung ultrasound = 1/15 (6.67%).

Conditional recommendation for either chest x-ray or lung ultrasound = 13/15 (86.67%).

PICO Question #2: Antibacterial therapy for CAP if a test for a respiratory virus is positive

Population: Adult CAP patients who test positive for a respiratory virus,

Intervention: Antibacterial therapy,

Comparator: No antibacterial therapy.

Outcomes:

Critical

Mortality (i.e. in-hospital, 28 day, 30 day, 60 day, 90 day, 180 day, <7% at 10 days)

Length of stay (i.e. hospital)

Treatment failure (i.e. decompensation, need for hospital admission, reasmission need for mechanical ventilation, need for vasopressor support, ICU transfer)

Clinical stability

Important

Antibiotic-associated adverse events (inc side effects and resistant organisms)

Secondary infection

Days of antibiotics

Return to function (work, exertion, home after hospitalization) or quality of life

Symptoms (i.e. total number, etc)

Cost

Search Strategy

Overall Question #1

((("antibiotic"[Title/Abstract]) OR ((("Anti-Bacterial Agents"[Mesh]) OR "Anti-Bacterial Agents" [Pharmacological Action]))) AND (((("Community-Acquired Infections"[MeSH Terms] OR ("community acquired"[All Fields] AND "infections"[All Fields]) OR "Community-Acquired Infections"[All Fields] OR ("community"[All Fields] AND "acquired"[All Fields] AND "infection"[All Fields])) OR "community acquired infection"[All Fields] OR "Community-Acquired Infections"[MeSH Terms])) AND ("pneumonia"[MeSH Terms] OR "pneumonia"[All Fields] OR "pneumonias"[All Fields] OR "pneumoniae"[All Fields] OR "pneumoniae s"[All Fields]))) AND (((("respiratory tract infections"[MeSH Terms] OR ("respiratory"[All Fields] AND "tract"[All Fields] AND "infections"[All Fields]) OR "respiratory tract infections"[All Fields])))))

Overall Question #1

((("communal"[All Fields] OR "communalism"[All Fields] OR "communalities"[All Fields] OR "communality"[All Fields] OR "communally"[All Fields] OR "commune"[All Fields] OR "communes"[All Fields] OR "community s"[All Fields] OR "communitys"[All Fields] OR "residence characteristics"[MeSH Terms] OR ("residence"[All Fields] AND "characteristics"[All Fields]) OR "residence characteristics"[All

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Indirect questions

((("antibiotic"[Title/Abstract] OR ("Anti-Bacterial Agents"[Mesh]) OR "Anti-Bacterial Agents"[Pharmacological Action])) AND ((("Community-Acquired Infections"[MeSH Terms] OR ("community acquired"[All Fields] AND "infections"[All Fields]) OR "Community-Acquired Infections"[All Fields] OR ("community"[All Fields] AND "acquired"[All Fields] AND "infection"[All Fields]) OR "community acquired infection"[All Fields] OR "Community-Acquired Infections"[MeSH Terms]) AND ("pneumonia"[MeSH Terms] OR "pneumonia"[All Fields] OR "pneumonias"[All Fields] OR "pneumoniae"[All Fields] OR "pneumoniae s"[All Fields])) AND ((("respiratory tract infections"[MeSH Terms] OR ("respiratory"[All Fields] AND "tract"[All Fields] AND "infections"[All Fields]) OR "respiratory tract infections"[All Fields] AND "anti bacterial agents/administration and dosage"[MeSH Terms]))))

Indirect population for Bronchitis

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Bronchitis

((("bronchitis"[MeSH Terms] OR "bronchitis"[All Fields] OR "bronchitides"[All Fields]) AND ("eur med j respir"[Journal] OR "respiratory"[All Fields]) AND ("virally"[All Fields] OR "virals"[All Fields] OR "virology"[MeSH Terms] OR "virology"[All Fields] OR "viral"[All Fields]) AND ("anti bacterial agents"[Pharmacological Action] OR "anti bacterial agents"[MeSH Terms] OR ("anti bacterial"[All Fields] AND "agents"[All Fields]) OR "anti bacterial agents"[All Fields] OR "antibiotic"[All Fields] OR "antibiotics"[All Fields] OR "antibiotic s"[All Fields] OR "antibiotical"[All Fields])) AND ((english[Filter] AND (alladult[Filter])))

Indirect population for Tracheobronchitis

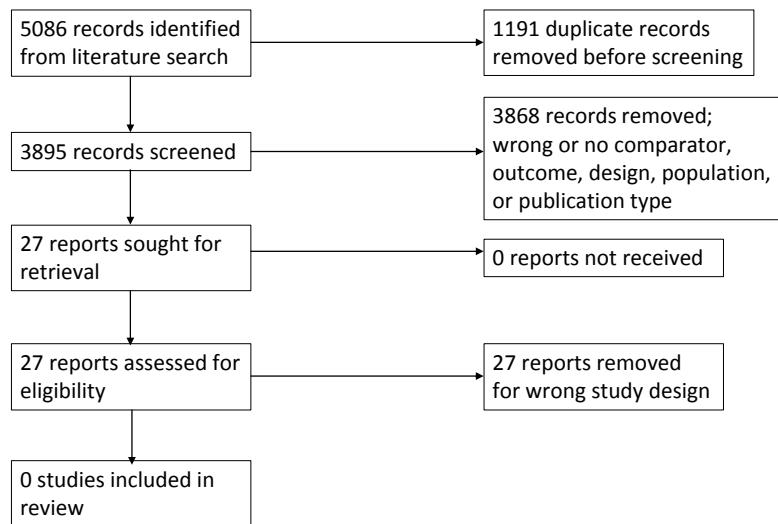
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("community acquired"[All Fields] AND "infections"[All Fields]) OR "Community-Acquired Infections"[All Fields] OR ("community"[All Fields] AND "acquired"[All Fields] AND "infection"[All Fields]) OR "community acquired infection"[All Fields] OR "Community-Acquired Infections"[MeSH Terms]) AND ("tracheobronchitis"[All Fields]) AND ("respiratory tract infections"[MeSH Terms] OR ("respiratory"[All Fields] AND "tract"[All Fields] AND "infections"[All Fields]) OR "respiratory tract infections"[All Fields]))

Tracheobronchitis

("tracheobronchitis"[All Fields] AND ((eur med j respir"[Journal] OR "respiratory"[All Fields]) AND ("virally"[All Fields] OR "virals"[All Fields] OR "virology"[MeSH Terms] OR "virology"[All Fields] OR "viral"[All Fields])) AND ("anti bacterial agents"[Pharmacological Action] OR "anti bacterial agents"[MeSH Terms] OR ("anti bacterial"[All Fields] AND "agents"[All Fields]) OR "anti bacterial agents"[All Fields] OR "antibiotic"[All Fields] OR "antibiotics"[All Fields] OR "antibiotic s"[All Fields] OR "antibiotical"[All Fields])) AND ((english[Filter]) AND (alladult[Filter])))

Figure S3: Flow of information diagram



Forest Plots

None

Evidence Profile

There are no studies (randomized or non-randomized) concerning CAP as diagnosed by signs, symptoms, and imaging that compare an antibiotic to no antibiotic regimen following the identification of a respiratory viral pathogen. Therefore, an evidence profile and evidence-to-decision table were not created. The committee informed its recommendations with non-comparative evidence and non-systematic clinical observations. In published investigations, the decision to continue or discontinue antibiotics after finding a viral pathogen included other considerations such as the likelihood of bacterial coinfection depending on the specific virus identified, the difficulty in excluding concomitant bacterial infections with available diagnostic techniques, and clinical stability of the patient.

PICO question #3: Antibiotic duration for CAP

Population: Adult patients with community acquired pneumonia

Intervention: Less than five days of antibiotics

Comparator: Five or more days of antibiotics

Outcomes

Critical

Mortality

Treatment success/failure

CAP-related complications

Important

Duration of hospitalization

Antibiotic-free days

Patient experience

Cost

Antibiotic resistance

Search Strategy

1. ("Pneumonia, Bacterial"[Mesh] OR "Pneumonia"[Mesh] OR "Chlamydial Pneumonia"[Mesh] OR "Pneumonia, Viral"[Mesh] OR "Pneumonia, Staphylococcal"[Mesh] OR "Pneumonia, Mycoplasma"[Mesh] OR "Pneumonia, Pneumococcal"[Mesh] OR "Respiratory Tract Infections"[Mesh]) AND ("Community-Acquired Infections"[Mesh]) AND ("anti bacterial agents"[Pharmacological Action] OR "anti bacterial agents"[MeSH Terms] OR ("anti bacterial"[All Fields] AND "agents"[All Fields]) OR "anti bacterial agents"[All Fields] OR "antibiotic"[All Fields] OR "antibiotics"[All Fields] OR "antibiotics"[All Fields] OR "antibiotical"[All Fields] OR "antibacterial agents"[Pharmacological Action] OR "anti bacterial agents"[MeSH Terms] OR ("anti bacterial"[All Fields] AND "agents"[All Fields]) OR "antibacterial agents"[All Fields] OR "antibacterial"[All Fields] OR "antibacterials"[All Fields] OR "antibacterially"[All Fields])) OR "Therapeutics"[Mesh] OR "therapy" [Subheading]) AND ("Duration of Therapy"[Mesh])
2. AND (English[Language]) AND (humans[Filter]) NOT ("infant"[mesh] OR "child"[mesh] OR adolescent"[mesh])
3. ("Pneumonia, Bacterial"[Mesh]) AND "Duration of Therapy"[Mesh]

Community acquired pneumonia treatment duration

4. Reference search of other identified studies

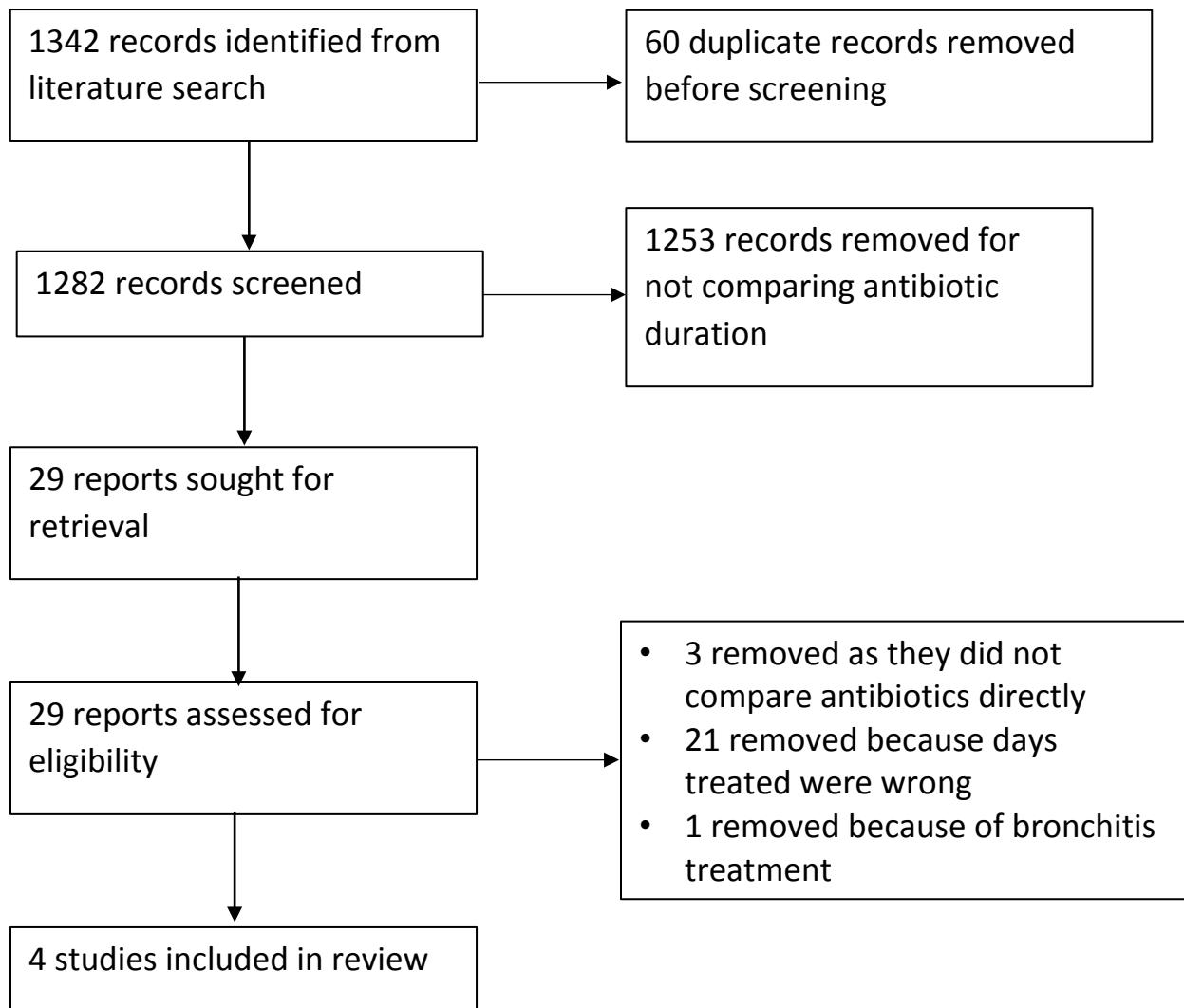
Figure S4: Flow of information diagram

Table S4: Studies selected

Study	Type of study	Location	Number of subjects (I/C)	Population	Outcomes
¹El Moussaoui - 2006	RCT	Netherlands	119 (56/63)	Inpatients	Clinical cure
²D'Ignazio - 2004	RCT	Worldwide (Canada, Chile, India, Lithuania, Mexico, Peru, Russia, and United States)	363 (174/189)	Outpatients	Clinical cure
³Dinh - 2021	RCT	France	310 (157/153)	Inpatients	Mortality, clinical cure, length of stay
⁴Drehobl - 2005	RCT	Worldwide (United States, Canada, Argentina, Russia, India, Estonia, and Lithuania)	411 (202/209)	Outpatients	Clinical cure

RCT=randomized controlled trial; I=intervention; C=control

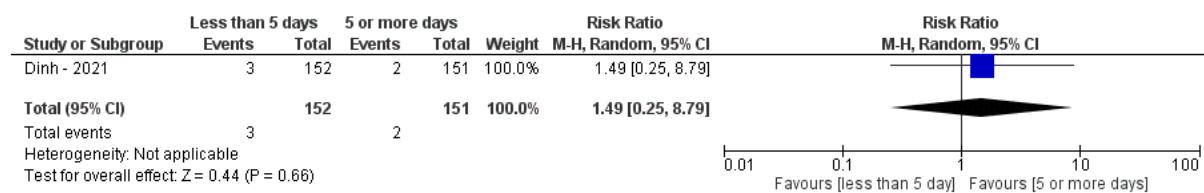
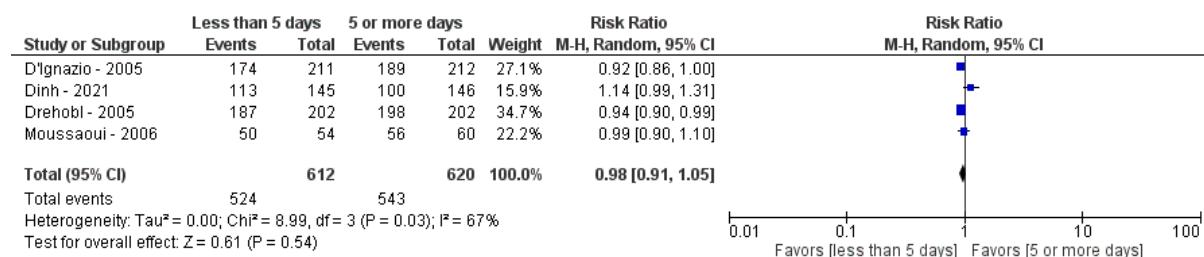
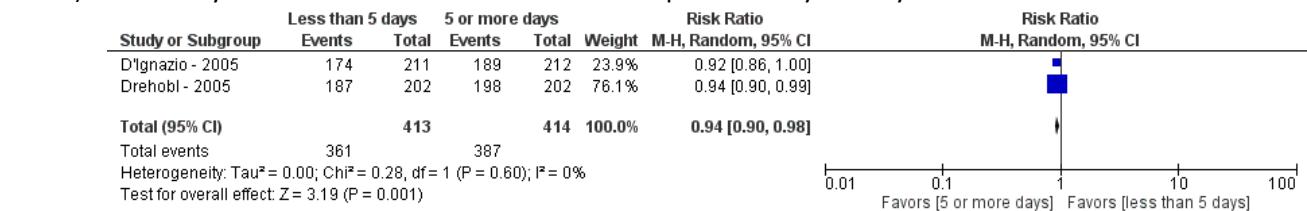
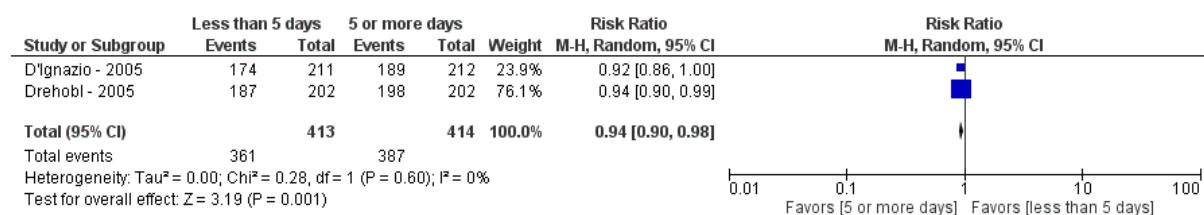
1. El Moussaoui, R., de Borgie, C. A., van den Broek, P., Hustinx, W. N., Bresser, P., van den Berk, G. E., Poley, J. W., van den Berg, B., Krouwels, F. H., Bonten, M. J., Weenink, C., Bossuyt, P. M., Speelman, P., Opmeer, B. C., Prins, J. M.. Effectiveness of discontinuing antibiotic treatment after three days versus eight days in mild to moderate-severe community acquired pneumonia: randomised, double blind study. *Bmj*; Jun 10 2006.
2. D'Ignazio, J., Camere, M. A., Lewis, D. E., Jorgensen, D., Breen, J. D.. Novel, single-dose microsphere formulation of azithromycin versus 7-day levofloxacin therapy for treatment of mild to moderate community-acquired Pneumonia in adults. *Antimicrob Agents Chemother*; Oct 2005
3. Dinh, A., Ropers, J., Duran, C., David, B., Deconinck, L., Matt, M., Senard, O., Lagrange, A., Makhloufi, S., Mellon, G., de Lastours, V., Bouchand, F., Mathieu, E., Kahn, J. E., Rouveix, E., Grenet, J., Dumoulin, J., Chinet, T., Pépin, M., Delcey, V., Diamantis, S., Benhamou, D., Vitrat, V., Dombret, M. C., Renaud, B., Perronne, C., Claessens, Y. E., Labarère, J., Bedos, J. P., Aegerter, P., Crémieux, A. C.. Discontinuing β -lactam treatment after 3 days for patients with community-acquired pneumonia in non-critical care wards (PTC): a double-blind, randomised, placebo-controlled, non-inferiority trial. *Lancet*; Mar 27 2021.
4. Drehobl, M. A., De Salvo, M. C., Lewis, D. E., Breen, J. D.. Single-dose azithromycin microspheres vs clarithromycin extended release for the treatment of mild-to-moderate community-acquired pneumonia in adults. *Chest*; Oct 2005.

Table S5: Study Interventions

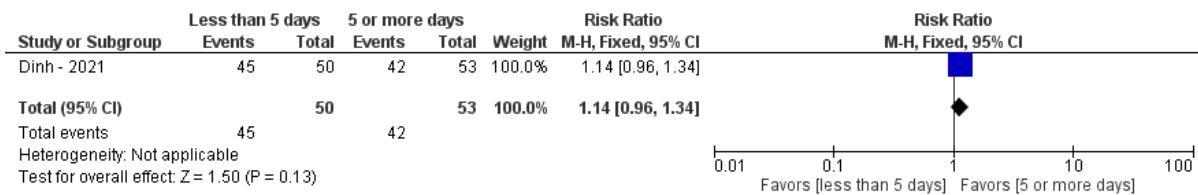
Study	Antibiotics (I VS C)	Intervention days	Control days
Inpatient			
¹ El Moussaoui - 2006	Patients who improved after 3 days of IV amoxicillin were randomized to placebo or 750 mg of oral amoxicillin TID	3	8
² Dinh - 2021	After 72 hours of beta-lactam treatment, patients were randomized to receive placebo or 500 mg amoxicillin plus 62.5 mg of clavulanate TID	3	8
Outpatient			
³ D'Ignazio - 2004	A single 2 gm dose azithromycin microspheres vs 500 mg oral levofloxacin	1	7
⁴ Drehobl - 2005	A single 2 gm dose azithromycin microspheres vs clarithromycin	1	7

I=intervention; C=control; TID=three times daily

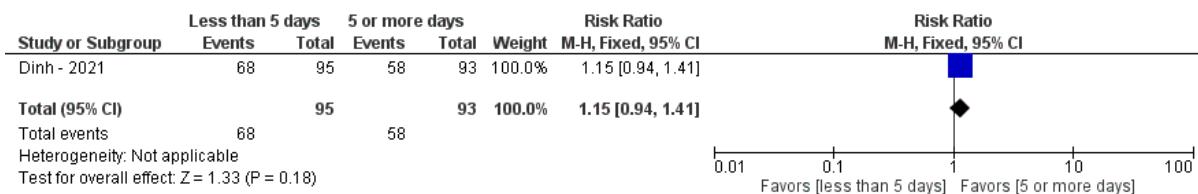
1. El Moussaoui, R., de Borgie, C. A., van den Broek, P., Hustinx, W. N., Bresser, P., van den Berk, G. E., Poley, J. W., van den Berg, B., Krouwels, F. H., Bonten, M. J., Weenink, C., Bossuyt, P. M., Speelman, P., Opmeer, B. C., Prins, J. M.. Effectiveness of discontinuing antibiotic treatment after three days versus eight days in mild to moderate-severe community acquired pneumonia: randomised, double blind study. *Bmj*; Jun 10 2006.
2. Dinh, A., Ropers, J., Duran, C., Davido, B., Deconinck, L., Matt, M., Senard, O., Lagrange, A., Makhlofi, S., Mellon, G., de Lastours, V., Bouchand, F., Mathieu, E., Kahn, J. E., Rouveix, E., Grenet, J., Dumoulin, J., Chinet, T., Pépin, M., Delcey, V., Diamantis, S., Benhamou, D., Vitrat, V., Dombret, M. C., Renaud, B., Perronne, C., Claessens, Y. E., Labarère, J., Bedos, J. P., Aegerter, P., Crémieux, A. C.. Discontinuing β-lactam treatment after 3 days for patients with community-acquired pneumonia in non-critical care wards (PTC): a double-blind, randomised, placebo-controlled, non-inferiority trial. *Lancet*; Mar 27 2021.
3. D'Ignazio, J., Camere, M. A., Lewis, D. E., Jorgensen, D., Breen, J. D.. Novel, single-dose microsphere formulation of azithromycin versus 7-day levofloxacin therapy for treatment of mild to moderate community-acquired Pneumonia in adults. *Antimicrob Agents Chemother*; Oct 2005
4. Drehobl, M. A., De Salvo, M. C., Lewis, D. E., Breen, J. D.. Single-dose azithromycin microspheres vs clarithromycin extended release for the treatment of mild-to-moderate community-acquired pneumonia in adults. *Chest*; Oct 2005.

Figure S5: Forest Plots**A) Analysis #1: Overall all-cause mortality****B) Analysis #2: Clinical cure – short follow-up (1-2 weeks)****C) Sub-analysis #2.1: Clinical cure – short follow-up: azithromycin only****D) Sub-analysis #2.2: Clinical cure – short follow-up: outpatient only****E) Sub-analysis #2.3: Clinical cure – short follow-up: inpatient only**

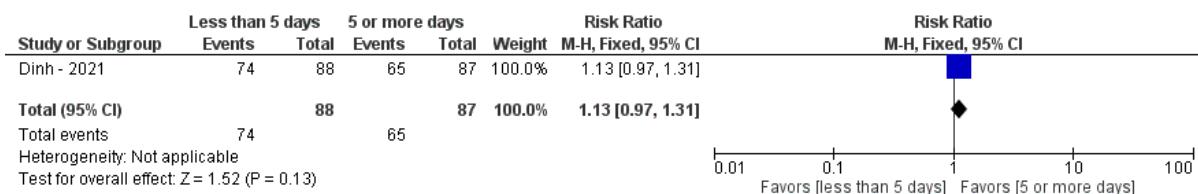
F) Sub-analysis #2.4: Clinical cure – short follow-up: PSI score <71



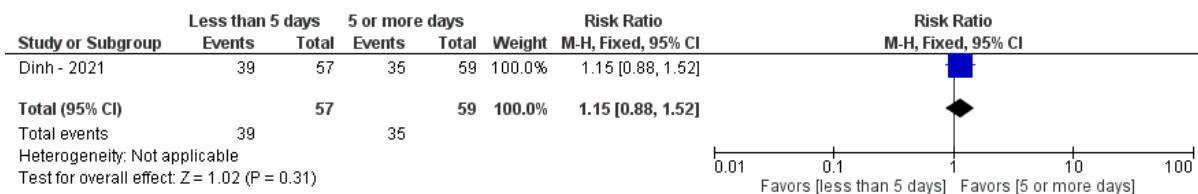
G) Sub-analysis #2.5: Clinical cure – short follow-up: PSI score >70



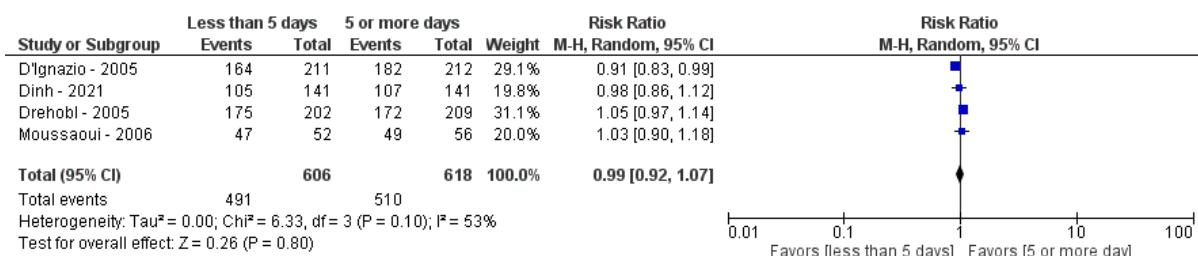
H) Sub-analysis #2.6: Clinical cure – short follow-up: PSI score <91



I) Sub-analysis #2.7: Clinical cure – short follow-up: PSI score >90



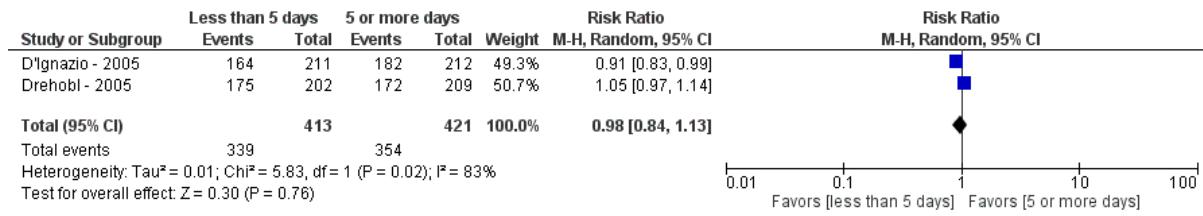
J) Analysis #3: Clinical cure – long follow-up (3-4 weeks)



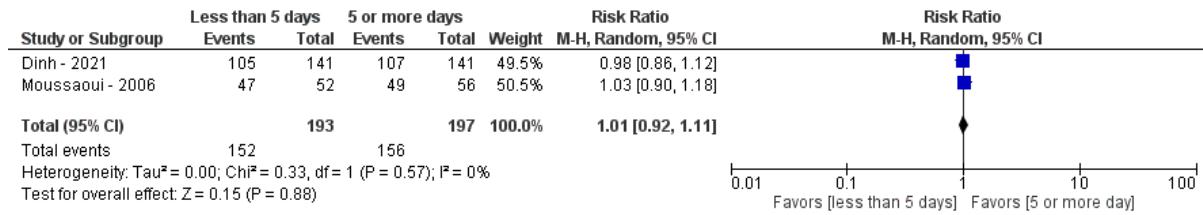
K) Sub-analysis #3.1: Clinical cure – long follow-up: azithromycin only



L) Sub-analysis #3.2: Clinical cure – long follow-up: outpatient only



M) Sub-analysis #3.3: Clinical cure – long follow-up: inpatient only



N) Analysis #4: Hospital length of stay

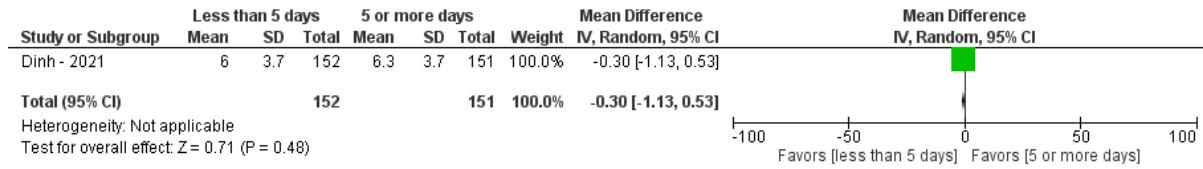


Table S6: Evidence Profiles**Table S6.1**

Population: Adult outpatients and inpatients with CAP who reach clinical stability
 Comparison: Less than five days of antibiotics versus five or more days of antibiotics
 Setting: All patients (outpatients and inpatients)

Certainty assessment							Nº of patients		Effect		Certainty	Importance
Nº of studies	Study design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	less than 5 days	5 or more days	Relative (95% CI)	Absolute (95% CI)		
Clinical cure rate at 1-2 weeks												
4 ^{1,2,3,4}	RCT	Not serious ⁵	Serious ⁶	Not serious	Serious ⁷	none	524/612 (85.6%)	543/620 (87.6%)	RR 0.98 (0.91 to 1.05)	18 fewer per 1,000 (from 79 fewer to 44 more)	⊕⊕○○ Low	CRITICAL
Clinical cure rate at 3-4 weeks												
4 ^{1,2,3,4}	RCT	Not serious ⁵	Serious ⁶	Not serious	Serious ⁷	none	491/606 (81.0%)	510/618 (82.5%)	RR 0.99 (0.92 to 1.07)	8 fewer per 1,000 (from 66 fewer to 58 more)	⊕⊕○○ Low	CRITICAL

CI: confidence interval; RCT: randomized controlled trial; RR: risk ratio

Footnotes:

1. el Moussaoui, R., de Borgie, C. A., van den Broek, P., Hustinx, W. N., Bresser, P., van den Berk, G. E., Poley, J. W., van den Berg, B., Krouwels, F. H., Bonten, M. J., Weenink, C., Bossuyt, P. M., Speelman, P., Opmeer, B. C., Prins, J. M.. Effectiveness of discontinuing antibiotic treatment after three days versus eight days in mild to moderate-severe community acquired pneumonia: randomised, double blind study. *Bmjj*; Jun 10 2006.
2. Drehobl, M. A., De Salvo, M. C., Lewis, D. E., Breen, J. D.. Single-dose azithromycin microspheres vs clarithromycin extended release for the treatment of mild-to-moderate community-acquired pneumonia in adults. *Chest*; Oct 2005.
3. Dinh, A., Ropers, J., Duran, C., Davido, B., Deconinck, L., Matt, M., Senard, O., Lagrange, A., Makhloifi, S., Mellon, G., de Lastours, V., Bouchand, F., Mathieu, E., Kahn, J. E., Rouveix, E., Grenet, J., Dumoulin, J., Chinet, T., Pépin, M., Delcey, V., Diamantis, S., Benhamou, D., Vitrat, V., Dombret, M. C., Renaud, B., Perronne, C., Claessens, Y. E., Labarère, J., Bedos, J. P., Aegerter, P., Crémieux, A. C.. Discontinuing β -lactam treatment after 3 days for patients with community-acquired pneumonia in non-critical care wards (PTC): a double-blind, randomised, placebo-controlled, non-inferiority trial. *Lancet*; Mar 27 2021.
4. D'Ignazio, J., Camere, M. A., Lewis, D. E., Jorgensen, D., Breen, J. D.. Novel, single-dose microsphere formulation of azithromycin versus 7-day levofloxacin therapy for treatment of mild to moderate community-acquired Pneumonia in adults. *Antimicrob Agents Chemother*; Oct 2005.
5. Risk of bias: Studies with minor protocol violations judged insufficient to warrant downgrading.
6. Inconsistency: Significant heterogeneity (defined as p -het <0.05 or $I^2 > 50\%$).
7. Imprecision: Wide confidence intervals, the ends of the confidence interval are likely to lead to different courses of action.

Table S6.2

Population: Adult outpatients with CAP who reach clinical stability

Comparison: Less than five days of antibiotics versus five or more days of antibiotics

Setting: Outpatients

No of studies	Study design	Risk of bias	Certainty assessment				No of patients		Effect		Certainty	Importance
			Inconsistency	Indirectness	Imprecision	Other considerations	less than 5 days	5 or more days	Relative (95% CI)	Absolute (95% CI)		
Clinical cure rate at 1-2 weeks												
2 ^{1,2}	RCT	Not serious ³	Not serious	Not serious	Not serious	none	361/413 (87.4%)	387/414 (93.5%)	RR 0.94 (0.90 to 0.98)	56 fewer per 1,000 (from 93 fewer to 19 fewer)	⊕○○○ Moderate	CRITICAL
Clinical cure rate at 3-4 weeks												
2 ^{1,2}	RCT	Not serious ³	Serious ⁴	Not serious	Serious ⁵	none	339/413 (82.1%)	354/421 (84.1%)	RR 0.98 (0.84 to 1.13)	17 fewer per 1,000 (from 135 fewer to 109 more)	⊕⊕○○ Low	CRITICAL

CI: confidence interval; RCT: randomized controlled trial; RR: risk ratio

Footnotes:

1. Drehobl, M. A., De Salvo, M. C., Lewis, D. E., Breen, J. D.. Single-dose azithromycin microspheres vs clarithromycin extended release for the treatment of mild-to-moderate community-acquired pneumonia in adults. *Chest*; Oct 2005.
2. D'Ignazio, J., Camere, M. A., Lewis, D. E., Jorgensen, D., Breen, J. D.. Novel, single-dose microsphere formulation of azithromycin versus 7-day levofloxacin therapy for treatment of mild to moderate community-acquired Pneumonia in adults. *Antimicrob Agents Chemother*; Oct 2005.
3. Risk of bias: Studies with minor protocol violations judged insufficient to warrant downgrading.
4. Inconsistency: Significant heterogeneity (defined as $p\text{-het} < 0.05$ or $I^2 > 50\%$).
5. Imprecision: Wide confidence intervals, the ends of the confidence interval are likely to lead to different courses of action.

Table S6.3

Population: Adult inpatients with CAP who reach clinical stability

Comparison: Less than five days of antibiotics versus five or more days of antibiotics

Setting: Inpatients

Nº of studies	Study design	Risk of bias	Certainty assessment				Nº of patients		Effect		Certainty	Importance
			Inconsistency	Indirectness	Imprecision	Other considerations	less than 5 days	5 or more days	Relative (95% CI)	Absolute (95% CI)		
Overall mortality												
1 ¹	RCT	Not serious ²	Not serious	Not serious	Serious ³	none	17/535 (3.2%)	18/371 (4.9%)	RR 0.63 (0.27 to 1.49)	18 fewer per 1,000 (from 35 fewer to 24 more)	⊕○○○ Moderate	CRITICAL
Clinical cure rate at 1-2 weeks												
2 ¹⁴	RCT	Not serious ²	Serious ⁵	Not serious	Serious ³	none	163/199 (81.9%)	156/206 (75.7%)	RR 1.06 (0.90 to 1.24)	45 more per 1,000 (from 76 fewer to 182 more)	⊕⊕○○ Low	CRITICAL
Clinical cure rate at 3-4 weeks												
2 ¹⁴	RCT	Not serious ²	Not serious	Not serious	Serious ³	none	152/193 (78.8%)	156/197 (79.2%)	RR 1.01 (0.92 to 1.11)	8 more per 1,000 (from 63 fewer to 87 more)	⊕○○○ Moderate	CRITICAL
Hospital length of stay												
1 ¹	RCT	Not serious	Not serious	Not serious	Serious ³	none	172	171	-	MD 0.35 lower (1.17 lower to 0.47 higher)	⊕○○○ Moderate	IMPORTANT

CI: confidence interval; RR: risk ratio; MD: mean difference.

Footnotes:

1. Dinh, A., Ropers, J., Duran, C., Davido, B., Deconinck, L., Matt, M., Senard, O., Lagrange, A., Makhloifi, S., Mellon, G., de Lastours, V., Bouchard, F., Mathieu, E., Kahn, J. E., Rouveix, E., Grenet, J., Dumoulin, J., Chinet, T., Pépin, M., Delcey, V., Diamantis, S., Benhamou, D., Vitrat, V., Dombret, M. C., Renaud, B., Perronne, C., Claessens, Y. E., Labarère, J., Bedos, J. P., Aegerter, P., Crémieux, A. C.. Discontinuing β -lactam treatment after 3 days for patients with community-acquired pneumonia in non-critical care wards (PTC): a double-blind, randomised, placebo-controlled, non-inferiority trial. *Lancet*; Mar 27 2021.
2. Risk of bias: Minor protocol violations, judged not severe enough to warrant downgrading.
3. Imprecision: wide confidence intervals, the ends of the confidence interval are likely to lead to different courses of action .
4. el Moussaoui, R., de Borgie, C. A., van den Broek, P., Hustinx, W. N., Bresser, P., van den Berk, G. E., Poley, J. W., van den Berg, B., Krouwels, F. H., Bonten, M. J., Weenink, C., Bossuyt, P. M., Speelman, P., Opmeer, B. C., Prins, J. M.. Effectiveness of discontinuing antibiotic treatment after three days versus eight days in mild to moderate-severe community acquired pneumonia: randomised, double blind study. *Bmj*; Jun 10 2006.
5. Inconsistency: Significant heterogeneity (defined as p -het <0.05 or $I^2 > 50\%$).

PICO Question #4: Systemic corticosteroids for CAP

Population: Hospitalized adult CAP patients

Intervention: Corticosteroids

Comparator: No corticosteroids

Outcomes:

Critical

Mortality

Treatment/clinical failure

Clinical stability

Adverse drug events

Important

Symptoms

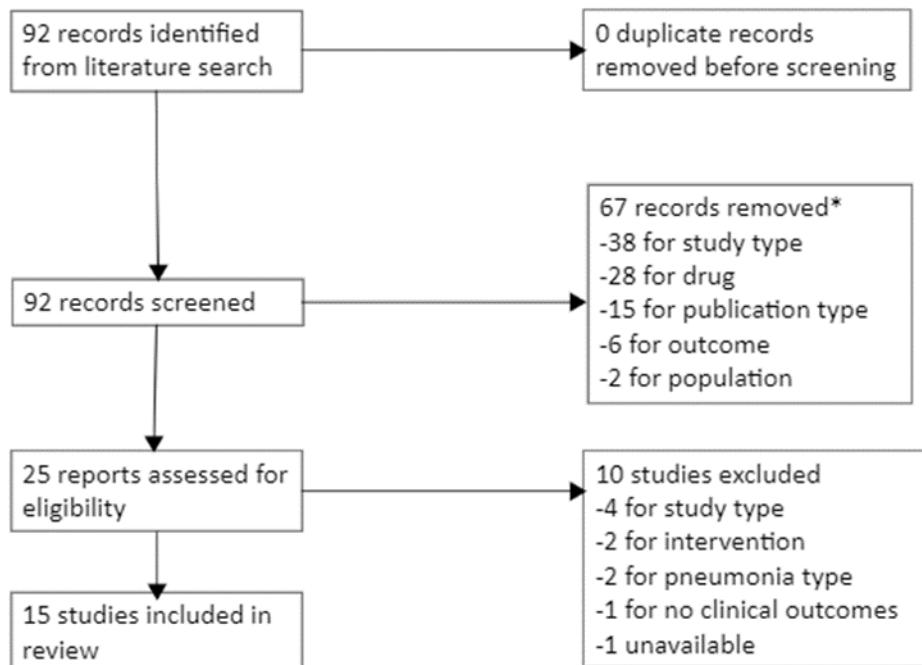
Disability or return to independence/function

Length of stay

Antibiotic days

Search strategy

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Figure S7: Flow of information diagram

**some studies removed for multiple reasons*

Table S7: Studies selected

Study	Type of Study	Location	Number of Subjects	Population	Intervention	Outcomes	Risk of Bias
Blum 2015	RCT	Switzerland	785	Hospital admission with CAP ^a	Prednisone 50 mg daily for 7 days	Mortality Clinical stability Adverse drug events Length of stay Antibiotic duration	None
Confalonieri 2005	RCT	Italy	46	ICU admission with severe CAP ^{b,c}	Hydrocortisone 200 mg IV bolus followed by 10 mg/hour for 7 days	Mortality Adverse drug events Length of stay	Serious
Dequin 2023	RCT	France	800	ICU admission with severe CAP ^d	Hydrocortisone 200 mg per day for 4 days with predefined criteria to administer for a total of 8 or 14 days with gradual taper	Mortality Adverse drug events	Serious
Fernandez 2011	RCT	Spain	45	Hospital admission with CAP ^e	Methylprednisolone 200 mg IV Followed by 20 mg/6 h for 3 days, then 20 mg/12 h for 3 days, then 20 mg/day for 3 days	Mortality Length of stay	Serious
Fitzgerald 2022	RCT	Multinational	79	Hospital admission with CAP and new pleural effusion	Dexamethasone 4 mg IV every 12 hours for 48 hours	Clinical stability Adverse drug events	Very Serious

						Length of stay Antibiotic duration	
Marik 1993	RCT	South Africa	30	ICU admission with CAP ^f	Hydrocortisone 10 mg/kg	Mortality Length of stay	Very Serious
Meduri 2022	RCT	USA	584	ICU admission with severe CAP ^g	Methylprednisolone 40 mg IV, then 40 mg/day days 1-7, 20 mg/day days 8-14, 12 mg/day days 15-17, and 4 mg/day days 18-20	Mortality Adverse drug events Length of stay	Serious
Meijvis 2011	RCT	Netherlands	304	Hospital admission with CAP ^h	Dexamethasone 5 mg IV followed by 5 mg daily for 3 days	Mortality Length of stay Antibiotic duration	None
Mikami 2007	RCT	Japan	31	Hospital admission with CAP ⁱ	Prednisolone 40 mg IV daily for 3 days	Length of stay Antibiotic duration	Very Serious
Nafae 2013	RCT	Egypt	80	Hospital admission with CAP ^h	Hydrocortisone 200 mg IV bolus followed by 10 mg/hour for 7 days	Mortality Length of stay Antibiotic duration	Serious
Sabry 2011	RCT	Egypt	80	ICU admission with CAP ^g	Hydrocortisone 200 mg IV bolus followed by 12.5 mg/hour for 7 days	Mortality	Serious
Snijders 2010	RCT	Netherlands	213	Hospital admission with CAP ^j	Prednisone 40 mg daily for 7 days	Mortality Treatment failure Clinical stability	Serious

						Adverse drug events	
						Length of stay	
Torres 2015	RCT	Spain	120	Hospital admission with severe CAP ^{c,h}	Methylprednisolone 0.5 mg/kg IV every 12 hours for 5 days	Mortality Treatment failure Clinical stability Length of stay	Serious
Wagner 1956	RCT	USA	113	Hospital admission with confirmed pneumococcal pneumonia	Hydrocortisone PO 80 mg once, then 60 mg every 6 hours for 3 doses, then 40 mg every 6 hours for 4 doses, then 20 mg every 6 hours for 4 doses, then 10 mg every 6 hours for 4 doses, then 10 mg every 12 hours for 2 doses	Mortality	Very Serious
Wittermans 2021	RCT	Netherlands	412	Hospital admission with CAP ^k	Dexamethasone 6 mg PO daily for 4 days	Mortality Length of stay	Serious

^aNiederman MS, Mandell LA, Anzueto A, et al. Guidelines for the management of adults with community-acquired pneumonia. Diagnosis, assessment of severity, antimicrobial therapy, and prevention. *Am J Respir Crit Care Med* 2001;163:1730–54.

^bNiederman MS, Bass JB Jr, Campbell GD, et al. Guidelines for the initial management of adults with community-acquired pneumonia: diagnosis, assessment of severity, and initial antimicrobial therapy. American Thoracic Society. Medical Section of the American Lung Association. *Am Rev Respir Dis* 1993;148:1418–1426.

^cEwig S, Ruiz M, Mensa J, et al. Severe community-acquired pneumonia: assessment of severity criteria. *Am J Respir Crit Care Med* 1998;158:1102–1108.

^dDiagnosis of Community-Acquired Pneumonia (CAP) suggested by at least two of the following: cough, purulent sputum, chest pain, dyspnea + Focal shadowing/infiltrate on chest X-ray or CT-scan + one of the following: Pneumonia Severity Index (PSI) > 130 (Fine class V), Patient placed on mechanical ventilation (invasive or not) for acute respiratory failure, with a PEEP level of 5 cm of water or more, Patient treated by high-flow oxygen therapy with a FiO₂ of 50% or more and a PaO₂:FiO₂ ratio lower than 300, or Patient treated by oxygen therapy with a partial rebreathing-mask with a reservoir bag,

provided that the PaO₂ is less than 180 mmHg for oxygen flow 6 L/min, 210 mmHg for oxygen flow 7 L/min, 240 mmHg for 8 L/min, 270 mmHg for 9 L/min, or 300 mHg for 10 L/min or more

^ePneumonia based on presence of a lung radiographic opacity and at least two of the following conditions: fever (>38.5°C), purulent expectoration, pleuritic chest pain, or leukocytosis (white blood cell count of >10,000/mm³) + with extensive radiographic consolidations (affecting at least two lobes) and respiratory failure (ratio of partial O₂ pressure to the fraction of inspired O₂, <300)

^fBritish Thoracic Society Research Committee. Community-acquired pneumonia in adults in British Hospitals in 1982-1983: a survey of aetiology, mortality, prognostic factors and outcome. *Q J Med* 1987;62:195-220

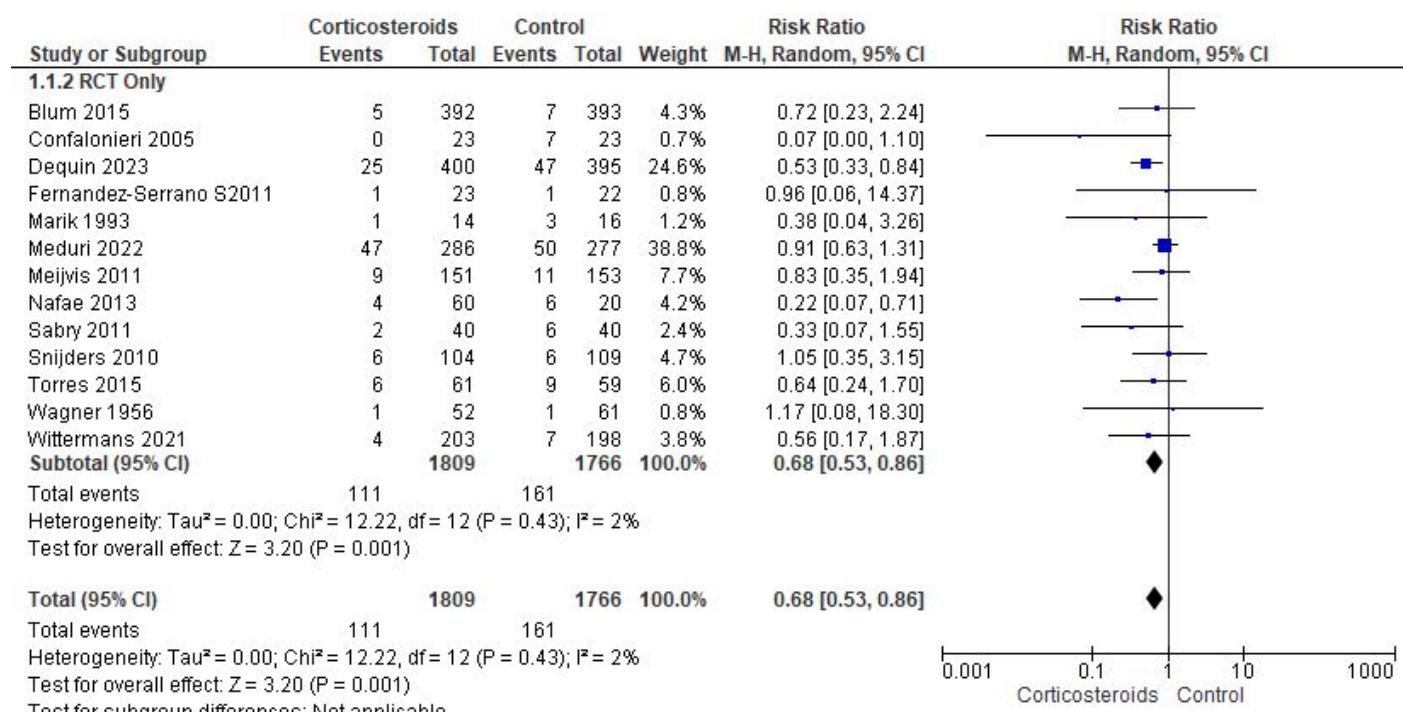
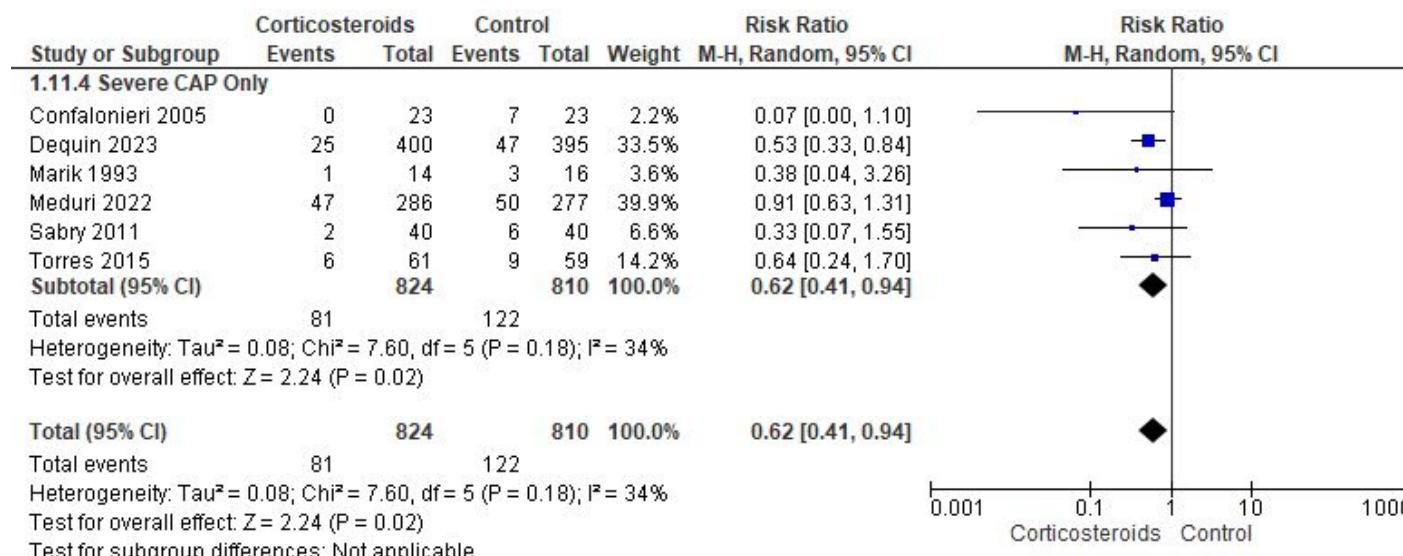
^gMandell LA, Wunderink RG, Anzueto A, et al. Infectious diseases society of America/American Thoracic Society consensus guidelines on the management of community-acquired pneumonia in adults. 2007; *Clin Infect Dis* 44(Suppl 2):S27-72

^hFine MJ, Singer DE, Hanusa BH, et al. Validation of a pneumonia prognostic index using the MedisGroups Comparative Hospital Database. *Am J Med* 993;94:153-59.

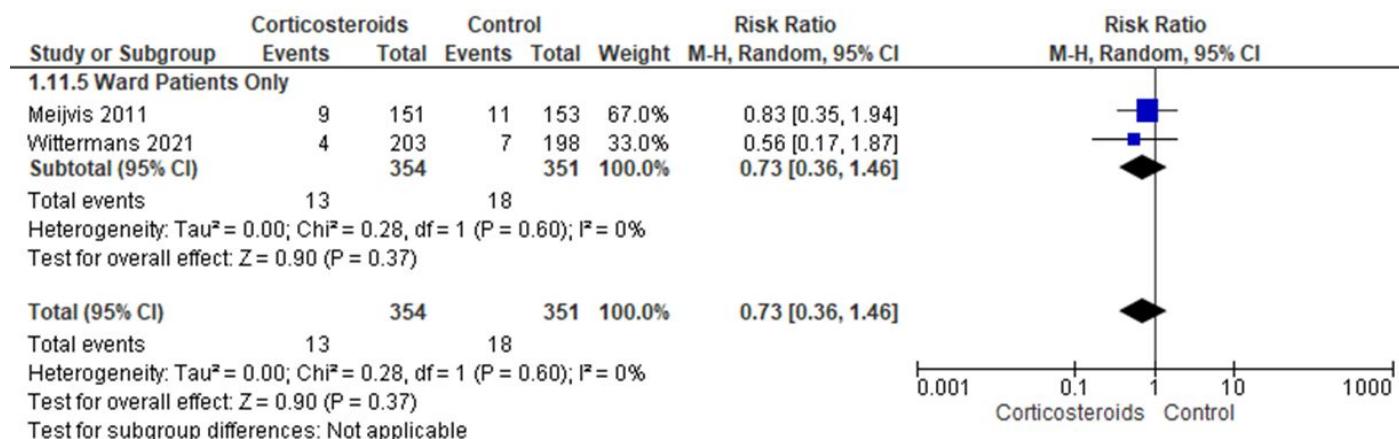
ⁱClinical signs and symptoms of lower respiratory tract infections + Radiographic abnormalities consistent with infection neither preexisting nor caused by any other previous conditions

^jClinical symptoms suggestive of CAP: cough (with or without sputum), fever (.38.58C), pleuritic chest pain, or dyspnea + new consolidations on chest radiograph.

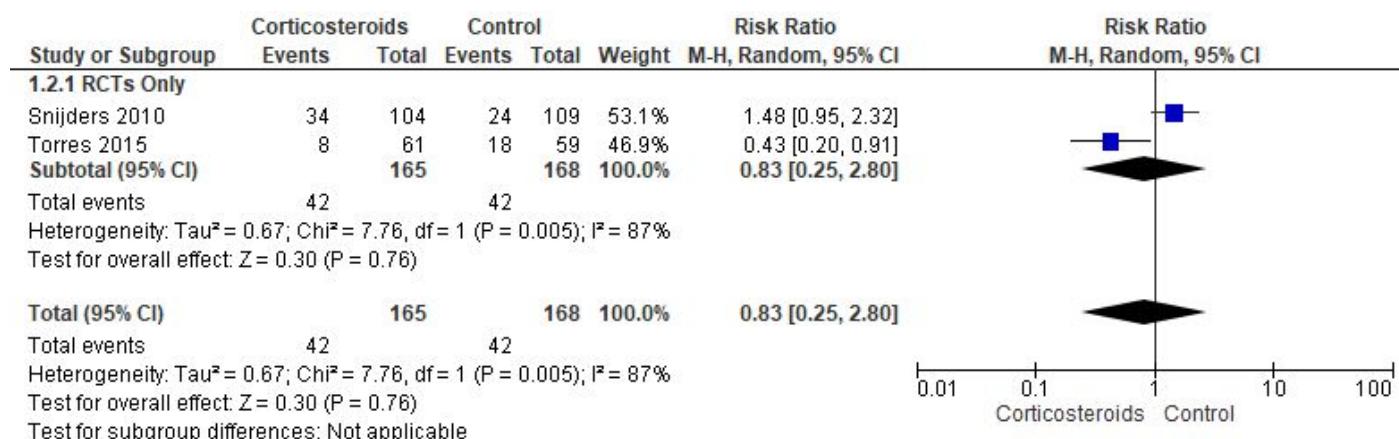
^kNew opacities on chest radiography, and two of the following signs and symptoms: cough, production of sputum, temperature >38.0°C or <36.0°C, abnormalities at auscultation consistent with pneumonia, C-reactive protein (CRP) >15 mg/L, white blood cell count >10×10⁹ or <4×10⁹ cell/L, or >10% of bands in leukocyte differentiation

Figure S8: Forest plots**A) Analysis #1: Mortality in CAP****B) Analysis #2: Mortality in Severe CAP**

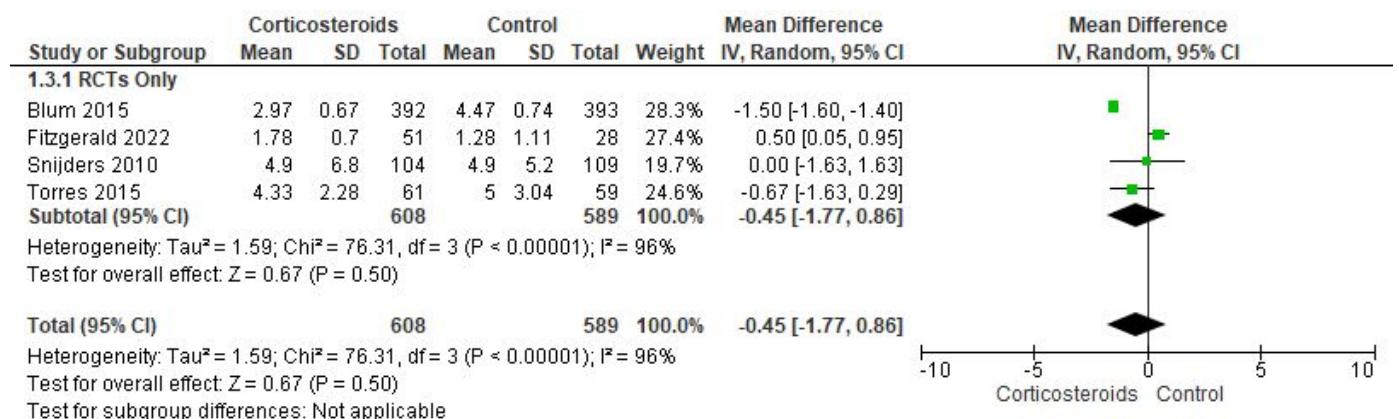
C) Analysis #3: Mortality in CAP Patients Admitted to Ward



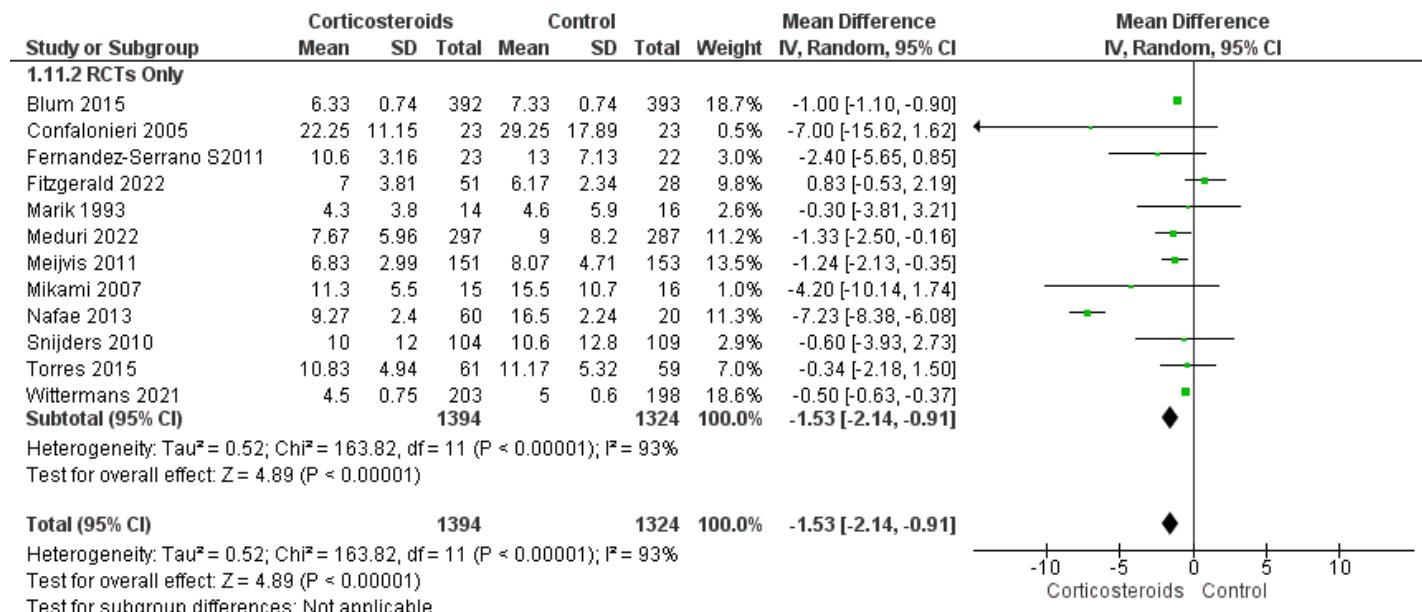
D) Analysis #4: Treatment Failure in CAP



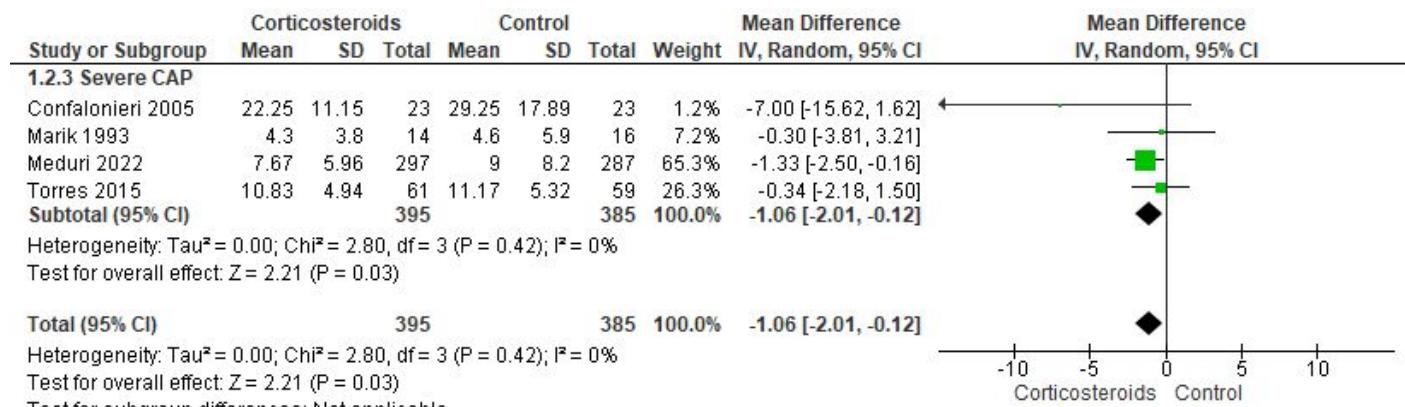
E) Analysis #5: Clinical Stability in CAP



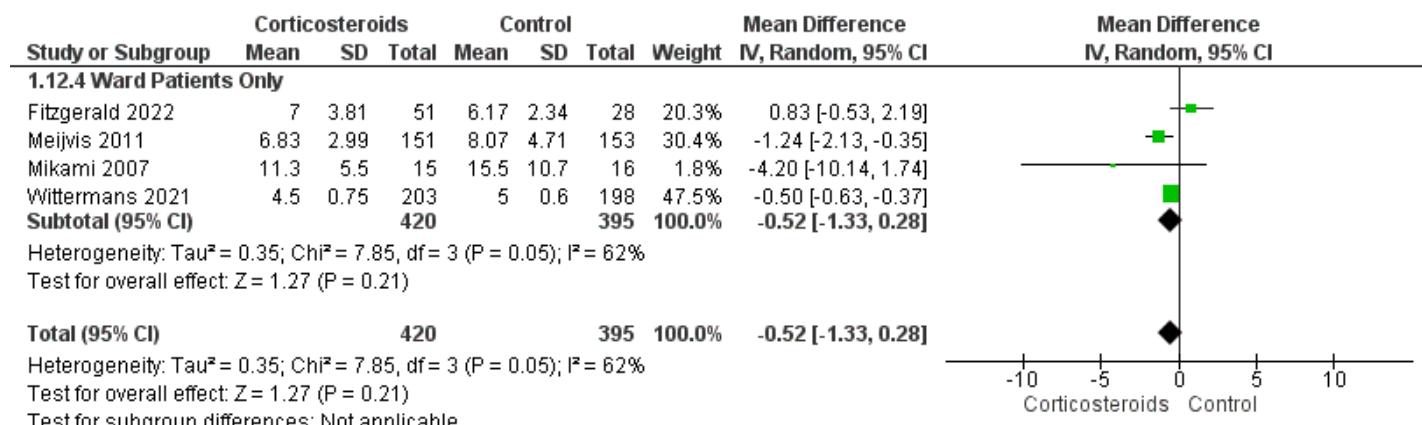
F) Analysis #6: Length of Stay in CAP



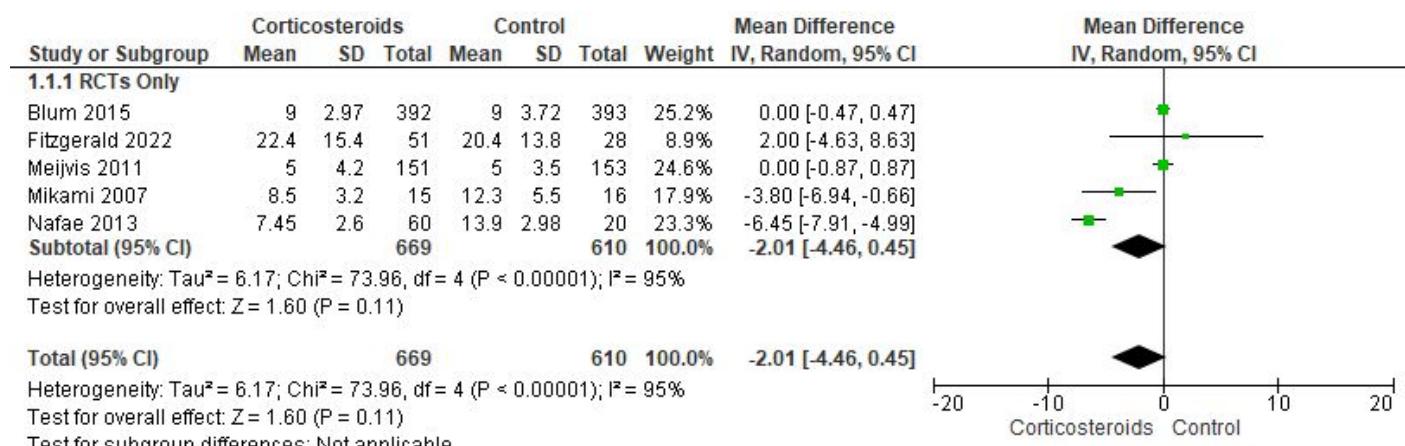
G) Analysis #7: Length of Stay in Severe CAP



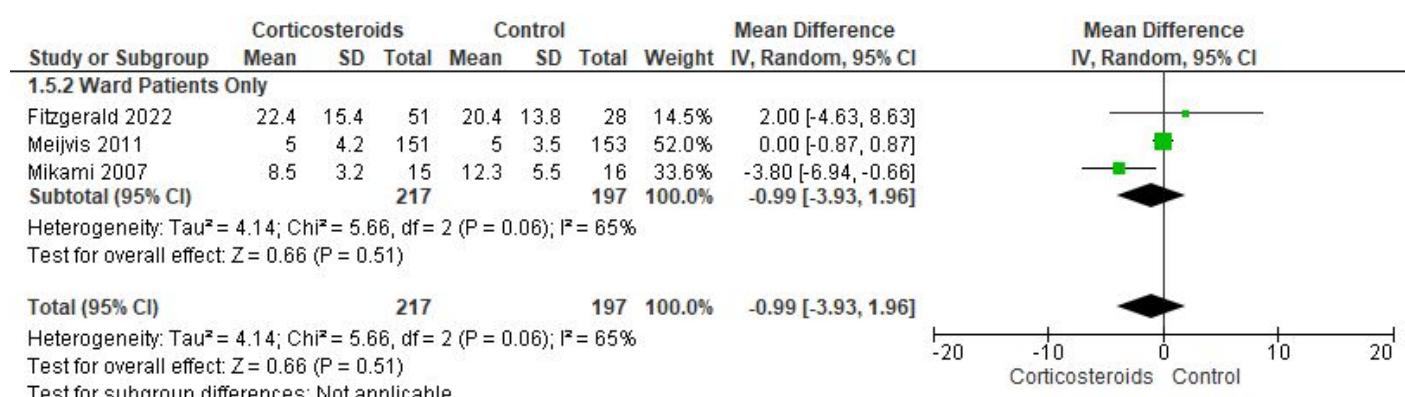
H) Analysis #8: Length of Stay in CAP Patients Admitted to Ward



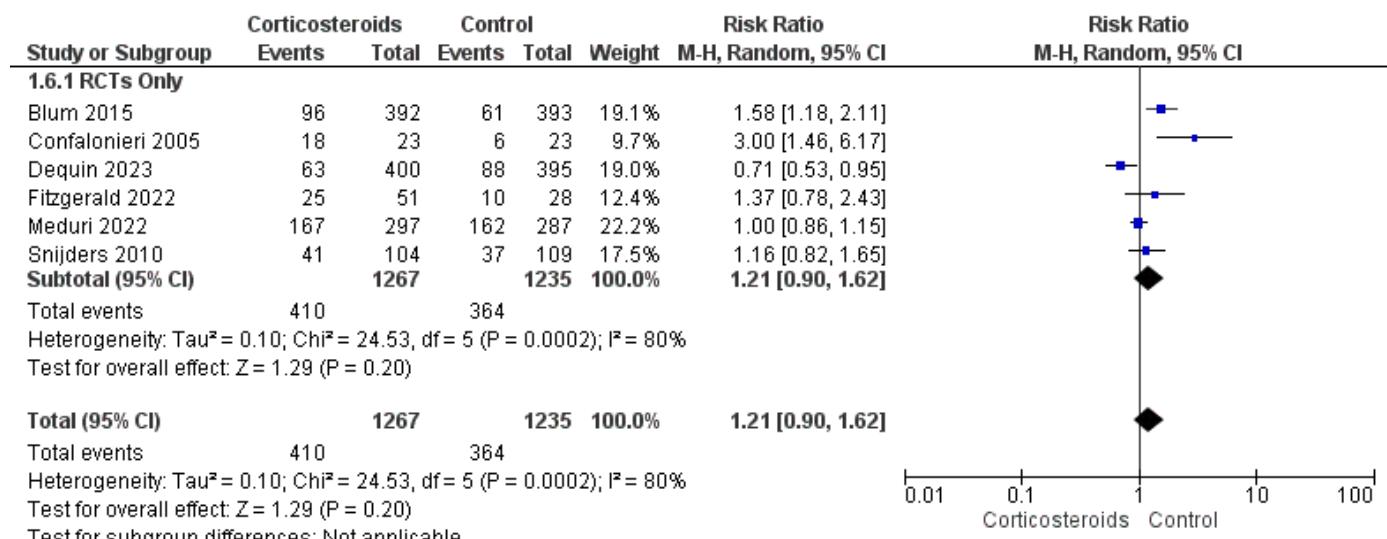
I) Analysis #9: Antibiotic Duration in CAP



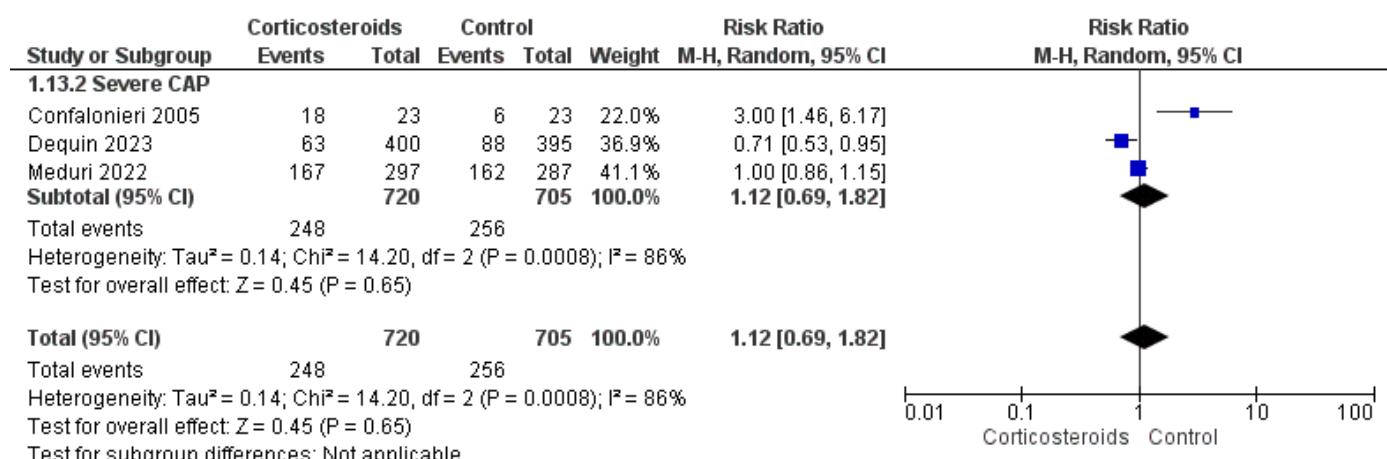
J) Analysis #10: Antibiotic Duration in CAP Patients Admitted to Ward



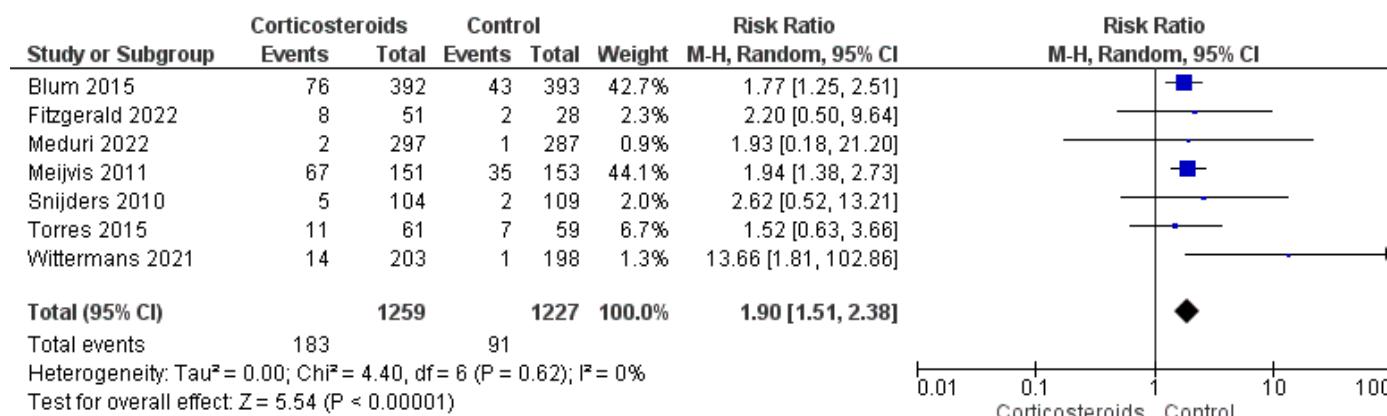
K) Analysis #11: Adverse Events in CAP



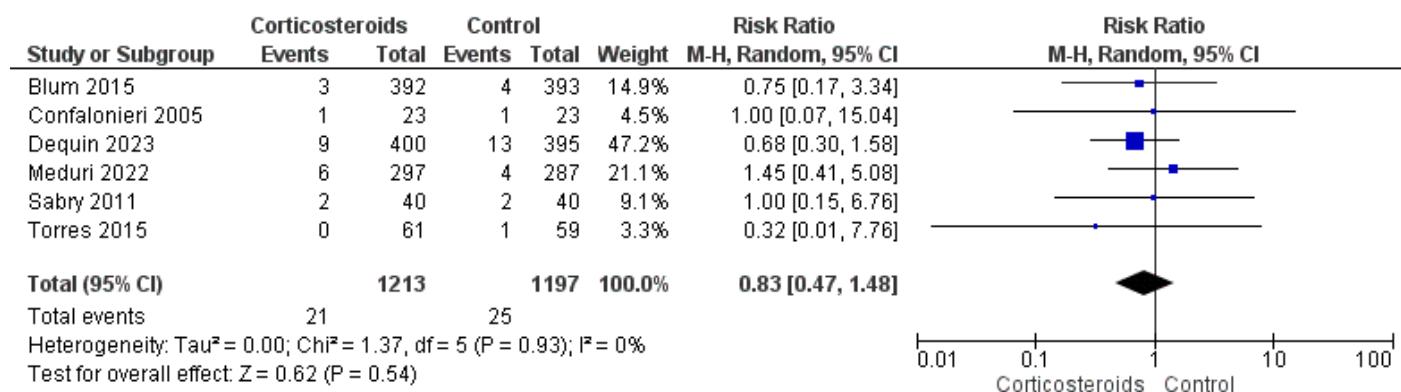
L) Analysis #12: Adverse Events in Severe CAP



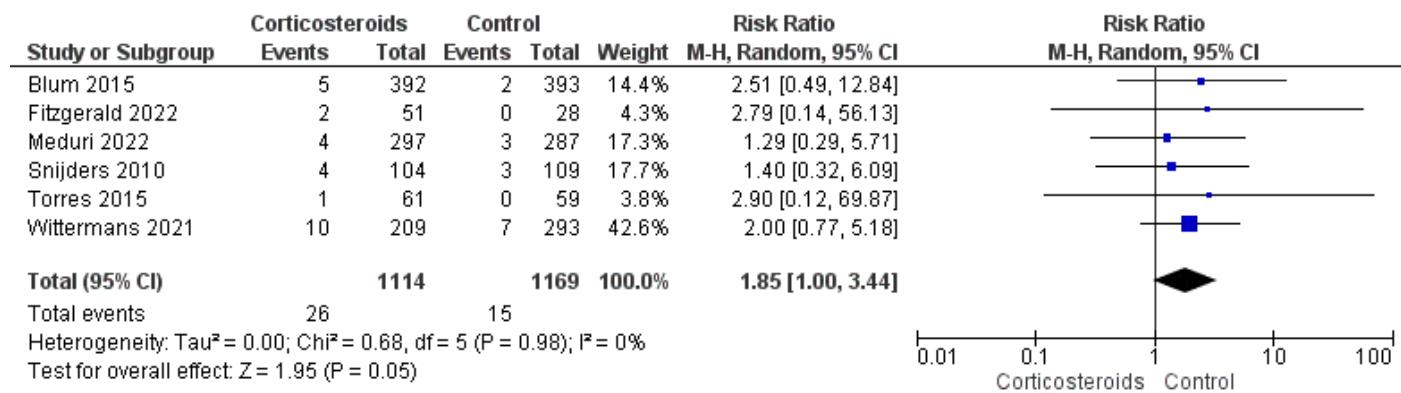
M) Analysis #13: Hyperglycemia in CAP



N) Analysis #14: Gastrointestinal Bleeding in CAP



O) Analysis #15: Neuropsychiatric Events in CAP



P) Analysis #16: Nosocomial Infection in CAP

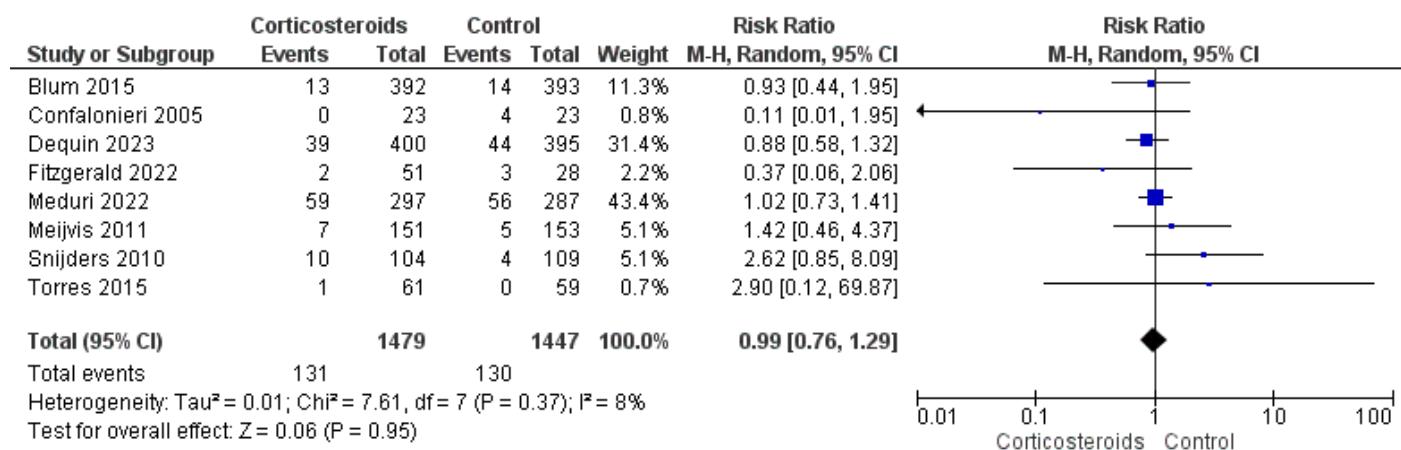


Table S8: Evidence profiles**Table S8.1**

Population: Adults with CAP

Comparison: Systemic corticosteroids versus no systemic corticosteroids

Setting: All patients (outpatients and inpatients)

Quality assessment								Summary of Findings				Quality	Importance
No of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other	Steroids	Placebo	Relative Effect (95% CI)	Absolute Effect (95% CI)			
Mortality													
13 ¹⁻¹³	RCT	Serious ¹⁴	Not serious	Not serious	Not serious	None	111/1809 (6.1%)	161/1766 (9.1%)	RR 0.68 (0.53 to 0.86)	29.12 per 1000 (42.77 to 12.74)	⊕○○○	Moderate	CRITICAL
Treatment Failure													
2 ¹⁰⁻¹¹	RCT	Not serious	Serious ¹⁵	Not serious	Serious ¹⁶	None	42/165 (25.5%)	42/168 (25.0%)	RR 0.83 (0.25 to 2.80)	52.53 per 1000 (231.75 to - 556.20)	⊕⊕○○	Low	CRITICAL
Clinical Stability													
4 ^{1,10-11,17}	RCT	Serious ¹⁴	Serious ¹⁵	Not serious ¹⁸	Serious ¹⁶	None	682	654	-	MD -0.45 (-1.77 to 0.86)	⊕○○○	Very Low	CRITICAL
Adverse Events													
6 ^{1,2-3,6,10,17}	RCT	Not serious	Serious ¹⁵	Not serious ¹⁸	Serious ¹⁶	None	410/1267 (32.4%)	364/1235 (29.5%)	RR 1.21 (0.90 to 1.62)	-61.95 per 1000 (29.5 to - 182.9)	⊕⊕○○	Low	CRITICAL
Length of Stay													
12 ^{1,2,4-8,10-11,13,17-15}	RCT	Serious ¹⁴	Serious ¹⁵	Not serious ¹⁸	Not serious	None	1394	1324	-	MD -1.53 (-2.14 to - 0.91)	⊕⊕○○	Low	IMPORTANT
Antibiotic Duration													
5 ^{1,7-8,17-19}	RCT	Not serious	Serious ¹⁵	Serious ^{18,20}	Serious ¹⁶	None	669	610	-	MD -2.01 (-4.46 to 0.45)	⊕○○○	Very Low	IMPORTANT

CI: confidence interval; RCT: randomized controlled trial; RR: risk ratio; MD: mean difference.

Footnotes:

¹ Blum CA, Nigro N, Briel M, et al. Adjunct prednisone therapy for patients with community-acquired pneumonia: a multicentre, double-blind, randomised, placebo-controlled trial. *Lancet*. 2015;385(9977):1511-8. doi: 10.1016/S0140-6736(14)62447-8.

² Confalonieri M, Urbino R, Potena A, et al. Hydrocortisone infusion for severe community-acquired pneumonia: a preliminary randomized study. *Am J Respir Crit Care Med*. 2005;171(3):242-8. doi: 10.1164/rccm.200406-808OC. Epub 2004 Nov 19. PMID: 15557131.

³ Dequin PF, Meziani F, Quenot JP, et al. Hydrocortisone in Severe Community-Acquired Pneumonia. *N Engl J Med*. 2023. doi: 10.1056/NEJMoa2215145. Epub ahead of print. PMID: 36942789.

⁴ Fernández-Serrano S, Dorca J, García-Vidal C, et al. Effect of corticosteroids on the clinical course of community-acquired pneumonia: a randomized controlled trial. *Crit Care*. 2011;15(2):R96. doi: 10.1186/cc10103.

⁵ Marik P, Kraus P, Sribante J, Havlik I, Lipman J, Johnson DW. Hydrocortisone and tumor necrosis factor in severe community-acquired pneumonia. A randomized controlled study. *Chest*. 1993;104(2):389-92. doi: 10.1378/chest.104.2.389.

⁶ Meduri GU, Shih MC, Bridges L, et al. Low-dose methylprednisolone treatment in critically ill patients with severe community-acquired pneumonia. *Intensive Care Med*. 2022;48(8):1009-1023. doi: 10.1007/s00134-022-06684-3.

⁷ Meijvis SC, Hardeman H, Remmelts HH, et al. Dexamethasone and length of hospital stay in patients with community-acquired pneumonia: a randomised, double-blind, placebo-controlled trial. *Lancet*. 2011;377(9782):2023-30. doi: 10.1016/S0140-6736(11)60607-7.

⁸ Nafae RM, Ragab MI, Amany FM, Rashed SB. Adjuvant role of corticosteroids in the treatment of community-acquired pneumonia. *Egyptian Journal of Chest Diseases and Tuberculosis*. 2013;62(3):439-445. doi: 10.1016/j.ejcdt.2013.03.009.

⁹ Sabry N, Omar E. Corticosteroids and ICU Course of Community Acquired Pneumonia in Egyptian Settings. *Pharmacology & Pharmacy*. 2011;2(2):73-81. doi: 10.4236/pp.2011.22009.

¹⁰Snijders D, Daniels JM, de Graaff CS, van der Werf TS, Boersma WG. Efficacy of corticosteroids in community-acquired pneumonia: a randomized double-blinded clinical trial. *Am J Respir Crit Care Med.* 2010;181(9):975-82. doi: 10.1164/rccm.200905-0808OC.

¹¹Torres A, Sibila O, Ferrer M, Polverino E, et al. Effect of corticosteroids on treatment failure among hospitalized patients with severe community-acquired pneumonia and high inflammatory response: a randomized clinical trial. *JAMA.* 2015;313(7):677-86. doi: 10.1001/jama.2015.88.

¹²Wagner HN Jr, Bennett IL Jr, Lasagna L, Cluff LE, Rosenthal MB, Mirick GS. The effect of hydrocortisone upon the course of pneumococcal pneumonia treated with penicillin. *Bull Johns Hopkins Hosp.* 1956;98(3):197-215.

¹³Wittermans E, Vestjens SMT, Spoorenberg SMC, et al. Adjunctive treatment with oral dexamethasone in non-ICU patients hospitalised with community-acquired pneumonia: a randomised clinical trial. *Eur Respir J.* 2021;58(2):2002535. doi: 10.1183/13993003.02535-2020.

¹⁴Risk of bias: Several studies have either an unclear risk of bias or a high risk of bias due to outcome reported differing from protocol, protocol violations, early study termination, limited information regarding randomization or enrollment procedures, etc.

¹⁵Inconsistency: Large heterogeneity ($p<0.05$ or $I^2 >50\%$)

¹⁶Imprecision: Wide confidence intervals, defined as the ends of the confidence intervals leading to different courses of action.

¹⁷Fitzgerald DB, Waterer GW, Budgeon C, et al. Steroid Therapy and Outcome of Parapneumonic Pleural Effusions (STOPPE): A Pilot Randomized Clinical Trial. *Am J Respir Crit Care Med.* 2022;205(9):1093-1101. doi: 10.1164/rccm.202107-1600OC.

¹⁸Indirectness of the population: Fitzgerald enrolled patients with a pleural effusion who received antibiotics for a longer duration; therefore, it is likely that the population was more severely ill. However, The committee concluded that this did not alter its confidence in the estimated effects because it was only one of many studies.

¹⁹Mikami K, Suzuki M, Kitagawa H, et al. Efficacy of corticosteroids in the treatment of community-acquired pneumonia requiring hospitalization. *Lung.* 2007;185(5):249-255. doi: 10.1007/s00408-007-9020-3.

²⁰Indirectness of outcomes: Varied definition of outcomes between studies.

Table S8.2

Population: Adult inpatients with severe CAP

Comparison: Systemic corticosteroids versus no systemic corticosteroids

Setting: Intensive care units

Quality assessment								Summary of Findings				Quality	Importance
No of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other	Steroids	Placebo	Relative Effect (95% CI)	Absolute Effect (95% CI)			
Mortality													
6 ¹⁻⁶	RCT	Serious ⁷	Not serious	Not serious ⁸	Not serious	None	81/824 (9.8%)	122/810 (15.1%)	RR 0.62 (0.41 to 0.94)	57.38 per 1000 (89.09 to 9.06)	⊕○○○	Moderate	CRITICAL
Adverse Events													
3 ^{1-2,5}	RCT	Not serious	Serious ⁹	Not serious ⁸	Serious ¹⁰	None	248/720 (34.4%)	256/705 (36.3%)	RR 1.12 (0.69 to 1.82)	43.56 per 1000 (112.53 to - 298.66)	⊕⊕○○	Low	CRITICAL
Length of Stay													
4 ^{1,3,5,6}	RCT	Serious ⁷	Not serious	Not serious ⁸	Not serious	None	395	385	-	MD - 1.06 (-2.01 to -0.12)	⊕⊕○○	Low	IMPORTANT

CI: confidence interval. CO: cohort study. MD: mean difference. OBS: RCT: randomized controlled trial. RR: risk ratio.

Footnotes:

¹ Confalonieri M, Urbino R, Potena A, et al. Hydrocortisone infusion for severe community-acquired pneumonia: a preliminary randomized study. *Am J Respir Crit Care Med.* 2005;171(3):242-8. doi: 10.1164/rccm.200406-808OC. Epub 2004 Nov 19. PMID: 15557131.² Dequin PF, Meziani F, Quenot JP, et al. Hydrocortisone in Severe Community-Acquired Pneumonia. *N Engl J Med.* 2023. doi: 10.1056/NEJMoa2215145. Epub ahead of print. PMID: 36942789.³ Marik P, Kraus P, Sribante J, Havlik I, Lipman J, Johnson DW. Hydrocortisone and tumor necrosis factor in severe community-acquired pneumonia. A randomized controlled study. *Chest.* 1993;104(2):389-92. doi: 10.1378/chest.104.2.389.⁴ Sabry N, Omar E. Corticosteroids and ICU Course of Community Acquired Pneumonia in Egyptian Settings. *Pharmacology & Pharmacy.* 2011;2(2):73-81. doi: 10.4236/pp.2011.22009.⁵ Meduri GU, Shih MC, Bridges L, et al. Low-dose methylprednisolone treatment in critically ill patients with severe community-acquired pneumonia. *Intensive Care Med.* 2022;48(8):1009-1023. doi: 10.1007/s00134-022-06684-3.⁶ Torres A, Sibila O, Ferrer M, Polverino E, et al. Effect of corticosteroids on treatment failure among hospitalized patients with severe community-acquired pneumonia and high inflammatory response: a randomized clinical trial. *JAMA.* 2015;313(7):677-86. doi: 10.1001/jama.2015.88.⁷ Risk of bias: Several studies have either an unclear risk of bias or a high risk of bias due to outcome reported differing from protocol, protocol violations, early study termination, limited information regarding randomization or enrollment procedures, etc.⁸ Indirectness: Meduri et al. and Torres et al. included a minority of patients who may have had non-severe CAP. However, the committee concluded that this did not alter its confidence in the estimated effects.⁹ Inconsistency: Large heterogeneity ($p<0.05$, $I^2 >50\%$)¹⁰ Imprecision: Wide confidence intervals, defined as the ends of the confidence intervals leading to different courses of action.

Table S8.3

Population: Adult inpatients with non-severe CAP

Comparison: Systemic corticosteroids versus no systemic corticosteroids

Setting: Medical wards

Quality assessment							Summary of Findings				Quality	Importance
No of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other	Steroids	Placebo	Relative Effect (95% CI)	Absolute Effect (95% CI)		
Mortality												
2 ¹⁻²	RCT	Serious ³	Not serious	Not serious ⁴	Serious ⁵	None	13/354 (3.7%)	18/351 (5.1%)	RR 0.73 (0.36 to 1.461)	13.77 per 1000 (32.64 to -23.46)	⊕⊕○○ Low	CRITICAL
Length of Stay												
4 ^{1-2,6-7}	RCT	Serious ³	Not serious	Not serious ⁴	Serious ⁵	None	420	395	-	MD - 0.52 (-1.33 to 0.28)	⊕⊕○○ Low	IMPORTANT
Antibiotic Duration												
3 ^{1,6-7}	RCT	Not serious	Not serious	Serious ^{4,8}	Serious ⁵	None	217	197	-	MD - 0.99 (-3.93 to 1.96)	⊕⊕○○ Low	IMPORTANT

CI: confidence interval. CO: cohort study. MD: mean difference. OBS: RCT: randomized controlled trial. RR: risk ratio.

Footnotes:

¹ Meijvis SC, Hardeman H, Remmerts HH, et al. Dexamethasone and length of hospital stay in patients with community-acquired pneumonia: a randomised, double-blind, placebo-controlled trial. *Lancet*. 2011;377(9782):2023-30. doi: 10.1016/S0140-6736(11)60607-7.² Wittermans E, Vestjens SMT, Spoorenberg SMC, et al. Adjunctive treatment with oral dexamethasone in non-ICU patients hospitalised with community-acquired pneumonia: a randomised clinical trial. *Eur Respir J*. 2021;58(2):2002535. doi: 10.1183/13993003.02535-2020.³ Risk of bias: Several studies have either an unclear risk of bias or a high risk of bias due to outcome reported differing from protocol, protocol violations, early study termination, limited information regarding randomization or enrollment procedures, etc.⁴ Indirectness of the population: Fitzgerald enrolled patients with a pleural effusion who received antibiotics for a longer duration; therefore, it is likely that the population was more severely ill. Meijvis et al. and Wittermans et al. included a minority of patients who may have had non-severe CAP. However, the committee concluded that this did not alter its confidence in the estimated effects because it was only one of many studies.⁵ Imprecision: Wide confidence intervals, defined as the ends of the confidence intervals leading to different courses of action.⁶ Fitzgerald DB, Waterer GW, Budgeon C, et al. Steroid Therapy and Outcome of Parapneumonic Pleural Effusions (STOPPE): A Pilot Randomized Clinical Trial. *Am J Respir Crit Care Med*. 2022;205(9):1093-1101. doi: 10.1164/rccm.202107-1600OC.⁷ Mikami K, Suzuki M, Kitagawa H, et al. Efficacy of corticosteroids in the treatment of community-acquired pneumonia requiring hospitalization. *Lung*. 2007;185(5):249-255. doi: 10.1007/s00408-007-9020-3.⁸ Indirectness of outcomes: Varied definition of outcomes between studies.

Table S9: EtD frameworks**A) Analysis #1: Patients with Severe CAP****QUESTION**

Should hospitalized patients with severe community-acquired pneumonia receive systemic corticosteroids rather than no systemic corticosteroids?

POPULATION:	Hospitalized patients with SEVERE community-acquired pneumonia
INTERVENTION:	Systemic corticosteroids
COMPARISON:	No systemic corticosteroids
SETTING:	Inpatients

ASSESSMENT**Desirable Effects**

How substantial are the desirable effects? “Substantial” refers to both the importance of the outcomes and the magnitude of effect. As an example, a small improvement in a critical outcome might be more substantial than a large improvement in an unimportant outcome.

JUDGEMENT	RESEARCH EVIDENCE
<ul style="list-style-type: none"> <input type="radio"/> Trivial <input type="radio"/> Small <input checked="" type="radio"/> Moderate <input type="radio"/> Large <input type="radio"/> Varies <input type="radio"/> Don't know <p>The magnitude of the effect is small but mortality is a very important outcome to most patients.</p> <p>Beneficial effects are seen in heterogeneous populations of patients with CAP. These effects appear to be driven by</p>	<p>DESIRABLE EFFECTS</p> <p><u>Decreased mortality:</u> CAP patients- 13 RCTs, 3575 patients, 6.1% versus 9.1% (NNT 34), RR 0.68, 95% CI 0.53-0.86. Severe CAP- 6 RCTs, 1634 patients, 9.8% versus 15.1% (NNT 17), RR 0.62, 95% CI 0.41-0.94. Non-severe CAP- 3 RCTs, 705 patients, 3.7% versus 5.1% (NNT 72) RR 0.73, 95% CI 0.36 to 1.46.</p> <p><u>Decreased length of stay:</u> CAP patients- 12 RCTs, 3403 patients, MD -1.11 days, 95% CI -1.66 to -0.55 days. Severe CAP- 4 RCTs, 780 patients, MD -1.06 days, 95% CI -2.01 to -0.12 days. Non-severe CAP – 5 RCTs, 1556 patients, MD -0.61 days, 95% CI -1.36 to 0.14 days.</p> <p>RCT= randomized controlled trial, NNT= number needed to treat, RR = risk ratio, CI = confidence interval, MD = mean difference.</p>

patients with severe CAP.					
Undesirable Effects					
	<p>How substantial are the undesirable effects? “Substantial” refers to both the importance of the outcomes and the magnitude of effect. As an example, a small increase in a critical adverse outcome might be more substantial than a large increase in an unimportant adverse outcome.</p>				
<table border="1"> <thead> <tr> <th>JUDGEMENT</th><th>RESEARCH EVIDENCE</th></tr> </thead> <tbody> <tr> <td> <input type="radio"/> Trivial <input checked="" type="radio"/> Small <input type="radio"/> Moderate <input type="radio"/> Large <input type="radio"/> Varies <input type="radio"/> Don't know The magnitude of the effect is small and is of average importance since it is treatable and reversible upon discontinuation. </td><td> <p>UNDESIRABLE EFFECTS</p> <p><u>Increased hyperglycemia:</u> CAP patients- 7 RCTs, 2476 patients, 14.5% versus 9% (NNH 18), RR 1.71, 95% 1.21-2.40. Severe CAP- no research evidence. Non-severe CAP- no research evidence.</p> <p>RCT= randomized controlled trial, NNH = number needed to harm, RR = risk ratio, CI = confidence interval.</p> </td></tr> </tbody> </table>		JUDGEMENT	RESEARCH EVIDENCE	<input type="radio"/> Trivial <input checked="" type="radio"/> Small <input type="radio"/> Moderate <input type="radio"/> Large <input type="radio"/> Varies <input type="radio"/> Don't know The magnitude of the effect is small and is of average importance since it is treatable and reversible upon discontinuation.	<p>UNDESIRABLE EFFECTS</p> <p><u>Increased hyperglycemia:</u> CAP patients- 7 RCTs, 2476 patients, 14.5% versus 9% (NNH 18), RR 1.71, 95% 1.21-2.40. Severe CAP- no research evidence. Non-severe CAP- no research evidence.</p> <p>RCT= randomized controlled trial, NNH = number needed to harm, RR = risk ratio, CI = confidence interval.</p>
JUDGEMENT	RESEARCH EVIDENCE				
<input type="radio"/> Trivial <input checked="" type="radio"/> Small <input type="radio"/> Moderate <input type="radio"/> Large <input type="radio"/> Varies <input type="radio"/> Don't know The magnitude of the effect is small and is of average importance since it is treatable and reversible upon discontinuation.	<p>UNDESIRABLE EFFECTS</p> <p><u>Increased hyperglycemia:</u> CAP patients- 7 RCTs, 2476 patients, 14.5% versus 9% (NNH 18), RR 1.71, 95% 1.21-2.40. Severe CAP- no research evidence. Non-severe CAP- no research evidence.</p> <p>RCT= randomized controlled trial, NNH = number needed to harm, RR = risk ratio, CI = confidence interval.</p>				
Certainty of evidence					
<p>What is the committee’s confidence in the accuracy of the above listed estimates (i.e., what is the quality of evidence)?</p>					
<table border="1"> <thead> <tr> <th>JUDGEMENT</th><th>RESEARCH EVIDENCE</th></tr> </thead> <tbody> <tr> <td> <input type="radio"/> Very low <input checked="" type="radio"/> Low <input type="radio"/> Moderate <input type="radio"/> High <input type="radio"/> No included studies </td><td> <p>QUALITY OF EVIDENCE</p> <p>Overall quality of evidence is the lowest quality of evidence among the critical outcomes.</p> <p>For the critical outcome of <u>adverse effects</u>, there is low-quality evidence because there are RCTs downgraded for inconsistency and imprecision.</p> </td></tr> </tbody> </table>		JUDGEMENT	RESEARCH EVIDENCE	<input type="radio"/> Very low <input checked="" type="radio"/> Low <input type="radio"/> Moderate <input type="radio"/> High <input type="radio"/> No included studies	<p>QUALITY OF EVIDENCE</p> <p>Overall quality of evidence is the lowest quality of evidence among the critical outcomes.</p> <p>For the critical outcome of <u>adverse effects</u>, there is low-quality evidence because there are RCTs downgraded for inconsistency and imprecision.</p>
JUDGEMENT	RESEARCH EVIDENCE				
<input type="radio"/> Very low <input checked="" type="radio"/> Low <input type="radio"/> Moderate <input type="radio"/> High <input type="radio"/> No included studies	<p>QUALITY OF EVIDENCE</p> <p>Overall quality of evidence is the lowest quality of evidence among the critical outcomes.</p> <p>For the critical outcome of <u>adverse effects</u>, there is low-quality evidence because there are RCTs downgraded for inconsistency and imprecision.</p>				
Balance of effects					
<p>Does the balance between desirable and undesirable effects favor the intervention or the comparison?</p>					
<table border="1"> <thead> <tr> <th>JUDGEMENT</th><th>RESEARCH EVIDENCE</th></tr> </thead> </table>		JUDGEMENT	RESEARCH EVIDENCE		
JUDGEMENT	RESEARCH EVIDENCE				

<input type="radio"/> Favors the comparison <input type="radio"/> Probably favors the comparison <input type="radio"/> Does not favor either the intervention or the comparison <input type="radio"/> Probably favors the intervention <input checked="" type="radio"/> Favors the intervention <input type="radio"/> Varies <input type="radio"/> Don't know	<p>The desirable effects (decreased mortality + decreased length of stay) were judged to outweigh the undesirable effects (increased hyperglycemia), thereby favoring systemic corticosteroids in patients with severe CAP.</p>
Acceptability Is the intervention acceptable to key stakeholders?	
JUDGEMENT	
RESEARCH EVIDENCE	
<input type="radio"/> No <input type="radio"/> Probably no <input type="radio"/> Probably yes <input checked="" type="radio"/> Yes <input type="radio"/> Varies <input type="radio"/> Don't know	
<p>The intervention is most often delivered intravenously or via the gastrointestinal tract, which is acceptable to most patients.</p> <p>This is based on the committee's non-systematic clinical observations.</p>	
Feasibility Is the intervention feasible to implement?	
JUDGEMENT	
RESEARCH EVIDENCE	
<input type="radio"/> No <input type="radio"/> Probably no <input type="radio"/> Probably yes <input checked="" type="radio"/> Yes <input type="radio"/> Varies <input type="radio"/> Don't know	
<p>The intervention is most often delivered intravenously or via the gastrointestinal tract, which is feasible in all hospitals.</p> <p>This is based on the committee's non-systematic clinical observations.</p>	

SUMMARY OF JUDGEMENTS

	JUDGEMENT						
DESIRABLE EFFECTS	Trivial	Small	Moderate	Large		Varies	Don't know
UNDESIRABLE EFFECTS	Trivial	Small	Moderate	Large		Varies	Don't know
BALANCE OF EFFECTS	Favors the comparison	Probably favors the comparison	Does not favor either the intervention or the comparison	Probably favors the intervention	Favors the intervention	Varies	Don't know
CERTAINTY OF EVIDENCE	Very low	Low	Moderate	High			No included studies
ACCEPTABILITY	No	Probably no	Probably yes	Yes		Varies	Don't know
FEASIBILITY	No	Probably no	Probably yes	Yes		Varies	Don't know

TYPE OF RECOMMENDATION

Strong recommendation against the intervention <input type="radio"/>	Conditional recommendation against the intervention <input type="radio"/>	Conditional recommendation for either the intervention or the comparison <input type="radio"/>	Conditional recommendation for the intervention <input checked="" type="radio"/>	Strong recommendation for the intervention <input type="radio"/>
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CONCLUSIONS

Recommendation

For hospitalized patients with severe community-acquired pneumonia, we suggest systemic corticosteroids (conditional recommendation, low quality of evidence).

Participation = 16/18 (89%)

Strong recommendation for systemic corticosteroids = 1/16 (6.25%).

Conditional recommendation for systemic corticosteroids = 14/16 (87.50%).

Strong recommendations against systemic corticosteroids = 0/16 (0%).

Condition recommendation against systemic corticosteroids = 1/16 (6.25%).

B) Analysis #2: Patients Admitted to Ward

QUESTION

Should hospitalized patients with severe community-acquired pneumonia received systemic corticosteroids rather than no systemic corticosteroids?

POPULATION:	Hospitalized patients with NON-SEVERE community-acquired pneumonia
INTERVENTION:	Systemic corticosteroids
COMPARISON:	No systemic corticosteroids
SETTING:	Inpatients

ASSESSMENT**Desirable Effects**

How substantial are the desirable effects? “Substantial” refers to both the importance of the outcomes and the magnitude of effect. As an example, a small improvement in a critical outcome might be more substantial than a large improvement in an unimportant outcome.

JUDGEMENT	RESEARCH EVIDENCE
<ul style="list-style-type: none"> ● Trivial (if any) ○ Small ○ Moderate ○ Large ○ Varies ○ Don't know <p>Beneficial effects are seen in heterogeneous populations of patients with CAP, but the effects appear to be driven by patients with severe CAP. There is no evidence of benefit in patients with non-severe CAP.</p>	<p>DESIRABLE EFFECTS</p> <p><u>Decreased mortality:</u> CAP patients- 13 RCTs, 3575 patients, 6.1% versus 9.1% (NNT 33), RR 0.68, 95% CI 0.53-0.86. Severe CAP- 6 RCTs, 1634 patients, 9.8% versus 15.1% (NNT 19), RR 0.62, 95% CI 0.41-0.94. Non-severe CAP- 3 RCTs, 705 patients, 3.7% versus 5.1% (NNT 72) RR 0.73, 95% CI 0.36 to 1.46.</p> <p><u>Decreased length of stay:</u> CAP patients- 12 RCTs, 3403 patients, MD -1.11 days, 95% CI -1.66 to -0.55 days. Severe CAP- 4 RCTs, 780 patients, MD -1.06 days, 95% CI -2.01 to -0.12 days. Non-severe CAP – 5 RCTs, 1556 patients, MD -0.61 days, 95% CI -1.36 to 0.14 days.</p> <p>RCT= randomized controlled trial, NNT= number needed to treat, RR = risk ratio, CI = confidence interval, MD = mean difference.</p>

Undesirable Effects

How substantial are the undesirable effects? “Substantial” refers to both the importance of the outcomes and the magnitude of effect. As an example, a small increase in a critical adverse outcome might be more substantial than a large increase in an unimportant adverse outcome.

JUDGEMENT	RESEARCH EVIDENCE
<input type="radio"/> Trivial <input checked="" type="radio"/> Small <input type="radio"/> Moderate <input type="radio"/> Large <input type="radio"/> Varies <input type="radio"/> Don't know The magnitude of the effect is small and it is average importance since it is treatable and reversible upon discontinuation.	UNDESIRABLE EFFECTS <u>Increased hyperglycemia:</u> CAP patients- 7 RCTs, 2476 patients, 14.5% versus 9% (NNH 18), RR 1.71, 95% 1.21-2.40. Severe CAP- no research evidence. Non-severe CAP- no research evidence. RCT= randomized controlled trial, NNH = number needed to harm, RR = risk ratio, CI = confidence interval.
Certainty of evidence	
What is the committee's confidence in the accuracy of the above listed estimates (i.e., what is the quality of evidence)?	
JUDGEMENT	RESEARCH EVIDENCE
<input type="radio"/> Very low <input checked="" type="radio"/> Low <input type="radio"/> Moderate <input type="radio"/> High <input type="radio"/> No included studies	QUALITY OF EVIDENCE The overall quality of evidence is determined by the lowest quality of evidence among critical outcomes. For the critical outcome of <u>mortality</u> , there is low-quality evidence because there are RCTs downgraded for risk of bias and imprecision.
Balance of effects	
Does the balance between desirable and undesirable effects favor the intervention or the comparison?	
JUDGEMENT	RESEARCH EVIDENCE
<input checked="" type="radio"/> Favors the comparison <input type="radio"/> Probably favors the comparison <input type="radio"/> Does not favor either the intervention or the comparison <input type="radio"/> Probably favors	The undesirable effects (increased hyperglycemia) outweigh the desirable effects (there might be no desirable effects in non-severe CAP), thereby favoring no systemic corticosteroids in patients with non-severe CAP.

the intervention <input type="radio"/> Favors the intervention <input type="radio"/> Varies <input type="radio"/> Don't know	
Acceptability Is the intervention acceptable to key stakeholders?	
JUDGEMENT	
<input type="radio"/> No <input type="radio"/> Probably no <input type="radio"/> Probably yes <input checked="" type="radio"/> Yes <input type="radio"/> Varies <input type="radio"/> Don't know	
RESEARCH EVIDENCE The intervention is most often delivered intravenously or via the gastrointestinal tract, which is acceptable to most patients. This is based on the committee's non-systematic clinical observations.	
Feasibility Is the intervention feasible to implement?	
JUDGEMENT	
<input type="radio"/> No <input type="radio"/> Probably no <input type="radio"/> Probably yes <input checked="" type="radio"/> Yes <input type="radio"/> Varies <input type="radio"/> Don't know	
RESEARCH EVIDENCE The intervention is most often delivered intravenously or via the gastrointestinal tract, which is feasible in all hospitals. This is based on the committee's non-systematic clinical observations.	

SUMMARY OF JUDGEMENTS

	JUDGEMENT						
DESIRABLE EFFECTS	Trivial	Small	Moderate	Large		Varies	Don't know
UNDESIRABLE EFFECTS	Trivial	Small	Moderate	Large		Varies	Don't know
BALANCE OF EFFECTS	Favors the comparison	Probably favors the comparison	Does not favor either the intervention or the comparison	Probably favors the intervention	Favors the intervention	Varies	Don't know
CERTAINTY OF EVIDENCE	Very low	Low	Moderate	High			No included studies
ACCEPTABILITY	No	Probably no	Probably yes	Yes		Varies	Don't know
FEASIBILITY	No	Probably no	Probably yes	Yes		Varies	Don't know

TYPE OF RECOMMENDATION

Strong recommendation against the intervention	Conditional recommendation against the intervention	Conditional recommendation for either the intervention or the comparison	Conditional recommendation for the intervention	Strong recommendation for the intervention
●	○	○	○	○

CONCLUSIONS**Recommendation**

For hospitalized patients with non-severe community-acquired pneumonia, we recommend NOT administering systemic corticosteroids (strong recommendation, low quality of evidence). Remark: The recommendation is strong despite the very low certainty of effects because the intent is to avoid harm due to unnecessary systemic corticosteroids.

Participation = 16/18 (89%)

Strong recommendations for systemic corticosteroids = 0/16 (0%).

Condition recommendation for systemic corticosteroids = 0/16 (0%).

Strong recommendation against systemic corticosteroids = 13/16 (81.25%).
Conditional recommendation against systemic corticosteroids = 3/16 (8.75%).