Bibliographic Cite	PMID Link	Literature Type	Level of Evidence	Objectives	Population	Intervention and Outcome Measures	Results/Recommendations	Study Limitations
Chen F, Shen YH, Zhu XQ, et al. Comparison between CT and MRI in the assessment of pulmonary embolism: A meta-analysis. Medicine (Baltimore). 2017;96(52):e8935.	29384894	Meta-analysis	Low	To perform a preliminary assessment of CT compared with MRI for diagnosing PE.	Ten studies with 590 cases were involved in the study. The inclusion criteria were as follows: CT and MRI were used to detect PE; the sensitivity and specificity of CT and MRI wereclearly noted; the complications happened in treatment were clearly declared; at least 10 patients entered; no lapping data was included.	A comprehensive computer search was conducted through internet up to July 2016. The quality assessment wasperformed by the Quality Assessment Tool for Diagnostic Accuracy Studies, version 2 tool. The diagnostic value of comparison between MRI and CT was evaluated by using the pooled estimate of sensitivity, specificity, and summary receiver operating characteristic (SROC) curve. In addition, sensitivity analysis and bias analysis were applied to ensure the accuracy of the results.	Heterogeneity existed in analysis of both CT and MRI. The pooled sensitivity of CT was 0.90 (95% CI: 0.85–0.93), pooled specificity was 0.88 (95% CI: 0.77 to 0.95), the pooled sensitivity of MRI was 0.92 (95% CI: 0.89–0.94), and pooled specificity was 0.91 (95% CI: 0.77–0.97). The Q index of sensitivity and specificity for CT and MRI were 71.38, 19.67, 47.14, and 12.35, respectively. The SROC curve area under the curve of CT and MRI were 0.94 (95% CI: 0.91–0.96) and 0.93 (95%CI: 0.91–0.95), respectively. This meta-analysis demonstrates that MRI has better sensitivity and specificity in detecting subsegmental artery PE. MRI is a relatively better detection technique for PE. This conclusion is consistent with many published researches.	Taking publication bias into consideration, there still existed several limitations. First, the analysis could be more abundant if data was comprehensive. Second, the total sampling size was needed to be more since a big sampling capacity can provide a more trustworthy result.
Crawford F, Andras A, Welch K, et al. D-dimer test for excluding the diagnosis of pulmonary embolism. Cochrane Database Syst Rev. 2016(8):CD010864.	27494075	Systematic review	High for d dimer and PE, low for age adjusted d dimer	To investigate the ability of the D-dimer test to rule out a diagnosis of acute PE in patients treated in hospital outpatient and accident and emergency (A&E) settings who have had a pre-test probability (PTP) of PE determined according to a clinical prediction rule (CPR), by estimating the accuracy of the test according to estimates of sensitivity and specificity. The review focuses on those patients who are not already established on anticoagulation at the time of study recruitment.	Literature search of 13 databases from conception until December 2013 with cross-check of the reference lists of relevant studies. SELECTION CRITERIA: Two review authors independently applied exclusion criteria to full papers and resolved disagreements by discussion. The authors included cross-sectional studies of D-dimer in which ventilation/perfusion (V/Q) scintigraphy, computerised tomography pulmonary angiography (CTPA), selective pulmonary angiography and magnetic resonance pulmonary angiography (MRPA) were used as the reference standard. PARTICIPANTS: Adults who were managed in hospital outpatient and A&E settings and were suspected of acute PE were eligible for inclusion in the review if they had received a pre-test probability score based on a CPR.	INDEX TESTS: quantitative, semi quantitative and qualitative D-dimer tests. Target condition: acute symptomatic PE. Reference standards: The authors included studies that used pulmonary angiography, V/Q scintigraphy, CTPA and MRPA as reference standard tests.; DATA COLLECTION AND ANALYSIS: Two review authors independently extracted data and assessed quality using Quality Assessment of Diagnostic Accuracy Studies-2 (QUADAS-2). The authors resolved disagreements by discussion. Review authors extracted patient-level data when available to populate 2 x 2 contingency tables (true-positives (TPs), true-negatives (TNs), false-positives (FPs) and false-negatives (FNs)).	MAIN RESULTS: The authors included four studies in the review (n = 1585 patients). None of the studies were at high risk of bias in any of the QUADAS-2 domains, but some uncertainty surrounded the validity of studies in some domains for which the risk of bias was uncertain. D-dimer assays demonstrated high sensitivity in all four studies, but with high levels of false-positive results, especially among those over the age of 65 years. Estimates of sensitivity ranged from 80% to 100%, and estimates of specificity from 23% to 63%.; AUTHORS' CONCLUSIONS: A negative D-dimer test is valuable in ruling out PE in patients who present to the A&E setting with a low PTP. Evidence from one study suggests that this test may have less utility in older populations, but no empirical evidence was available to support an increase in the diagnostic threshold of interpretation of D-dimer results for those over the age of 65 years.	Limited evidence provided by the studies included in this review suggests that quantitative D-dimer tests used in emergency departments result in few false-negatives but very high levels of falsepositive results, with a high level of sensitivity consistently evident across all age groups. This makes the test useful as a rule-out test but means that a positive result will require further investigation with diagnostic imaging test(s).
Dong C, Zhou M, Liu D, et al. Diagnostic accuracy of computed tomography for chronic thromboembolic pulmonary hypertension: A systematic review and meta-analysis. PLoS ONE. 2015;10(4):e0126985.	25923810	Systematic review and meta-analysis	Moderate	This study aimed to determine the diagnostic accuracy of computed tomography imaging for the diagnosis of chronic thromboembolic pulmonary hypertension (CTEPH). Additionally, the effect of test and study characteristics was explored.	Systematic Review of studies published between 1990 and 2015 identified by PubMed, OVID search and citation tracking were examined. Of the 613 citations, 11 articles (n=712) met the inclusion criteria.	Diagnostic accuracy of computed tomography imaging for the diagnosis of chronic thromboembolic pulmonary hypertension (CTEPH). QUADAS-2 tool was used to assess the quality of studies included. Based on the results from the derived contingency tables, pooled sensitivity, specificity andDOR were calculated.	The patient-based analysis demonstrated a pooled sensitivity of 76% (95% confidence interval [CI]: 69% to 82%), and a pooled specificity of 96% (95%CI: 93% to 98%). This resulted in a pooled diagnostic odds ratio (DOR) of 191 (95%CI: 75 to 486). The vessel-based analyses were divided into 3 levels: total arteries, main+ lobar arteries, and segmental arteries.The pooled sensitivity were 88% (95%CI: 87% to 90%)95% (95%CI: 92% to 97%) and 88% (95%CI: 87% to 90%), respectively, with a pooled specificity of 90% (95%CI: 88% to 91%)96% (95%CI: 94% to 97%) and 89% (95% CI: 87% to 91%). This resulted in a pooled diagnostic odds ratio of 76 (95%CI: 23 to 254),751 (95%CI: 57 to 9905) and 189 (95%CI: 21 to 1072), respectively.	Our meta-analysis has the following potential limitations. First, the number of included studies was insufficient. This might reduce the statistical power of meta-analysis. Second, the authors' metaanalysis combined results from trials with different CT techniques, which may lead to bias. Third, patients referred for suspected or confirmed CTEPH may lead to bias although subgroup analysis revealed no significant effect of patient selection. Fourth, the reference standards of included studies referred as DSA or V/Q scanning influence the reliability of the pooled data - differential verification. Fifth, although subgroup analyses were conducted in overall arterials, some potential factors might be missed such as the contrast agent and the prevalence. High degree of heterogeneity not explained by study quality or technique factors alone.
Fabia Valls MJ, van der Hulle T, den Exter PL, et al. A. Performance of a diagnostic algorithm based on a prediction rule, D-dimer and CT-scan for pulmonary embolism in patients with previous venous thromboembolism. A systematic review and meta-analysis. Thromb Haemost. 2015;113(2):406-13.	25373512	Systematic review and meta-analysis	High	To evaluate the safety and efficiency of the standard diagnostic algorithm consisting of a CPR, D-dimer test and computed tomography pulmonary angiography (CTPA) in this specific patient category.	Systematic literature search and review for prospective studies evaluating a diagnostic algorithm in consecutive patients with clinically suspected PE and a history of VTE. Four studies concerning 1,286 patients were included.	The VTE incidence rates during three-month follow-up and the number of indicated CTPAs were pooled using random effect models.	1,286 patients were included with a pooled baseline PE prevalence of 36% (95% confidence interval [CI] 30-42). In only 217 patients (15%; 95%CI 11-20) PE could be excluded without CTPA. The three-month VTE incidence rate was 0.8% (95%CI 0.06-2.4) in patients managed without CTPA, 1.6% (95%CI 0.3-4.0) in patients in whom PE was excluded by CTPA and 1.4% (95%CI 0.6-2.7) overall. In the pooled studies, PE was safely excluded in patients with a history of VTE based on a CPR followed by a D-dimer test and/or CTPA, although the efficiency of the algorithm is relatively low compared to patients without a history of VTE.	First, only three published cohorts of varying quality could be included in this meta-analysis which may limit the interpretation of the results. Second, the accuracy of neither the Wells rule nor the Geneva score has been validated in a large population of patients with suspected recurrent VTE. Third, different D-dimer tests were used between the included studies. Since all studies utilized high sensitivity quantitative D-dimer tests, the authors do not believe that the quality of the authors' results suffered from this. Fourth, the authors included patients with a prior PE or a prior DVT, and not a prior PE only, since the availability of such cohorts is very limited. Finally, the authors were not able to perform a patient-level meta-analysis that would have enabled us to evaluate adjusted thresholds of the D-dimer test or CPR.

Hess S, Frary EC, Gerke O, et al. State-of-the-Art Imaging in Pulmonary Embolism: Ventilation / Perfusion Single-Photon Emission Computed Tomography versus Computed Tomography Angiography - Controversies, Results, and Recommendations from a Systematic Review. Semin Thromb Hemost. 2016;42(8):833-45.	27764879	Systematic review	Low	Evaluate the role of V/Q SPECT, V/Q SPECT/CT, and CTA in pulmonary embolism	Systematic literature search and review of studies published between 1946 and February 1, 2016 identified by PubMed and Embase. Of the 2857 citations, 8 articles met the inclusion criteria	Analyses were done for five parameters (sensitivity, specificity, PPV, NPV, and accuracy) and were stratified by modality.	V/Q SPECT, V/Q SPECT/CT, and CTA are all viable options, but the authors consider V/Q SPECT/CT to be superior in most clinical settings with better overall diagnostic performance, that is, pooled sensitivities (97.6 vs. 82.0%), specificities (95.9 vs. 94.9%), positive predictive values (93.0 vs. 93.8%), negative predictive values (98.6 vs. 84.7%), and accuracies (96.5 vs. 88.6%). The authors further address some of the ongoing controversies regarding the various modalities, that is, radiation exposure, the issues of subsegmental PE, nondiagnostic studies, and various challenges in specific patient populations.	Limitations of the authors' study pertain primarily to the process of literature search, article sorting, and data synthesis: although the initial literature search was performed lege artis and in conjunction with a specialist, the keywords used on this subject are numerous with several different modalities, some of which have changed designation over the years and it is possible that some were inadvertently missed. Bias may be introduced if patients are only included in clinical studies when they are not straightforward, for example, patients with comorbidities or equivocal scans. Sources of high heterogeneity for diagnostic accuracy of CTA not examined; few studies of VQ Spect both done by the same author; patient characteristics of included studies not provided; no assessment of study bias. Overall moderate to low methodological review quality.
Kan Y, Yuan L, Meeks JK, et al. The accuracy of V/Q SPECT in the diagnosisof pulmonary embolism: A meta-analysis. Acta Radiol. 2015;56(5):565-72.	24917606	Meta-analysis	High	To systematically review and perform a meta-analysis of published data on the performance of V/Q SPECT in the diagnosis of acute PE.	A comprehensive computer search was conducted on literature published through 31 December 2013 in an effort to find relevant articles on the diagnostic performance of V/Q SPECT in the diagnosis of PE patients. Nine studies, comprising a total sample size of 3454 patients, were included.	Pooled sensitivity, specificity, negative likelihood ratio (LR), and positive LR, the area under the receiver-operating characteristic (ROC) curve of V/Q SPECT in the diagnosis of PE patients were calculated.	The pooled sensitivity, specificity of V/Q SPECT in the diagnosis of acute PE patients, calculated on a per-patient-based analysis, was 96% (95% confidence interval [CI], 95-97%), 97% (95% CI, 96-98%). The pooled negative LR, positive LR of V/Q SPECT in acute PE patients was 0.06 (range, 0.02-0.19) and 16.64 (range, 9.78-31.54). The area under the ROC curve of V/Q SPECT in the diagnosis of acute PE patients was 0.99 on a per-patient-based analysis. CONCLUSION: V/Q SPECT is an accurate method in acute PE patients with high sensitivity and high specificity in the diagnosis of PE.	Using QUADAS criteria, studies were scored between 7 and 13 with a median score of 11. Two out of nine (22.2%) studies scored between 8 and 9 while 77.8% or seven out of nine studies scored 10 or more. Although none of the studies achieved an A rating, four (44.4%) received a B rating, three (33.3%) received a C rating, and two (22.2%) received a D rating. Overall, the methodological quality of the included studies was medium–high. Most studies in this meta-analysis did not combine pretest clinical probability with V/Q SPECT. Some studies in this meta-analysis had a prospective design, while others were retrospective. The reference standard in all studies included in this meta-analysis was not the same, as some reference standards included lower limb compression ultrasonography, while others did not.
Li J, Feng L, Li J, Tang J. Diagnostic accuracy of magnetic resonance angiography for acute pulmonary embolism - a systematic review and meta-analysis. Vasa. 2016;45(2):149-54.	27058801	Systematic review and meta-analysis	Moderate	To evaluate the diagnostic accuracy of magnetic resonance angiography (MRA) for acute pulmonary embolism	A systematic literature search was conducted that included studies from January 2000 to August 2015 using the electronic databases PubMed, Embase and Springer link. Five studies were included in this meta-analysis.	The summary receiver operating characteristic (SROC) curve, sensitivity, specificity, positive likelihood ratios (PLR), negative likelihood ratios (NLR), and diagnostic odds ratio (DOR) as well as the 95 % confidence intervals (CIs) were calculated to evaluate the diagnostic accuracy of MRA for acute PE. Meta-disc software version 1.4 was used to analyze the data.	The pooled sensitivity (86 %, 95 % CI: 81 % to 90 %) and specificity (99 %, 95 % CI: 98 % to 100 %) demonstrated that MRA diagnosis had limited sensitivity and high specificity in the detection of acute PE. The pooled estimate of PLR (41.64, 95 % CI: 17.97 to 96.48) and NLR (0.17, 95 % CI: 0.11 to 0.27) provided evidence for the low missed diagnosis and misdiagnosis rates of MRA for acute PE. The high diagnostic accuracy of MRA for acute PE was demonstrated by the overall DOR (456.51, 95 % CI: 178.38 - 1168.31) and SROC curves (AUC = 0.9902 +/- 0.0061). MRA can be used for the diagnosis of acute PE. However, due to limited sensitivity, MRA cannot be used as a stand-alone test to exclude acute PE.	First, the number of included studies and the sample size were small in this meta-analysis, so more studies with larger sample sizes are needed to verify the results of this study. Second, although no heterogeneityfrom the threshold effect was detected, significant heterogeneity was found among the included studies in the analysis of sensitivity. Confounding factors such as sex and the age of the participants, the magnetic field intensity and the MRI scan sequence may be sources of heterogeneity. However, analyses exploring the sources of heterogeneity could not be performed due to a lack of sufficient available data. In addition, it is unclear how authors in the reviewed studies handled indeterminate results
Patel P, Patel P, Bhatt M, et al. Systematic review and meta-analysis of test accuracy for the diagnosis of suspected pulmonary embolism. Blood Adv. 2020; 4(18):4296-4311.	32915980	Systematic review and meta-analysis	Moderate	To determine the accuracy of commonly available diagnostic tests for PE, which can be used to inform a combined strategy for diagnosis.	A total of 61 studies were ultimately included. Studies reporting data on diagnostic test accuracy (randomized control trials, cohort studies, cross-sectional studies) for PE were eligible for inclusion in this systematic review. Studies published in any language were included. Studies that did not provide sufficient data to determine test accuracy (sensitivity and specificity) and abstracts published before 2014 were excluded. Studies with sample size ,100 patients were excluded to increase feasibility. Patients that were asymptomatic and pregnant were excluded. Studies reporting on both adult and pediatric patients were eligible for inclusion but were excluded when .80% of the study sample was younger than 18 years of age or if the mean age was younger than 25 years.	Two investigators screened and abstracted data. Risk of bias was assessed using Quality Assessment of Diagnostic Accuracy Studies-2 and certainty of evidence using the Grading of Recommendations Assessment, Development and Evaluation framework. Estimates of sensitivity and specificity were pooled.	The pooled estimates for D-dimer sensitivity and specificity were 0.97 (95% confidence interval [CI], 0.96-0.98) and 0.41 (95% CI, 0.36-0.46) respectively, whereas CTPA sensitivity and specificity were 0.94 (95% CI, 0.89-0.97) and 0.98 (95% CI, 0.97-0.99), respectively, and CUS sensitivity and specificity were 0.49 (95% CI, 0.31-0.66) and 0.96 (95% CI, 0.95-0.98), respectively. Three variations of pooled estimates for sensitivity and specificity of V/Q scan were carried out, based on interpretation of test results. D-dimer had the highest sensitivity when compared with imaging. CTPA and V/Q scans (high probability scan as a positive and low/non-diagnostic/normal scan as negative) both had the highest specificity.	The high sensitivity of age-adjusted D dimer is limited by the fact that only one study evaluating age-adjusted D-dimer prospectively was identified for analysis. Many emerging and promising modalities such as MRI (and V/Q SPECT) because limited data are available. In addition, many of the studies that were included did not have an actual reference test. Occasionally, studies used follow up (eg, 3 months, 6 months) as a reference standard to testing, which was deemed acceptable by the panel. Clinically insignificant PE may be missed with follow-up as a reference. Last, the diagnostic test accuracy estimates were determined for a test done in a standalone manner, combinations of tests in a pathway for establishing a diagnosis of PE were not considered.

Phillips JJ, Straiton J, Staff RT. Planar and SPECT ventilation/perfusion imaging and computed tomography for the diagnosis of pulmonary embolism: A systematic review and meta-analysis of the literature, and cost and dose comparison. Eur J Radiol. 2015;84(7):1392-400.	25868674	Systematic review and meta-analysis	high for diagnostic accuracy , moderate for radiation dose (downgrade 1 due to applicability concerns)	Review, compare and aggregate the published diagnostic performance of each modality and assesses the short-term consequences in terms of diagnostic outcomes, monetary cost, and radiation burden.	Formal literature review of available data and aggregated the finding using a summary receiver operating characteristic. The review found 19 studies, which comprised 27 data sets (6393 examinations, from 5923 patients).	A decision tree approach was used to estimate cost and dose per correct diagnosis. True-positive, true-negative,false-negative and false-positive values were extracted from the data given. When these values were not noted explicitly, they were inferred from the given values for sensitivity, specificity, positive predictive value and negative predictive value.	These findings show no performance difference between V/Q SPECT and CTPA; planar V/Q is inferior. CTPA represents best value; 129 per correct diagnosis compared to 243 (SPECT) and 226 (planar). In terms of radiation burden V/Q SPECT was the most effective with a dose of 2.12 mSv per correct diagnosis compared with 3.46 mSv (planar) and 4.96 (CTPA) mSv.	All papers were judged to have high risk of bias in the reference test section; all studies used a composite standard as the reference standard, where the test under consideration figured into the final diagnosis. An additional weakness of this study is the heterogeneous nature and age of the data in the literature. Limited data available for CT technique and modern techniques like dose reduction have not been taken into account.
Squizzato A, Pomero F, Allione A, et al. Diagnostic accuracy of magnetic resonance imaging in patients with suspected pulmonary embolism: A bivariate meta-analysis. Thromb Res. 2017;154:64-72.	28427005	Meta-analysis	Moderate	The authors aimed to systematically assess the diagnostic accuracy of magnetic resonance imaging (MRI) for PE diagnosis.	13 studies of 1170 patients with PE	Studies evaluating the diagnostic accuracy of MRI for the diagnosis of PE were systematically searchedin the PubMed and EMBASE databases (up to May 2016). QUADAS - 2 toolwas used for the quality assessment ofthe primary studies. A bivariate random-effects regression approach was used for summary estimates of bothsensitivity and specificity.	Thirteen studies, for a total of 1170 patients, were included.Weighted mean prevalence of PE was 37% at random-effect model. Weighted mean inconclusive MRI results were 19% at random-effect model. After exclusion of technical inadequate results, MRI bivariate weighted mean sensitivity was 80.9% (95% confidence interval [CI] 68.2, 89.4%), with a bivariate weighted mean specificity of 96.4% (95% CI 92.4, 98.3%).Conclusions: MRI has high specificity but limited sensitivity for the diagnosis of PE. Inconclusive results are a major limitation to the practical application of MRI. Management studies are needed to more precisely define the role of MRI in the diagnostic workup of patients with suspected PE.	Study limitations included variability in design characteristics of the primary studies and the poor quality of reporting. Finally, the mean prevalence of PE in the included studies was 37%. This higher rate in comparison to management studies suggests the potential for a selection bias and the possibility that included patients may not be fully representative of the general population.
Zhou M, Hu Y, Long X, et al. Diagnostic performance of magnetic resonance imaging for acute pulmonary embolism: A systematic review and meta-analysis. J Thromb Haemost. 2015;13(9):1623-34.	26179627	Systematic review and meta-analysis	Low	To clarify the comprehensive role of MRI in diagnosing APE.	Studies were identified through a search of Pubmed and Ovid databases, and the QUADAS-2 tool was applied for quality assessment of the included studies. Fifteen studies based on patients and nine based on vessels were retrieved.	We included a study if: (i) it assessed MRI as a diagnostic test to evaluate patients for the presence of APE, (ii) itprovided absolute numbers of true positive, false positive, true negative and false negative results, or these data were derivable from the presented results, and (iii) it was publishedin English. The QUADAS-2 tool was applied for quality assessment of the included studies. Pooled measures of sensitivity, specificity, positive likelihood ratio (PLR), negative likelihood ratio (NLR) and diagnostic odds ratio (DOR) with 95% confidence intervals (CIs) for both patient (all patients and patients with technically adequate images) and vessel levels were estimated with the DerSimonian and Laird random effects model.	The patient-based analysis yielded an overall sensitivity of 0.75 (95% confidence interval, 0.70-0.79) and 0.84 (0.80-0.87) for all patients and patients with technically adequate images, respectively, with an overall specificity of 0.80 (0.77-0.83) and 0.97 (0.96-0.98) and a pooled diagnostic odds ratio (DOR) of 51.07 (18.36-142.05) and 155.22 (86.83-277.47). On average, MRI was technically inadequate in 18.89% of patients (range, 2.10%-27.70%). A direct comparison of different MRI modalities showed that the combined MRI test had the highest pooled DOR and the lowest proportion of inconclusive images. Of note, heterogeneity and moderate quality were observed. On a vessel basis, the MRI had high sensitivity and specificity in larger-order vessels, but a significantly lower sensitivity of 0.55 (0.50-0.60) for subsegmental APE. CONCLUSIONS: On a patient-based level, MRI yields high diagnostic accuracy for the detection of APE, especially in technically adequate images, and the inconclusive MRI examinations mainly result from motion artifact and poor arterial opacification. The combined MRI test appears to be a more promising diagnostic tool with greater power of discrimination than single techniques. From a vessel-based perspective, MRI exhibits a high diagnostic capability with proximal arteries, but lacks sensitivity for peripheral embolism.	First, systematic reviews of diagnostic studies on a patient basis are hampered by the threshold effect and heterogeneity among results. Subgroup analyses demonstrated that sample size, publication date and duration between tests significantly affect the diagnostic performance on an all-patient-based level.However, the power to detect sources of heterogeneityhas been limited by the low number of studies and missing data in specific subgroups. Second, on a patient basis, 10 of the 15 included studies had a small sample size (< 89), and eight had a prevalence of APE that was much higher than that observed in clinical practice, suggesting selection bias. These factors could have potentially biased our results in a favorable direction considering the results of the subgroup analyses. Finally, the studies we reviewed were generally of moderate quality. They showed a high risk of bias in terms of flow and timing, patient selection and reference standard, which were met by less than 70% of the studies.