ACP American College of Physicians®
Leading Internal Medicine, Improving Lives

CLINICAL GUIDELINE

# 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

**Amir Qaseem, MD, PhD, MHA; Itziar Etxeandia-Ikobaltzeta, PharmD, PhD; Reem A. Mustafa, MD, MPH, PhD; Devan Kansagara, MD, MCR; Nick Fitterman, MD; and Timothy J. Wilt, MD, MPH; for the Clinical Guidelines Committee of the American College of Physicians***

**Description:** The American College of Physicians (ACP) developed this guideline to provide clinical recommendations on the appropriate use of point-of-care ultrasonography (POCUS) in patients with acute dyspnea in emergency department (ED) or inpatient settings to improve the diagnostic, treatment, and health outcomes of those with suspected congestive heart failure, pneumonia, pulmonary embolism, pleural effusion, or pneumothorax.

**Methods:** The ACP Clinical Guidelines Committee based this guideline on a systematic review on the benefits, harms, and diagnostic test accuracy of POCUS; patient values and preferences; and costs of POCUS. The systematic review evaluated health outcomes, diagnostic timeliness, treatment decisions, and test accuracy. The critical health, diagnostic, and treatment outcomes evaluated were in-hospital mortality, time to diagnosis, and time to treatment. The important outcomes evaluated were intensive care unit admissions, correctness of diagnosis, disease-specific outcomes, hospital readmissions, length of hospital stay, and quality of life. The critical test accuracy outcomes included false-positive results for suspected pneumonia, pneumothorax, and pulmonary embolism and false-negative results for suspected congestive heart failure, pneumonia, pneumothorax, and pulmonary embolism. Important test accuracy outcomes included false-positive results for suspected congestive heart failure and false-negative and false-positive results for suspected pleural effusion. This guideline was developed using the GRADE (Grading of Recommendations Assessment, Development and Evaluation) method.

**Target Audience and Patient Population:** The target audience is all clinicians, and the target patient population is adult patients with acute dyspnea in ED or inpatient settings.

**Recommendation:** *ACP suggests that clinicians may use point-of-care ultrasonography in addition to the standard diagnostic pathway when there is diagnostic uncertainty in patients with acute dyspnea in emergency department or inpatient settings (conditional recommendation; low-certainty evidence).*

*Ann Intern Med.* doi:10.7326/M20-7844 **Annals.org**
For author, article, and disclosure information, see end of text.
This article was published at Annals.org on 27 April 2021.

In recent years, use of point-of-care ultrasonography (POCUS) as a potential diagnostic tool has increased due in part to its increased availability and perceived user-friendliness (1). Physicians trained to use POCUS can do it in real-time at the patient's bedside to possibly improve diagnostic performance compared with standard clinical examinations (2–4). Point-of-care ultrasonography may also facilitate timely and appropriate management of critically ill patients or alleviate the need for ultrasonography or other diagnostic tests.

Point-of-care ultrasonography can be used for various clinical indications. This guideline targets a symptom-based approach to evaluate the effectiveness, test accuracy, and harms of using POCUS in emergency department (ED) or other inpatient settings for patients with acute dyspnea suspected to be due to congestive heart failure, pleural effusion, pneumonia, pneumothorax, or pulmonary embolism but in whom there was diagnostic uncertainty. Dyspnea, defined as a subjective and distressing experience of

**See also:**

Editorial comment
Related article

*Web-Only*
Supplement

* This paper, written by Amir Qaseem, MD, PhD, MHA; Itziar Etxeandia-Ikobaltzeta, PharmD, PhD; Reem A. Mustafa, MD, MPH, PhD; Devan Kansagara, MD, MCR; Nick Fitterman, MD; and Timothy J. Wilt, MD, MPH, was developed for the Clinical Guidelines Committee of the American College of Physicians. Individuals who served on the Clinical Guidelines Committee from initiation of the project until its approval were Timothy J. Wilt, MD, MPH (*Chair*)†; Devan Kansagara, MD, MCR (*Vice Chair*)†; Mary Ann Forciea, MD (*Immediate Past Chair*)‡; Pelin Batur, MD, NCMP, CCD†; Thomas G. Cooney, MD†; Carolyn J. Crandall, MD, MS†; Nick Fitterman, MD†; Lauri A. Hicks, DO†; Carrie Horwitch, MD, MPH‡; Jennifer S. Lin, MD, MCR†; Michael Maroto, JD, MBA†§; Robert M. McLean, MD‡; Reem A. Mustafa, MD, MPH, PhD†; Jeffrey Tice, MD†; Janice E. Tufte†§; Sandeep Vijan, MD, MS†; and John W. Williams, Jr., MD, MHS†. Approved by the ACP Board of Regents on 7 November 2020.
† Author.
‡ Nonauthor contributor.
§ Nonphysician public representative.

breathing discomfort, is a common symptom that contributes to more than 1 million ED visits each year (5, 6). Many underlying diseases can cause dyspnea. The diagnostic approach to a patient with acute dyspnea is challenging because of the number of potential causes, several of which are serious and potentially life-threatening.

The standard diagnostic approach to identify the underlying causes of acute dyspnea involves obtaining a patient history, doing a physical examination, and ordering diagnostic testing, such as blood laboratory test, chest or cardiac imaging, and electrocardiography. In relation to the standard diagnostic pathway, POCUS can be used before, after, or in addition to the standard tests or as a replacement for 1 or more standard tests.

## GUIDELINE FOCUS AND TARGET POPULATION

The purpose of this American College of Physicians (ACP) guideline is to provide recommendations on the appropriate use of POCUS in addition to or as a replacement for the standard diagnostic pathway in the approach to patients with acute dyspnea in ED or inpatient settings. The Clinical Guidelines Committee (CGC) developed the recommendations, which are based on the best available evidence on the clinical benefits and harms, test accuracy, patient values and preferences, and consideration of costs.

The target audience for this guideline is all clinicians, and the target patient population is adult patients with acute dyspnea in ED or inpatient settings in whom there is diagnostic uncertainty. These recommendations are based on a systematic review done by Cochrane Austria at Danube University Krems and funded by ACP (7). ACP also did a separate rapid review to assess the costs of POCUS.

## METHODS

The CGC developed this guideline according to ACP's guideline development process, details of which can be found in ACP's methods articles (8, 9).

### Systematic Review of the Evidence

Details and methods for the supporting systematic review are included in the accompanying systematic review (7) and in the **Appendix** (available at Annals.org). The CGC identified the key questions and convened a technical expert panel made up of clinical topic experts, clinicians, and epidemiologists to inform the systematic review and assist in refining the scope and key questions (**Appendix**).

The accompanying systematic review (7) searched several databases for studies published in English from January 2004 to August 2020. Included studies compared bedside POCUS (trolley- or cart-based, compact–handheld, or application-based) done by students, residents, general internists, or intensivists as an intervention of interest in hospitalized or ED patients with acute dyspnea to assess health outcomes or treatment decisions or as an index test to assess test accuracy in detecting congestive heart failure, pneumonia, pulmonary embolism, pleural effusion, or pneumothorax. Further details can be found in the accompanying systematic review (7).

### Main Outcomes

The systematic review (7) evaluated health outcomes, diagnostic timeliness, treatment decisions, and test accuracy. Members of the CGC (clinicians and nonclinician public members) and the CGC Public Panel were asked a priori to independently rate the importance of evaluated outcomes (**Appendix Table**, available at Annals.org). A separate outcome, correctness of diagnosis, which is the proportion of patients receiving a correct diagnosis with or without the use of POCUS, was not listed in the original protocol as an outcome but was derived from the included studies and considered important by the CGC. The systematic review graded the 7 highest-rated outcomes, and all critical and important outcomes were considered in developing recommendations.

The CGC and technical expert panel members also estimated the typical prevalence of each specific disease in patients with acute dyspnea and low, medium, or high pretest probability for the disease, as informed by the prevalence reported in the included studies. This information was used to calculate the number of false-positive and false-negative test results from POCUS for each indication of interest.

### Values and Preferences and Public Panel Review

The evidence review team searched several databases (MEDLINE, the Cochrane Library, EMBASE, and Epistemonikos) to identify literature on patient values and preferences about the use of POCUS. The development of this guideline also included perspectives, values, and preferences of 2 CGC members who represent the public and a 7-member CGC Public Panel, who rated outcomes, provided input on preferences among the intervention options via a direct-choice exercise, and provided comments on the draft guideline and recommendations.

### Costs

To identify literature on the costs of the interventions, ACP staff searched PubMed (MEDLINE) from inception through February 2020 and several additional databases (National Health Service Economic Evaluation Database, Database of Abstracts of Reviews of Effects, and Health Technology Assessment database) from inception through 2015 (the last year that the additional databases were updated). ACP staff also used the Medicare Fee Schedules to identify Medicare reimbursements fees for POCUS and other tests included in the standard diagnostic work-up for the included conditions.

### Evidence to Recommendations

The CGC used the GRADE (Grading of Recommendations Assessment, Development and Evaluation) tables in the accompanying systematic review (7) when reporting the evidence and graded the evidence and recommendations using the GRADE method (10, 11) (**Figure 1**). The GRADE evidence-to-decision tables illustrate the evidence framework supporting the recommendation (**Tables 1 and 2** of **Supplement 1**, available at Annals.org).

***Figure 1.*** Grading the certainty of evidence and strength of recommendations of ACP clinical guidelines using GRADE.

| Grading Certainty of Evidence | | | |
|---|---|---|---|
| High | Confident that the true effect is close to the estimated effect. | | |
| Moderate | Moderately confident in the effect estimate: The true effect is likely close to the estimated effect, but there is a sizeable possibility that it is substantially different. | | |
| Low | Confidence in the effect estimate is limited: The true effect may be substantially different from the estimated effect. | | |
| **Grading Strength of Recommendations** | | | |
| **Strength** | **Balance of Benefits and Harms** | **Applicable Patient Population** | **Policy Implications** |
| Strong | Confidence that the benefits clearly outweigh risks and burden or vice versa. | Applies to most patients in most circumstances. | Only strong recommendations could be considered as quality indicators to guide the development of accountability, reporting, and payment programs. |
| Conditional | Benefits probably outweigh the risks and burden, or vice versa, but there is appreciable uncertainty. | Applies to many patients but may differ depending on circumstances or patients' values and preferences. | Policymaking will require substantial debates and involvement of many stakeholders. Policies are also more likely to vary between regions. Quality indicators would have to focus on the fact that adequate deliberation about the management options has taken place. |

ACP = American College of Physicians; GRADE = Grading of Recommendations Assessment, Development and Evaluation.

### Peer Review

The guideline underwent a peer review process through the journal and was posted online for comments from ACP Regents and ACP Governors who represent internal medicine and its subspecialty physician members at the national and international levels. The CGC considered any comments before finalizing the guideline.

## Summary of the Evidence

Tables 1 and 2 of Supplement 1 provide a detailed summary of findings, and the full findings of the systematic review are published in the accompanying systematic review (7), but main points are highlighted here. No studies were identified that used POCUS before or after the standard diagnostic pathway. The reference standards for test accuracy studies varied. Most ($n$ = 42) of the studies were done in the ED; the remaining were done in inpatient hospital wards or the intensive care unit. Most ($n$ = 44) studies used standard portable POCUS devices (any device that could be moved to a patient's bed but was not a handheld), and 5 used handheld devices (12–16).

### Key Findings From the Systematic Review on Critical and Important Outcomes: POCUS in Addition to the Standard Diagnostic Pathway

#### *Health, Diagnostic, and Treatment Outcomes*

Evidence was very uncertain (insufficient) on the following critical outcomes for using POCUS in addition the standard diagnostic pathway (7): mortality (17–19), time to diagnosis (13), and time to treatment (13). Among important outcomes, moderate-certainty evidence showed that POCUS probably increases the proportion of correct diagnoses from 59% to 91% (absolute risk difference, 31.9% [95% CI, 22.4% to 53.8%) (7, 17, 20, 21) and probably does not reduce the length of hospital stay (data could not be pooled) (7, 13, 17, 18, 20).

#### *Test Accuracy*

Depending on indication and protocol, low-certainty evidence showed that sensitivities of POCUS in addition to the standard diagnostic pathway ranged from 79% to 100% and specificities ranged from 63% to 100%, compared with sensitivities of standard diagnostic pathway alone ranging from 0% to 83% and specificities ranging from 68% to 100%. Table 1 and Figure 2 present test accuracy of POCUS in addition to the standard diagnostic pathway, reporting numbers of false-positive and false-negative findings across various suspected underlying conditions and according to pretest probabilities of suspected underlying conditions.

*Congestive Heart Failure.* Low-certainty evidence showed that POCUS (lung alone or in combination with heart, inferior vena cava, and deep veins) in addition to the standard diagnostic pathway correctly identified 79% to 100% of patients with unspecified dyspnea who had congestive heart failure and 95% to 99% of patients who did not congestive heart failure (7, 17, 18, 20).

*Pleural Effusion.* Low-certainty evidence showed that POCUS (lung, heart, and deep veins; lung, heart, and inferior vena cava) in addition to the standard diagnostic pathway correctly identified 89% to 100% of patients with unspecified dyspnea who had pleural effusion and 98% to 100% of patients who did not have pleural effusion (7, 17, 20).

*Pneumonia.* Low-certainty evidence showed that POCUS (lung, heart, inferior vena cava, and deep veins) in addition to the standard diagnostic pathway correctly identified 92% of patients with unspecified dyspnea who had pneumonia and 63% to 98% of patients who did not have pneumonia (7, 17, 20).

***Table 1.*** Test Accuracy of POCUS in Addition to the Standard Diagnostic Pathway Versus the Standard Diagnostic Pathway Alone, in Patients With Acute Dyspnea Across Common Underlying Conditions*

| Underlying Condition (Studies, *n* [Reference]) | Certainty of Evidence | Sensitivity and Specificity | | | | | | Prevalence, %† | False Test Results per 1000 Patients | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Standard Plus POCUS | | | Standard Alone | | | | False-Negative Test Results | | | False-Positive Test Results | |
| | | Patient Range, *n* | Sensitivity, Range, % | Specificity Range, % | Patient Range, *n* | Sensitivity Range, % | Specificity Range, % | | Standard Plus POCUS Range, *n* | Standard Alone Range, *n* | Absolute Difference Range, *n* | Standard Plus POCUS Range, *n* | Standard Alone Range, *n* | Absolute Difference Range, *n* |
| Congestive heart failure (3 RCTs [17, 18, 20]) | Low‡ | 158–224 | 79–100 | 95–99 | 88–218 | 38–83 | 68–92 | 50 | 0–105 | 85–310 | **205 fewer–15 fewer** | 5–25 | 40–160 | 155 fewer–35 fewer |
| Pleural effusion (2 RCTs [17, 20]) | Low‡ | 58–168 | 89–100 | 98–100 | 8–157 | 17–18 | 98–100 | 5 | 0–5 | 41§ | 41 fewer–36 fewer | 0–19 | 0–19 | 0 fewer§ |
| Pneumonia (2 RCTs [17, 20]) | Low‡ | 58–168 | 92–92 | 63–98 | 8–157 | 14–83 | 72–97 | 40 | 32§ | 68–344 | **312 fewer–36 fewer** | 12–222 | 18–168 | **6 fewer–54 more** |
| Pulmonary embolism (2 RCTs [17, 20]) | Low‡ | 58–168 | 89–100 | 95–100 | 8–157 | 0–80 | 97–99 | 5 | 0–5 | 10–49 | **44 fewer–10 fewer** | 0–47 | 9–28 | **9 fewer–19 more** |
| | | | Downstream consequences‖ | | | | | | Delay or failure to initiate appropriate follow-up care | | | Delay in appropriate care. May lead to unnecessary follow-up care. | |

CGC = Clinical Guidelines Committee; POCUS = point-of-care ultrasonography; RCT = randomized controlled trial; TEP = technical expert panel.
* Studies did not report on pneumothorax. Absolute differences for false test results that were rated as critical outcomes (by type and condition) are boldfaced. Absolute differences for false test results that are not boldfaced were rated as important outcomes.
† The CGC and TEP estimated typical prevalence of specific underlying conditions in patients with acute dyspnea and low, medium, and high pretest probabilities, and estimates were informed by prevalence reported in the studies. For decision making in patients in whom there is diagnostic uncertainty, the CGC created evidence profiles for average prevalence expected to be seen in the emergency department (e.g., the proportion of patients with pulmonary embolism compared with the proportion of patients who have congestive heart failure and pneumonia in emergency department is relatively small). Table 3 of Supplement 1 provides clinical descriptions of low, medium, and high pretest probabilities according to specific condition.
‡ Small sample size; downgraded 2 steps for serious imprecision.
§ Same value across studies.
‖ Table 4 of Supplement 1 provides descriptions of potential clinical consequences of false-positive and false-negative test results according to specific condition.

*Pneumothorax.* No studies assessed the test accuracy of POCUS in addition to the standard diagnostic pathway for detecting pneumothorax.

*Pulmonary Embolism.* Low-certainty evidence showed that POCUS (lung, heart, inferior vena cava, and deep veins) in addition to the standard diagnostic pathway correctly identified 89% to 100% of patients with unspecified dyspnea who had pulmonary embolism and 95% to 100% of patients who did not have pulmonary embolism (7, 17, 20).

## Key Findings From the Systematic Review on Critical and Important Outcomes: POCUS as a Replacement Diagnostic Test

### *Health, Diagnostic, and Treatment Outcomes*

No studies reported on general health outcomes for POCUS as a replacement to the standard diagnostic pathway in patients with acute dyspnea. Three prospective cohort studies reported on diagnostic and treatment outcomes (22–24) in patients with unspecified dyspnea. Evidence was insufficient to assess correctness of diagnosis with POCUS as a replacement test compared with the standard diagnostic pathway, and no other outcomes were reported (7).

### *Test Accuracy*

Most studies did not report the test accuracy of the standard diagnostic pathway without POCUS, and comparative data are limited for specific conditions. Two studies (low-certainty evidence) reported sensitivity and specificity for POCUS as a replacement to the standard diagnostic pathway and the standard diagnostic pathway alone across various potential underlying conditions in patients with unspecified dyspnea (Table 2) (17, 19). The systematic review did not meta-analyze studies with high risk of bias; across all other included studies (regardless of whether comparative data were reported), sensitivities for POCUS as a replacement to the standard diagnostic pathway ranged from 40% to 100%, and specificities ranged from 58% to 100%, depending on indication and protocol (17, 19, 25–30). These findings are summarized here and reported in more detail in the systematic review (7) and Table 2 of Supplement 1.

*Congestive Heart Failure.* Moderate-certainty evidence showed that POCUS (lung) as a replacement test correctly identified 76% of patients with unspecified dyspnea who had congestive heart failure (CI, 48% to 91%) and 96% who did not have congestive heart failure (CI, 90% to 98%) (7, 17, 19, 25, 27, 29). Low-certainty evidence showed that POCUS (lung, heart, and inferior vena cava) correctly identified 88% of patients with unspecified dyspnea who had congestive heart failure (CI, 85% to 91%) and 96% of patients who did not have congestive heart failure (CI, 95% to 97%) (7, 30).

*Pleural Effusion.* Low-certainty evidence showed that POCUS (lung, heart, and deep veins; lung, heart, and inferior vena cava) as a replacement test correctly

***Figure 2.*** Frequencies of false test results when using POCUS in addition to the standard diagnostic pathway according to low, medium, and high pretest probabilities in patients with acute dyspnea across common underlying conditions.

| Underlying Condition (Studies, *n* [Reference]) | Certainty of Evidence | Patients, *n* | Pretest Probability (Prevalence, %)* | False Test Results per 1000 Patients† | |
|---|---|---|---|---|---|
| | | | | False-Negative Test Results Range, *n* | False-Positive Test Results Range, *n* |
| Congestive heart failure (3 RCTs [17, 18, 20]) | Low‡ | 544 | High (70)<br>Medium (50)<br>Low (20) | 0–147<br>0–105<br>0–42 | 3–15<br>5–25<br>8–40 |
| Pleural effusion (2 RCTs [17, 20]) | Low‡ | 326 | High (25)<br>Medium (15)<br>Low (5) | 0–27<br>0–17<br>0–6 | 0–15<br>0–17<br>0–19 |
| Pneumonia (2 RCTs [17,20]) | Low‡ | 326 | High (70)<br>Medium (40)<br>Low (20) | 56§<br>32§<br>16§ | 6–111<br>12–222<br>16–296 |
| Pulmonary embolism (2 RCTs [17, 20]) | Low‡ | 326 | High (20)<br>Medium (10)<br>Low (5) | 0–22<br>0–11<br>0–5 | 0–40<br>0–45<br>0–47 |

No evidence was available to assess the test accuracy of using POCUS in addition to the standard diagnostic pathway for suspected pneumothorax. No studies reported data on inconclusive test results or test complications. CGC = Clinical Guideline Committee; POCUS = point-of-care ultrasonography; RCT = randomized controlled trial; TEP = technical expert panel.

* The CGC and TEP estimated typical prevalence of specific underlying conditions in patients with acute dyspnea and low, medium, and high pretest probabilities, and estimates were informed by prevalence reported in the studies. Table 3 of Supplement 1 provides clinical descriptions of low, medium, and high pretest probabilities according to specific condition.

† Table 4 of Supplement 1 provides descriptions of clinical consequences of false-positive and false-negative test results according to specific condition.

‡ Small sample size; downgraded 2 steps for serious imprecision.

§ Same value across studies.

identified 78% to 89% of patients with unspecified dyspnea who had pleural effusion and 88% to 99% of patients who did not have pleural effusion (7, 17, 30).

*Pneumonia.* Moderate-certainty evidence showed that POCUS (lung; lung, heart, and deep veins; lung, heart, and inferior vena cava; lung, heart, deep veins, and inferior vena cava) as a replacement test correctly identified 52% to 88% of patients with mainly unspecified dyspnea who had pneumonia and correctly identified 58% to 92% of patients who did not have pneumonia (7, 17, 27, 28, 30).

*Pneumothorax.* Evidence is very uncertain (insufficient) about the test accuracy of POCUS as a replacement test for detecting pneumothorax in patients with unspecified dyspnea (7, 24, 30).

*Pulmonary Embolism.* Moderate-certainty evidence showed that POCUS (heart; lung, heart, and deep veins; lung, heart, and inferior vena cava; lung, heart, inferior vena cava, and deep veins) as a replacement test correctly identified 40% to 100% of patients with unspecified dyspnea who had pulmonary embolism and 97% to 100% of patients who did not have pulmonary embolism (7, 17, 26, 27, 30).

### Harms of POCUS in Addition to the Standard Diagnostic Pathway or as a Replacement Diagnostic Test

No studies reported direct complications due to POCUS or the downstream consequences of false-positive or false-negative results from POCUS or additional diagnostic interventions because of incidental findings. Few studies reported on indeterminate sonography results.

### Values and Preferences

No relevant literature was identified that assessed the values and preferences of patients with dyspnea for the selected outcomes.

Feedback from the CGC Public Panel showed preferences trending in favor of adding POCUS to the standard diagnostic pathway, mostly because of the findings for correctness of diagnosis. For POCUS as a replacement test, most CGC Public Panel members responded that they would not be willing to undergo POCUS.

### Costs

No studies were identified that reported on the costs of POCUS compared with standard diagnostic pathways in the United States. Table 3 presents the Medicare national average reimbursement rates by condition.

## Multiple Chronic Conditions: Clinical Considerations

Many ($n$ = 34) of the studies evaluated for this guideline included patients with 2 or more chronic conditions; thus, these recommendations likely apply to those with multiple chronic conditions. There may be differences in pretest probability depending on the individual clinical situation that would affect the test accuracy of POCUS in addition to or as a replacement for the standard diagnostic pathway.

## Areas of Inconclusive Evidence

Overall, evidence to make a recommendation for or against the use of POCUS as a replacement test in

***Table 2.*** Test Accuracy of POCUS as a Replacement Test Versus the Standard Diagnostic Pathway Alone in Patients With Acute Dyspnea Across Common Underlying Conditions*

| Underlying Condition (Studies, *n* [Reference]) | Certainty of Evidence | Sensitivity and Specificity | | | | | | Prevalence, %† | False Test Results per 1000 Patients | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | POCUS as a Replacement Test | | | Standard Alone | | | | False-Negative Test Results | | | False-Positive Test Results | | |
| | | Patient Range, *n* | Sensitivity, Range, % | Specificity Range, % | Patient Range, *n* | Sensitivity (95% CI), % | Specificity (95% CI), % | | POCUS Range, *n* | Standard Alone Range, *n* | Absolute Difference Range, *n* | POCUS Range, *n* | Standard Alone Range, *n* | Absolute Difference Range, *n* |
| Congestive heart failure (2 RCTs [17, 19] | Low‡ | 158–258 | 68–94 | 93–96 | 157–258 | 38–85 | 89–92 | 50 | 30–160 | 75–310 | **150 fewer–45 fewer** | 5–20 | 40 –55 | 35 fewer |
| Pleural effusion (1 RCT [17]) | Low‡ | 158 | 89 | 88 | 157 | 18 (5–40) | 98 (95–100) | 5 | 5 | 41 | 36 fewer | 114 | 19 | 95 more |
| Pneumonia (1 RCT [17]) | Low‡ | 158 | 60 | 59 | 157 | 83 (72–92) | 72 (62–81) | 40 | 160 | 68 | **92 more** | 246 | 168 | **78 more** |
| Pulmonary embolism (1 RCT [17]) | Low‡ | 158 | 63 | 97 | 157 | 80 (28–100) | 97 (93–99) | 5 | 18 | 10 | **8 more** | 28 | 28 | **0 fewer** |
| | | | Downstream consequences§ | | | | | | Delay or failure to initiate appropriate follow-up care | | | Delay in appropriate care. May lead to unnecessary follow-up care. | | |

CGC = Clinical Guideline Committee; POCUS = point-of-care ultrasonography; RCT = randomized controlled trial; TEP = technical expert panel.
* Studies did not report on pneumothorax. Absolute differences for false test results that were rated as critical outcomes (by type and condition) are boldfaced. Absolute differences for false test results that are not boldfaced were rated as important outcomes.
† The CGC and TEP estimated typical prevalence of specific underlying conditions in patients with acute dyspnea and low, medium, and high pretest probabilities, and estimates were informed by prevalence reported in the studies. For decision making in patients in whom there is diagnostic uncertainty, the CGC created evidence profiles for average prevalence expected to be seen in the emergency department (e.g., the proportion of patients with pulmonary embolism compared with the proportion of patients who have congestive heart failure and pneumonia in emergency department is relatively small). Table 3 of Supplement 1 provides clinical descriptions of low, medium, and high pretest probabilities according to specific condition.
‡ Only 1 or 2 studies and small sample size, probably not enough to meet optimal information size threshold; downgraded 2 steps for serious imprecision.
§ Table 4 of Supplement 1 provides descriptions of clinical consequences of false-positive and false-negative test results according to specific condition.

patients with acute dyspnea is inconclusive, given the absence of any direct evidence on health outcomes.

On the basis of the data included in this guideline and the accompanying systematic review (7), the effect of the amount and type of physician training and type of device used on the outcomes remained unclear. More research is needed to understand the linkage among physician training, device type, and health outcomes.

## Areas of No Evidence

No studies provided information for the following outcomes when POCUS was used in addition to the standard diagnostic pathway or as a replacement test in patients with acute dyspnea: quality of life, admissions to intensive care units, and disease-specific health outcomes (unnecessary use of antibiotics, need to use breathing support, time to referral, and lung computed tomography [proportion of patients]). No studies reported the consequences of false-positive or false-negative findings from POCUS in addition to the standard diagnostic pathway or as a replacement test, including additional or downstream testing.

## Recommendation

Supplement 2 (available at Annals.org) presents a graphic summary of the recommendation, evidence and rationale, and clinical considerations.

*Recommendation: ACP suggests that clinicians may use point-of-care ultrasonography in addition to the standard diagnostic pathway when there is diagnostic uncertainty in patients with acute dyspnea in emergency department or inpatient settings (conditional recommendation; low-certainty evidence).*

## Rationale

The rationale to add POCUS to the standard diagnostic pathway is largely based on diagnostic accuracy studies and encompasses several considerations. First, POCUS increased the proportion of correct diagnoses by 32% when used in addition to the standard diagnostic pathway (moderate-certainty evidence). Second, the test accuracy, particularly sensitivity, of standard diagnostic testing with the addition of POCUS is better than the test accuracy of standard diagnostic pathway alone without a substantial tradeoff in specificity (low-certainty evidence) (Table 1). The test accuracy of POCUS is generally acceptable, particularly for diagnosis of congestive heart failure or pleural effusion, although the usefulness of POCUS varies somewhat according to the underlying disease (Table 1 and Figure 2; see Clinical Considerations). Third, it is unlikely that POCUS is directly associated with serious harms. Finally, POCUS is not a high-cost test (Table 3). Of note, although correctness of diagnosis was not a prespecified outcome of importance, the CGC believed it was likely of value to patients and clinicians and was likely to

***Table 3.*** National Average Medicare Reimbursement Rates for the Diagnostic Work-up of Common Underlying Conditions for Acute Dyspnea, With POCUS and Without POCUS*

| Work-up Component | Medicare Reimbursement Rate† | | Relevant Work-up Components by Condition‡ | | | | |
|---|---|---|---|---|---|---|---|
| | Physician, *U.S. $* | Hospital ED or Laboratory, *U.S. $* | Congestive Heart Failure | Pulmonary Embolism | Pleural Effusion | Pneumonia | Pneumothorax |
| Ultrasonography, chest cardiac, limited | 26 | 233 | ✓ | – | – | – | – |
| Ultrasonography, chest, real-time imaging, and documentation | 30 | 112 | – | ✓ | ✓ | ✓ | ✓ |
| Electrocardiography | 17 | – | ✓ | – | – | – | – |
| Complete blood count without differential | – | 6 | ✓ | – | – | – | – |
| Brain natriuretic peptide | – | 39 | ✓ | – | – | – | – |
| Chest radiography | 11 | 80 | ✓ | – | ✓ | ✓ | ✓ |
| D-dimer | – | 10 | – | ✓ | – | – | – |
| Total sum of national average reimbursement rates for standard work-up | | | | | | | |
| Without POCUS, *U.S. $* | | | 153 | 10 | 91 | 91 | 91 |
| With POCUS, *U.S. $* | | | 412 | 152 | 233 | 233 | 233 |

ED = emergency department; POCUS = point-of-care ultrasonography.
*Hospital ED visits are paid under the Medicare Outpatient Prospective Payment System called the Ambulatory Payment Classifications system. Each Ambulatory Payment Classification comprises services that are similar in clinical intensity, resource use, and cost. Services in the ED followed by inpatient stays or services during inpatient stays are not individually reimbursed. These services are paid in an episode-of-care bundle under Medicare's Inpatient Prospective Payment System. Laboratory services, although not the clinical services provided to evaluate need for laboratory work, are paid under the Medicare Clinical Laboratory Fee Schedule. Sources: Medicare fee schedules (www.cms.gov/Medicare/Medicare-Fee-for-Service-Payment/PhysicianFeeSched; www.cms.gov/Medicare/Medicare-Fee-for-Service-Payment/ClinicalLabFeeSched; www.cms.gov/Medicare/Medicare-Fee-for-Service-Payment/HospitalOutpatientPPS/Addendum-A-and-Addendum-B-Updates; https://www.cms.gov/medicaremedicare-fee-service-paymentdmeposfeescheddmepos-fee-schedule/dme20).
† The 2020 national average rates for participating providers (physicians, hospitals, and laboratories). Costs rounded to nearest U.S. dollar.
‡ The ✓ indicates included in work-up.

correlate with the delivery of appropriate care and improved health outcomes.

The CGC graded this as a conditional recommendation because there was limited evidence examining the effect of POCUS on health outcomes, and there are many uncertainties related to variation in testing protocols, training, clinician experience, clinical setting, and equipment. Limited evidence on health outcomes showed that POCUS did not reduce hospital length of stay or readmissions (moderate-certainty evidence). However, there was no increase in length of stay with the addition of POCUS. The CGC determined that the lack of demonstrated effects on other health outcomes was either of low certainty or insufficient and thus does not preclude clinically meaningful benefits, especially given the supporting evidence on correctness of diagnosis and test accuracy as well as the lack of evidence of serious harms or high costs.

## Clinical Considerations

- The included studies enrolled adult patients presenting in EDs and inpatient settings with dyspnea as a primary symptom (unspecified acute dyspnea) and who were later confirmed to have 1 of the conditions of interest (congestive heart failure [including pulmonary edema], pleural effusion, pneumonia, pneumothorax, or pulmonary embolism).
- Findings may differ in outpatient settings. Thus, our recommendation applies to EDs and inpatient settings.
- The systematic review excluded studies that included patients with other medical conditions that can cause dyspnea (for example, chronic obstructive pulmonary disease, asthma, acute coronary symptoms, and trauma) if the patients were not also confirmed to have 1 of the conditions of interest.
- This recommendation does not apply to handheld devices; evidence from 1 high risk of bias study is very uncertain (insufficient) about the effect of handheld POCUS devices in addition to the standard pathway on health, diagnostic, and treatment outcomes. Future research is needed to assess the effectiveness, harms, and diagnostic accuracy characteristics of handheld devices.
- Clinicians who use POCUS should be trained in the use and interpretation of findings and ongoing care quality assessment. This is an important area for future research: In the included studies, the experience and training of POCUS operators varied and reporting was limited.
- As with any diagnostic test, this recommendation applies to clinical scenarios where there is diagnostic uncertainty. Clinicians should understand and consider that the test accuracy of POCUS varies according to the likelihood of underlying diseases.
- Figure 2 shows that, using the prevalence estimates of various conditions reported in the studies, the rate of false-positive test results for pneumonia and pulmonary embolism may be higher than what many clinicians and patients are comfortable with, especially because false-positive results for these conditions may lead to unnecessary use of anticoagulation and antibiotics.
- Clinicians can also review Figure 2 and consider that the severity of consequences of false-negative or false-positive test results may differ according to

condition. Table 4 of Supplement 1 provides clinical descriptions of potential consequences according to specific conditions: It may be more "serious" to miss a diagnosis of pneumonia or pulmonary embolism than to miss a diagnosis of heart failure or pleural effusion.

- However, we do not have direct evidence about the health outcome effect of false-negative or false-positive testing in POCUS.
- In patients who are clinically unstable, the use of POCUS should not delay management actions derived from results of other diagnostic tests in the pathway.
- The extent of organs and anatomical sites imaged varied across included studies, with some confined to the lungs, whereas others included more comprehensive assessment of the inferior vena cava, deep veins, and heart. Clinicians should focus POCUS on anatomical sites consistent with their diagnostic and treatment uncertainties.

From American College of Physicians, Philadelphia, Pennsylvania (A.Q., I.E.); University of Kansas Medical Center, Kansas City, Kansas (R.A.M.); Portland VA Medical Center, Portland, Oregon (D.K.); Northwell Health, Huntington, New York (N.F.); and Minneapolis VA Medical Center, Minneapolis, Minnesota (T.J.W.).

**Note:** Clinical practice guidelines are "guides" only and may not apply to all patients and all clinical situations. Thus, they are not intended to override clinicians' judgment. All ACP clinical practice guidelines are considered automatically withdrawn or invalid 5 years after publication, or once an update has been issued.

**Acknowledgment:** The CGC thanks members of the ACP Guidelines Public Panel for their review and comments on the article from a patient perspective: Cynthia Appley, Larry Curley, Ray Haeme, James Pantelas, Billy Oglesby, Missy Carson Smith, and Lelis Vernon. The authors also thank Yuqing "Madison" Zhang, MD, PhD, MSc, for her methodological review and input on the draft guideline.

**Financial Support:** Financial support for the development of this guideline comes exclusively from the ACP operating budget.

**Disclosures:** All financial and intellectual disclosures of interest were declared and potential conflicts were discussed and managed. No committee members were recused from participation due to a conflict of interest. A record of disclosures of interest and management of conflicts is kept for each CGC meeting and conference call and can be viewed at www.acponline.org/clinical_information/guidelines/guidelines/conflicts_cgc.htm. Disclosures can also be viewed at www.acponline.org/authors/icmje/ConflictOfInterestForms.do?msNum=M20-7844.

**Corresponding Author:** Amir Qaseem, MD, PhD, MHA, American College of Physicians, 190 N. Independence Mall West, Philadelphia, PA 19106; e-mail, aqaseem@acponline.org.

Current author addresses and author contributions are available at Annals.org.

## References

1. **Narula J, Chandrashekhar Y, Braunwald E.** Time to add a fifth pillar to bedside physical examination: inspection, palpation, percussion, auscultation, and insonation. JAMA Cardiol. 2018;3:346-350. [PMID: 29490335] doi:10.1001/jamacardio.2018.0001
2. **Kobal SL, Trento L, Baharami S, et al.** Comparison of effectiveness of hand-carried ultrasound to bedside cardiovascular physical examination. Am J Cardiol. 2005;96:1002-6. [PMID: 16188532]
3. **Panoulas VF, Daigeler AL, Malaweera AS, et al.** Pocket-size hand-held cardiac ultrasound as an adjunct to clinical examination in the hands of medical students and junior doctors. Eur Heart J Cardiovasc Imaging. 2013;14:323-30. [PMID: 22833550] doi:10.1093/ehjci/jes140
4. **Vourvouri EC, Poldermans D, Deckers JW, et al.** Evaluation of a hand carried cardiac ultrasound device in an outpatient cardiology clinic. Heart. 2005;91:171-6. [PMID: 15657226]
5. **Parshall MB, Schwartzstein RM, Adams L, et al; American Thoracic Society Committee on Dyspnea.** An official American Thoracic Society statement: update on the mechanisms, assessment, and management of dyspnea. Am J Respir Crit Care Med. 2012;185:435-52. [PMID: 22336677] doi:10.1164/rccm.201111-2042ST
6. **Rui P, Kang K, Ashman JJ.** National Hospital Ambulatory Medical Care Survey: 2016 emergency department summary tables. Accessed at www.cdc.gov/nchs/ahcd/ahcd_products.htm on 25 March 2021.
7. **Gartlehner G, Wagner G, Affengruber L, et al.** Point-of-care ultrasonography in patients with acute dyspnea: an evidence report for a clinical practice guideline by the American College of Physicians. Ann Intern Med. 27 April 2021. [Epub ahead of print]. doi:10.7326/M20-5504
8. **Qaseem A, Kansagara D, Lin JS, et al; Clinical Guidelines Committee of the American College of Physicians.** The development of clinical guidelines and guidance statements by the Clinical Guidelines Committee of the American College of Physicians: update of methods. Ann Intern Med. 2019;170:863-870. [PMID: 31181568]. doi:10.7326/M18-3290
9. **Qaseem A, Wilt TJ; Clinical Guidelines Committee of the American College of Physicians.** Disclosure of interests and management of conflicts of interest in clinical guidelines and guidance statements: methods from the Clinical Guidelines Committee of the American College of Physicians. Ann Intern Med. 2019;171:354-361. [PMID: 31426089]. doi:10.7326/M18-3279
10. **Schünemann H, Brożek J, Guyatt G, et al, eds.** GRADE Handbook. Updated October 2013. Accessed at https://gdt.gradepro.org/app/handbook/handbook.html on 24 February 2020.
11. **GRADEpro GDT: GRADEpro Guideline Development Tool.** McMaster University and Evidence Prime; 2015. Available at https://gradepro.org/.
12. **Carlino MV, Paladino F, Sforza A, et al.** Assessment of left atrial size in addition to focused cardiopulmonary ultrasound improves diagnostic accuracy of acute heart failure in the emergency department. Echocardiography. 2018;35:785-791. [PMID: 29522655] doi:10.1111/echo.13851
13. **Colclough A, Nihoyannopoulos P.** Pocket-sized point-of-care cardiac ultrasound devices: role in the emergency department. Herz. 2017;42:255-261. [PMID: 28341982] doi:10.1007/s00059-016-4531-4
14. **Filopei J, Siedenburg H, Rattner P, et al.** Impact of pocket ultrasound use by internal medicine housestaff in the diagnosis of dyspnea. J Hosp Med. 2014;9:594-7. [PMID: 24891227] doi:10.1002/jhm.2219
15. **Kajimoto K, Madeen K, Nakayama T, et al.** Rapid evaluation by lung-cardiac-inferior vena cava (LCI) integrated ultrasound for differentiating

heart failure from pulmonary disease as the cause of acute dyspnea in the emergency setting. Cardiovasc Ultrasound. 2012;10:49. [PMID: 23210515] doi:10.1186/1476-7120-10-49
16. **Sforza A, Mancusi C, Carlino MV, et al.** Diagnostic performance of multi-organ ultrasound with pocket-sized device in the management of acute dyspnea. Cardiovasc Ultrasound. 2017;15:16. [PMID: 28629375] doi:10.1186/s12947-017-0105-8
17. **Laursen CB, Sloth E, Lassen AT, et al.** Point-of-care ultrasonography in patients admitted with respiratory symptoms: a single-blind, randomised controlled trial. Lancet Respir Med. 2014;2:638-46. [PMID: 24998674] doi:10.1016/S2213-2600(14)70135-3
18. **Baker K, Brierley S, Kinnear F, et al.** Implementation study reporting diagnostic accuracy, outcomes and costs in a multicentre randomised controlled trial of non-expert lung ultrasound to detect pulmonary oedema. Emerg Med Australas. 2020;32:45-53. [PMID: 31207146] doi:10.1111/1742-6723.13333
19. **Pivetta E, Goffi A, Nazerian P, et al; Study Group on Lung Ultrasound from the Molinette and Careggi Hospitals.** Lung ultrasound integrated with clinical assessment for the diagnosis of acute decompensated heart failure in the emergency department: a randomized controlled trial. Eur J Heart Fail. 2019;21:754-766. [PMID: 30690825] doi:10.1002/ejhf.1379
20. **Pirozzi C, Numis FG, Pagano A, et al.** Immediate versus delayed integrated point-of-care-ultrasonography to manage acute dyspnea in the emergency department. Crit Ultrasound J. 2014;6:5. [PMID: 24940478] doi:10.1186/2036-7902-6-5
21. **De Carvalho H, Javaudin F, Le Bastard Q, et al.** Effect of chest ultrasound on diagnostic workup in elderly patients with acute respiratory failure in the emergency department: a prospective study. Eur J Emerg Med. 2021;28:29-33. [PMID: 32568788] doi:10.1097/MEJ.0000000000000732
22. **Silva S, Biendel C, Ruiz J, et al.** Usefulness of cardiothoracic chest ultrasound in the management of acute respiratory failure in critical care practice. Chest. 2013;144:859-865. [PMID: 23670087] doi:10.1378/chest.13-0167
23. **Mantuani D, Frazee BW, Fahimi J, et al.** Point-of-care multi-organ ultrasound improves diagnostic accuracy in adults presenting to the emergency department with acute dyspnea. West J Emerg Med. 2016;17:46-53. [PMID: 26823930] doi:10.5811/westjem.2015.11.28525
24. **Sen S, Acash G, Sarwar A, et al.** Utility and diagnostic accuracy of bedside lung ultrasonography during medical emergency team (MET) activations for respiratory deterioration. J Crit Care. 2017;40:58-62. [PMID: 28342384] doi:10.1016/j.jcrc.2017.03.007
25. **Buessler A, Chouihed T, Duarte K, et al.** Accuracy of several lung ultrasound methods for the diagnosis of acute heart failure in the ED: a multicenter prospective study. Chest. 2020;157:99-110. [PMID: 31381880] doi:10.1016/j.chest.2019.07.017
26. **Filipiak-Strzecka D, Kasprzak JD, Lipiec P.** Brief cardiovascular imaging with pocket-size ultrasound devices improves the accuracy of the initial assessment of suspected pulmonary embolism. Int J Cardiovasc Imaging. 2018;34:1595-1605. [PMID: 29850969] doi:10.1007/s10554-018-1382-5
27. **Laursen CB, Sloth E, Lambrechtsen J, et al.** Focused sonography of the heart, lungs, and deep veins identifies missed life-threatening conditions in admitted patients with acute respiratory symptoms. Chest. 2013;144:1868-1875. [PMID: 23948720] doi:10.1378/chest.13-0882
28. **Perrone T, Maggi A, Sgarlata C, et al.** Lung ultrasound in internal medicine: a bedside help to increase accuracy in the diagnosis of dyspnea. Eur J Intern Med. 2017;46:61-65. [PMID: 28793969] doi:10.1016/j.ejim.2017.07.034
29. **Sartini S, Frizzi J, Borselli M, et al.** Which method is best for an early accurate diagnosis of acute heart failure? Comparison between lung ultrasound, chest X-ray and NT pro-BNP performance: a prospective study. Intern Emerg Med. 2017;12:861-869. [PMID: 27401330] doi:10.1007/s11739-016-1498-3
30. **Zanobetti M, Scorpiniti M, Gigli C, et al.** Point-of-care ultrasonography for evaluation of acute dyspnea in the ED. Chest. 2017;151:1295-1301. [PMID: 28212836] doi:10.1016/j.chest.2017.02.003
31. **Higgins JPT, Sterne JAC, Savović J, et al.** A revised tool for assessing risk of bias in randomized trials. Cochrane Database Syst Rev. 2016;10(Suppl 1):29-31.
32. **Whiting PF, Rutjes AW, Westwood ME, et al; QUADAS-2 Group.** QUADAS-2: a revised tool for the quality assessment of diagnostic accuracy studies. Ann Intern Med. 2011;155:529-36. [PMID: 22007046]. doi:10.7326/0003-4819-155-8-201110180-00009

**Current Author Addresses:** Dr. Qaseem: American College of Physicians, 190 N. Independence Mall West, Philadelphia, PA 19106.
Dr. Etxeandia-Ikobaltzeta: 1, Santa Margarita Hospital Street, Ground Floor 2, Office 1, Room 2, 20303 Irun, Gipuzkoa, Spain.
Dr. Mustafa: 3901 Rainbow Boulevard, MS3002, Kansas City, KS 66160.
Dr. Kansagara: Portland VA Medical Center, 3710 SW US Veterans Hospital Road, Portland, OR 97239.
Dr. Fitterman: Northwell Health, 270 Park Avenue, Huntington, NY 11743.
Dr. Wilt: VA Medical Center 111-0, Minneapolis, MN, 55417.

**Author Contributions:** Conception and design: A. Qaseem, I. Etxeandia-Ikobaltzeta, R.A. Mustafa, D. Kansagara, N. Fitterman, T.J. Wilt, M.A. Forciea, R. McLean, J.E. Tufte.
Analysis and interpretation of the data: A. Qaseem, I. Etxeandia-Ikobaltzeta, R.A. Mustafa, D. Kansagara, N. Fitterman, T.J. Wilt, M.A. Forciea, P. Batur, T.G. Cooney, C.J. Crandall, R. McLean, J. Tice, S. Vijan.
Drafting of the article: A. Qaseem, I. Etxeandia-Ikobaltzeta, R.A. Mustafa, D. Kansagara, N. Fitterman, T.J. Wilt, C. Horwitch, J.E. Tufte.
Critical revision of the article for important intellectual content: A. Qaseem, I. Etxeandia-Ikobaltzeta, R.A. Mustafa, D. Kansagara, N. Fitterman, T.J. Wilt, M.A. Forciea, T.G. Cooney, C. J. Crandall, L.A. Hicks, J.S. Lin, R. McLean, J. Tice, J.E. Tufte, S. Vijan.
Final approval of the article: A. Qaseem, I. Etxeandia-Ikobaltzeta, R.A. Mustafa, D. Kansagara, N. Fitterman, T.J. Wilt, M.A. Forciea, P. Batur, T.G. Cooney, C.J. Crandall, L.A. Hicks, C. Horwitch, J.S. Lin, M. Maroto, R. McLean, J. Tice, J.E. Tufte, S. Vijan.
Provision of study materials or patients: I. Etxeandia-Ikobaltzeta.
Statistical expertise: A. Qaseem, T.J. Wilt.
Administrative, technical, or logistic support: A. Qaseem, I. Etxeandia-Ikobaltzeta, T.J. Wilt.
Collection and assembly of data: I. Etxeandia-Ikobaltzeta, D. Kansagara.

## Appendix: Detailed Methods of the Systematic Review and Guideline

Cochrane Austria at Danube University Krems conducted the supporting systematic review. Details of the ACP guideline development process can be found in ACP's methods articles (8, 9). Disclosure of interests and management of any conflicts can be found at https://www.acponline.org/clinical_information/guidelines/guidelines/conflicts_cgc.htm.

### Key Questions Addressed

Key question 1: In patients with acute dyspnea, what are the beneficial and harmful health effects of POCUS plus clinical examination compared with clinical examination alone?

Key question 2: What is the diagnostic test accuracy of POCUS in patients with acute dyspnea to detect congestive heart failure, pneumonia, pulmonary embolism, pleural effusion, or pneumothorax as the underlying cause of acute dyspnea?

### Search Strategy of Systematic Review

Reviewers searched several databases for studies and systematic reviews published in English from 2004 to August 2020.

### Quality Assessment, Synthesis, and Overall Certainty of Evidence

Reviewers used the Cochrane Risk of Bias Tool (31) and the QUADAS-2 (Quality Assessment of Diagnostic Accuracy Studies 2) tool (32) to assess the risk of bias for randomized controlled trials and diagnostic accuracy studies, respectively.

### Population Studied

Adult patients with unspecified acute dyspnea or acute dyspnea due to a suspected diagnosis of congestive heart failure (including pulmonary edema), pneumonia, pulmonary embolism, pleural effusion, or pneumothorax.

### Interventions Evaluated

Bedside POCUS (trolley- or cart-based, compact-handheld, or application-based) in addition to clinical examination with or without a standard diagnostic pathway.

### Comparators

Standard diagnostic pathway without POCUS; reference tests: chest radiography, echocardiography, laboratory values for congestive heart failure, chest radiography and computed tomography scan for pleural effusion and pneumonia, chest radiography for pneumothorax, and computed tomography pulmonary angiography and ventilation perfusion scanning for pulmonary embolism.

### Outcomes

Members of the CGC (clinicians and nonclinician public members) and the CGC Public Panel members were asked a priori to independently rate the importance of evaluated outcomes.

### Setting

Hospital settings (ED, intensive care units, and nonintensive care settings) in countries with a "very high" Human Development Index.

### Target Audience

The target audience is all clinicians.

### Target Patient Population

The target patient population is adult patients with acute dyspnea in ED or inpatient settings.

### Public or Patient Involvement

The development of this guideline also included perspectives, values, and preferences of 2 nonphysician CGC members who represent the public and a 7-member CGC Public Panel. In addition, the CGC Public Panel was also surveyed to assess their preferences with regards of the intervention options.

*Appendix Table.* Outcome Ratings for the Appropriate Use of POCUS in Patients With Acute Dyspnea in Emergency Department or Inpatient Settings

| Critical Outcomes | Important Outcomes |
|---|---|
| False-positive results for suspected pneumonia | Correctness of diagnosis |
| False-positive results for suspected pneumothorax | Hospital admission/readmission |
| False-positive results for suspected pulmonary embolism | Hospital length of stay |
| False-negative results for suspected congestive heart failure | False-positive results for suspected congestive heart failure |
| False-negative results for suspected pneumonia | False-negative results for suspected pleural effusion |
| False-negative results for suspected pneumothorax | False-positive results for suspected pleural effusion |
| False-negative results for suspected pulmonary embolism | Intensive care unit admission |
| In-hospital mortality | Need to use breathing support |
| Time to treatment | Proportion of patients to receive lung computed tomography |
| Time to diagnosis | Quality of life |
| | Time to referral |
| | Unnecessary use of antibiotics |

POCUS = point-of-care ultrasonography.

## Cost Search

ACP staff searched PubMed (MEDLINE) from inception to February 2020. ACP staff searched several other databases (National Health Service Economic Evaluation Database, Database of Abstracts of Reviews of Effects, and the Health Technology Assessment database) from inception through 2015, at which point the databases stopped adding records. The search used a modified search string strategy from the clinical effectiveness review that added cost, resource use, and economic search terms as identified by the Canadian Agency for Drugs and Technologies in Health Information Services Filters Working Group.

ACP staff used the Medicare Fee Schedules to identify Medicare reimbursements fees for POCUS and other tests included in the standard diagnostic work-up for the included conditions. The search yielded 779 citations, of which 6 were selected for full-text review.

## Peer Review

The supporting systematic review and guideline each had a peer review process through the journal. The guideline was posted online for comments from ACP Regents and ACP Governors, who represent internal medicine and its subspecialty physician members at the national and international levels.