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ABSTRACT

Introduction: Whether clinical prediction rules for pulmonary embolism are accepted and used among general internal medicine residents remains uncertain. We therefore evaluated the frequency of use and acceptability of the Revised Geneva Score (RGS) and the Pulmonary Embolism Severity Index (PESI), and explored which factors were associated with rule use.

Materials/Methods: In an online survey among general internal medicine residents from 10 Swiss hospitals, we assessed rule acceptability using the Ottawa Acceptability of Decision Rules Instrument (OADRI) and explored the association between physician and training-related factors and rule use using mixed logistic regression models.

Results: The response rate was 50.4% (433/859). Overall, 61% and 36% of the residents reported that they always or regularly use the RGS and the PESI, respectively. The mean overall OADRI score was 4.3 (scale 0-6) for the RGS and 4.1 for the PESI, indicating a good acceptability. Rule acceptability (odds ratio [OR] 6.19 per point, 95% confidence interval [CI] 3.64-10.51), prior training in emergency medicine (OR 5.14, CI 2.20-12.01), and availability of internal guidelines recommending RGS use (OR 4.25, CI 2.15-8.43) were associated with RGS use. Rule acceptability (OR 6.43 per point, CI 4.17-9.92) and rule taught at medical school (OR 2.06, CI 1.24-3.43) were associated with PESI use.

Conclusions: The RGS was more frequently used than the PESI. Both rules were considered acceptable. Rule acceptability, prior training in emergency medicine, availability of internal guidelines, and rule taught at medical school were associated with rule use and represent potential targets for quality improvement interventions.

KEYWORDS: Clinical Prediction Rule, Pulmonary Embolism, Acceptability, Rule Use, Survey.

ABBREVIATIONS: CI, confidence interval; CPR, clinical prediction rules; OADRI, Ottawa Acceptability of Decision Rules Index; OR, odds ratio; PE, pulmonary embolism; PESI, Pulmonary Embolism Severity Index; RGS, Revised Geneva Score; SE, standard error.

INTRODUCTION

Clinical prediction rules (CPRs) are tools that combine clinical variables to estimate the probability of a certain disease or outcome, and thus help physicians improve accuracy of clinical judgment (1-6). However, evidence suggests that CPRs are underused in clinical practice (7, 8). A variety of factors explain this underuse, including insufficient implementation, absence of infrastructure supporting the rule, lack of awareness of the rule, complexity of the rule, absence of a suggested course of action, perceived superiority of clinical judgment and lack of benefit, insufficient confidence in the rule, fear of missing a diagnosis, and concern of not applying the rule correctly (2-5, 7-12). One or several of these factors usually determine clinician acceptability of a CPR.

Several well validated CPRs exist for diagnosing and managing pulmonary embolism (PE), including the Revised Geneva Score (RGS) and the Pulmonary Embolism Severity Index (PESI) (13, 14). The RGS estimates a patient's clinical pretest probability of PE, and its utilization, combined with a highly-sensitive D-dimer test, can avoid CT scanning in about 35% of patients with suspected PE (15). The PESI predicts 30-day mortality following PE and identifies up to 30% of patients with PE who are at low-risk and who can be safely treated in the less costly outpatient setting (16). The use of these rules is recommended as an option in international guidelines (17, 18). However, even though both CPRs fulfill the criteria for high-quality CPRs (3, 4), whether they are used in clinical practice remains unknown.

We therefore evaluated the frequency of use of the RGS and PESI and their clinical acceptability in an online survey. We also explored whether physician and training-related factors are associated with rule use. We focused on the RGS and PESI because both rules are well validated in Swiss patients (15, 16, 19-23). The target population of our survey were general internal medicine residents because residents usually are the first-line managing physicians in Swiss emergency departments.

MATERIAL AND METHODS

Study design and population

We conducted an online survey among junior and senior general internal medicine residents from five Swiss university and five large non-university teaching hospitals in July 2016. We have chosen general internal medicine residents as our target population because emergency medicine is a mandatory part of postgraduate training in general internal medicine in Switzerland and general internal medicine residents, supervised by more senior physicians, are often the first-line managing physicians for patients with suspected and confirmed PE in Swiss emergency departments. To increase the sample size and the efficiency of our survey, we included only general internal medicine divisions with at least 30 residents. The chiefs of the 10 general internal medicine divisions were invited for study participation and all allowed their residents to participate in an online survey.

We focused on the RGS and the PESI rather than on other well-validated rules (for instance, the Wells score) because both rules are well known and validated in Swiss patients (15, 16, 19-23), and other PE-related clinical prediction rules are infrequently used in Swiss hospitals.

As our project did not include any patient information, it did not require ethics committee approval (Kantonale Ethikkommission Bern, Ref. no KEK-BE 2016-00802).

Online survey

We first developed an online survey tool using the REDCap™ software and obtained the email addresses of all 859 junior and senior residents working in the participating general internal medicine divisions. We then sent an email to all residents containing an invitation to participate, a brief description of the survey goals, and a web link to the online survey. Survey

completion was estimated to require 5 to 10 minutes. The survey tool was successfully tested in a pilot study in 10 residents from Bern University Hospital.

To increase the response rate, four reminders (at 7, 14, 21, and 28 days) were sent out. After completion of the survey, all data were fully anonymized and all email addresses were deleted from the database.

The survey included three parts: (1) collection of physician and educational characteristics, (2) assessment of use of the RGS and PESI, and (3) evaluation of the acceptability of the RGS and PESI.

We collected self-reported physician demographics (age, gender) and training-related information (senior resident status, number of years of clinical experience, prior training in emergency medicine, rule taught at medical school, current training at a university hospital, availability of internal PE guidelines recommending the RGS/PESI). Prior training in emergency medicine was defined as any past clinical experience in an emergency room during residency.

Part 2 and 3 of the survey were preceded by a brief presentation of the RGS and the PESI. Participants were then asked to indicate the frequency of use of the RGS and the PESI in daily clinical practice ("never", "occasionally", "regularly", "always", "I was not aware of the rule prior to this survey" or "I use another rule"). Participants who indicated "I use another rule" were asked to specify that rule and to indicate the frequency of use of this rule ("occasionally", "regularly" or "always").

To evaluate the acceptability of the two rules, we used German and French translations of the Ottawa Acceptability of Decision Rules Instrument (OADRI) (24). The OADRI is a validated 12-item questionnaire that was specifically developed to assess acceptability of CPRs in clinical practice (24). The OADRI covers key domains of CPRs, such as rule characteristics, risk and benefit of use, face validity, and the impact of the working

environment on rule use. For each item in the OADRI, physicians indicate their level of agreement on a 6-point Likert scale (1= strongly disagree, 6= strongly agree). Overall, the OADRI accounts for >85% of the reasons mentioned by physicians when they judge a given CPR as unacceptable (24). We considered OADRI questionnaires with >4 missing items as incomplete (24). Items scored as 1, 2, or 3 were re-scaled to 0, 1, and 2, respectively. The answers "No opinion/Don't know" were coded as the middle of the scale (score 3), as done previously (24). The scores of items 8 to 12 were reversed so that higher scores always denote higher acceptability (24).

Statistical analyses

In descriptive analyses, we assessed baseline characteristics of the respondents and determined the frequency of rule use. We calculated the mean score for each OADRI item over all respondents and determined overall acceptability by averaging all item scores per respondent. Mean scores range from 0 (lowest) to 6 (highest acceptability). An overall mean score >3 indicates a good acceptability (24).

We explored the association between physician and training-related characteristics and rule use using mixed logistic regression models. The outcome variable was the self-reported rule use dichotomized as regular use (always or regular use) vs. non-regular use (occasional or never use, respondents not knowing the rule or using another rule). Predictor variables included gender, status as senior resident, years of clinical experience, prior training in emergency medicine, rule taught at medical school, current training at a university hospital, availability of internal PE guidelines/pathways recommending the RGS/PESI, and rule acceptability based on the OADRI. Due to the correlated nature of data within hospitals, we introduced a random intercept for hospitals in the models. In case of missing values, which

were very rare (<1%), we used simple imputations using the median value. All analyses were done using STATA 14 (StataCorp LP, College Station, TX).

RESULTS

Survey sample

Overall, 433 out of 858 (50.4%) invited residents responded to our survey. Of the 433 respondents, 3 returned an entirely empty survey form and 3 an incomplete OADRI questionnaire (>4 missing items), leaving a final sample of 427 residents. The characteristics of the respondents are shown in Table 1. Overall, the majority of residents was aged 31-35 years, 62% were female, 64% were working in a university hospital, 87% had prior training in emergency medicine, and most had a clinical experience between 4 and 6 years. A total of 58% of the residents indicated that internal guidelines for PE were available in their hospital, whereas 29% did not know whether such guidelines existed. If internal guidelines were reported to be available, 81% and 72% of the residents indicated that these guidelines recommended the use of the RGS and the PESI, respectively.

Table 1. Demographic and training characteristics

Characteristic	Respondents n (%)* N=427
Age	
20-25 years	100 (24)
26-30 years	118 (28)
31-35 years	142 (33)
≥36 years	65 (15)
Female gender	264 (62)
Position	
Junior resident	310 (73)
Senior resident	117 (27)
Current training at a university hospital	272 (64)
Years of clinical experience	
0 to <2 years	57 (13)
≥2 to <4 years	118 (28)
≥4 to <6 years	144 (34)
≥6 to <8 years	45 (11)

≥8 years	62 (15)
Prior training in emergency medicine	372 (87)
Availability of internal guidelines for PE†	
Yes	247 (58)
No	55 (13)
Don't know	125 (29)
RGS taught at medical school	
Yes	274 (64)
No	119 (28)
Don't know	34 (8)
PESI taught at medical school	
Yes	159 (37)
No	216 (51)
Don't know	51 (12)

Abbreviations: PE, Pulmonary embolism; RGS, Revised Geneva Score; PESI, Pulmonary Embolism Severity Index.

*1 respondent had missing values for Years of clinical experience, 1 for Prior training in emergency medicine, and 1 for PESI taught at medical school.

†Among the 247 residents responding that internal guidelines were available, 199 (81%) indicated that the guidelines recommended the use of the RGS and 178 (72%) the use of the PESI.

Frequency of rule use

Overall, 61% of the residents reported that they always or regularly use the RGS and 36% that they always or regularly use the PESI. (Table 2). A total of 26% and 50% of the residents occasionally or never used the RGS and the PESI, respectively. Finally, 4% of the residents were not familiar with the RGS and 11% were not familiar with the PESI, 8% used another diagnostic (Wells rule) and 2% another prognostic CPR (1 simplified PESI, 6 Geneva Score, and 3 other scores).

Table 2. Frequency of rule use

	Respondents n (%) N=427
I use the Revised Geneva Score:	
Always	103 (24%)
Regularly	160 (37%)
Occasionally	91 (21%)
Never	20 (5%)
I am not familiar with the rule	19 (4%)
I use another rule*****	34 (8%)
I use the Pulmonary Embolism Severity Index:	
Always	46 (11%)
Regularly	107 (25%)
Occasionally	151 (35%)
Never	65 (15%)
I am not familiar with the rule	48 (11%)
I use another rule[†]	10 (2%)

*All 34 residents used the Wells rule.

[†]1 resident used the simplified PESI, 6 the Geneva Score, and 3 residents other scores.

Acceptability of the RGS and the PESI based on the OADRI

The mean overall OADRI score was 4.3 and 4.1 points for the RGS and the PESI, respectively, indicating a good rule acceptability (Table 3). The overall score of both rules, as well as each item score, was lower among non-regular users than in regular users. The items "The rule is easy to use" and "The wording of the rule is clear and unambiguous" yielded the highest scores for both the RGS (5.35 and 5.10) and the PESI (4.66 and 4.70). The RGS showed the lowest mean scores for the items "I am already using another rule or similar strategy" (3.66) and "The rule does not account for an important clinical cue" (3.52), whereas the PESI had the lowest mean scores for the items "The rule is easy to remember" (3.04) and "The evidence supporting the rule is flawed" (3.52).

Table 3. Acceptability of the RGS and the PESI based on the OADRI

	Revised Geneva Score			Pulmonary Embolism Severity Index		
	All users	Regular users*	Non-regular users†	All users	Regular users*	Non-regular users†
	Mean (SE)			Mean (SE)		
Overall score‡	4.34 (0.03)	4.60 (0.03)	3.94 (0.04)	4.06 (0.04)	4.57 (0.05)	3.78 (0.04)
Single item score‡						
1) The rule is easy to use	5.35 (0.04)	5.54 (0.04)	5.06 (0.07)	4.66 (0.06)	5.21 (0.08)	4.36 (0.08)
2) The rule is easy to remember	3.78 (0.07	3.94 (0.09)	3.54 (0.11)	3.04 (0.08)	3.75 (0.12)	2.65 (0.09)
3) The rule is useful in my practice	4.93 (0.05)	5.23 (0.05)	4.45 (0.09)	4.31 (0.06)	5.07 (0.06)	3.88 (0.07)
4) The wording of the rule is clear and unambiguous	5.10 (0.04)	5.19 (0.05)	4.95 (0.07)	4.70 (0.05)	5.09 (0.07)	4.48 (0.06)
5) My colleagues support use of the rule	4.39 (0.06)	4.86 (0.06)	3.63 (0.09)	4.00 (0.06)	4.59 (0.09)	3.67 (0.07)
6) Patients benefit from use of the rule	4.53 (0.05)	4.89 (0.06)	3.95 (0.08)	4.30 (0.05)	4.99 (0.07)	3.92 (0.06)
7) Using the rule results in improved use of resources	4.58 (0.06)	4.91 (0.06)	4.06 (0.09)	4.31 (0.06)	4.92 (0.08)	3.97 (0.07)
8) Using the rule would increase the chance of lawsuits§	3.94 (0.06)	4.09 (0.08)	3.71 (0.09)	3.91 (0.06)	4.13 (0.11)	3.79 (0.07)
9) The evidence supporting the rule is flawed§	3.71 (0.06)	3.96 (0.08)	3.31 (0.07)	3.52 (0.05)	3.88 (0.10)	3.33 (0.05)
10) I am already using another rule or similar strategy§	3.66 (0.10)	4.35 (0.11)	2.55 (0.16)	3.70 (0.09)	4.52 (0.13)	3.25 (0.12)
11) The rule does not account for an important clinical cue§	3.52 (0.08)	3.46 (0.10)	3.61 (0.12)	3.83 (0.06)	4.08 (0.11)	3.69 (0.08)
12) The environment I work in makes it difficult to use the rule§	4.64 (0.06)	4.75 (0.08)	4.46 (0.10)	4.44 (0.06)	4.65 (0.11)	4.33 (0.07)

Abbreviations: OADRI, Ottawa Acceptability of Decision Rule Instrument; SE, standard error.

*Respondents who indicated that they always or regularly use the rule.

[†]Respondents who indicated that they occasionally or never use the rule, are not familiar with the rule, or use another rule.

[‡]Range 0-6 points, a score of 0 indicating the lowest and a score of 6 the highest acceptability.

[§]Reversed scores.

Factors associated with rule use

Rule acceptability was the factor with the strongest association with rule use for both the RGS (odds ratio [OR] 6.19 per score point, 95% confidence interval [CI] 3.64-10.51) and the PESI (OR 6.43 per score point, CI 4.17-9.92) (Table 4). The use of the RGS was also associated with prior training in emergency medicine (OR 5.14, CI 2.20-12.01) and availability of internal guidelines recommending RGS use (OR 4.25, CI 2.15-8.43), whereas the use of the PESI was also associated with rule taught at medical school (OR 2.06, CI 1.24-3.43). Gender or current training at a university hospital was not associated with rule use.

Table 4. Factors associated with rule use

Factors	Adjusted* OR (95% CI)	p-value
Revised Geneva Score		
Female gender	1.48 (0.84 – 2.61)	0.18
Senior resident	1.03 (0.45 – 2.38)	0.94
Current training at a university hospital	1.29 (0.27 – 6.21)	0.75
Years of clinical experience, per year	0.97 (0.88 – 1.06)	0.46
Prior training in emergency medicine	5.14 (2.20 – 12.01)	<0.001
Availability of internal guidelines recommending use of the RGS	4.25 (2.15 – 8.43)	<0.001
Rule taught at medical school	1.55 (0.83 – 2.91)	0.17
Rule acceptability, per OADRI score point	6.19 (3.64 – 10.51)	<0.001
Pulmonary Embolism Severity Index		
Female gender	0.83 (0.51 – 1.35)	0.45
Senior resident	1.85 (0.92 – 3.71)	0.08
Current training at a university hospital	1.28 (0.74 – 2.23)	0.38
Years of clinical experience, per year	1.02 (0.93 – 1.11)	0.70
Prior training in emergency medicine	1.76 (0.74 – 4.19)	0.20
Availability of internal guidelines recommending use of the PESI	1.20 (0.71 – 2.03)	0.50
Rule taught at medical school	2.06 (1.24 – 3.43)	<0.01
Rule acceptability, per OADRI score point	6.43 (4.17 – 9.92)	<0.001

Abbreviations: OR, odds ratio; CI, confidence interval; RGS, Revised Geneva Score, OADRI, Ottawa Acceptability of Decision Rule Instrument; PESI, Pulmonary Embolism Severity Index.

*Adjustments were made for all other variables.

DISCUSSION

Our survey results demonstrate that the RGS was always or regularly used by 61% and the PESI by 36% of residents. Residents judged both rules to be acceptable. Several factors (rule acceptability, prior training in emergency medicine, availability of internal guidelines, and rule taught at medical school) were significantly associated with rule use. Overall, only few residents were not familiar with the RGS and PESI or used other CPRs for PE.

A survey conducted in 555 attending physicians, residents, physician assistants, nurse practitioners, and medical students from 31 academic and non-academic U.S. and U.K. medical centers in 2005/2006 showed that 68% of respondents were familiar with at least one of two diagnostic CPRs for PE, the Wells or the Charlotte rule, and 50% used these rules in more than 50% of cases suspected with PE (25). Overall, frequency of use did not differ substantially between academic and non-academic centers. In 2010, a survey conducted in 128 Italian thrombosis specialists reported that 45% always or often used a CPR for PE and another small survey in 63 Dutch internists/pulmonologist demonstrated that a CPR was used in 49% of respondents (26, 27). In contrast, surveys conducted in general practitioners reported that the majority of respondents were not aware of CPRs for diagnosing PE (28) (29), probably, because general practitioners who practice outside the hospital are less likely to encounter patients with PE. The higher proportion of respondents who were familiar with the RGS (96%) and the higher user rate (61%) observed in our survey may be explained by the fact that we enrolled mostly emergency medicine-experienced hospital physicians. Moreover, diagnostic CPR are commonly recommended in practice guidelines for PE and

physicians may have been more familiar with such CPRs in 2016 than in earlier years (17, 18).

The evidence on the use of prognostic CPRs in PE is more limited. A retrospective chart review of 60 patients with PE from a single hospital in 2009/2010 showed that no use of the PESI, or any other prognostic CPR, was documented in any of the patients' notes, suggesting they had not been used (30). While the use of prognostic CPRs may have improved since then, the PESI use rate of 36% indicates that prognostic CPRs are still less well established than diagnostic CPRs in PE.

Although both the RGS and the PESI showed good overall and item-specific acceptability based on the OADRI (all mean scores >3) in our survey, several measures could further increase rule acceptability. First, the 11-item PESI was judged less acceptable in terms of memorability than the 8-item RGS, underlining the need to develop simpler rules that can be easily remembered, such as the 6-item simplified PESI (31). Second, the respondents believed that the evidence supporting the rule (PESI, RGS) might be flawed or that the rule may not account for an important clinical cue (RGS), although both the PESI and the RGS have been extensively validated and have undergone an impact analysis in randomized clinical trials (15, 16). The main reason why physicians override a diagnostic CPR for PE when it disagrees with their clinical judgment is when the CPR does not account for a clinical cue presented by the patient and deemed important by the physician (32). Interestingly, regular rule users had higher mean item scores than non-regular users in almost all instances. These findings indicate that educational measures and information about the evidence supporting the RGS/PESI may be helpful to increase the acceptability of these rules.

Given that rule acceptability was by far the strongest predictor of rule use (RGS, PESI) in our study, improving rule acceptability is of paramount importance. Other predictors of rule use included prior training in emergency medicine (RGS), availability of internal

guidelines recommending the use of the rule (RGS), and rule taught at medical school (PESI), confirming the importance of educational measures to increase the use of validated and clinically useful CPRs. Gender or current training at a university hospital was not a significant predictor of rule use.

Our study has several limitations. First, our response rate of 50% is decent and approaches the average response rate of surveys conducted among physicians (54%) (33), who are notoriously difficult to survey. Yet, we cannot know whether our survey is representative of the entire surveyed physician population. Second, we restricted our survey to general internal medicine residents and thus we cannot extrapolate our results to fully qualified attending physicians and other medical specialties, such as emergency physicians. Indeed, experienced physicians may use CRPs less frequently and probably may be more prone to diagnose and manage PE based on the patient's clinical *gestalt* (34). Third, both the RGS and the PESI were developed by Swiss investigators and may have a higher rule acceptability in Swiss hospitals than in other countries, where other rules (e.g. the Wells rule) may predominate. Fourth, the cross-sectional design of our survey precludes any projections about the frequency of rule use once the residents have completed their specialty exams. Finally, our results are subject to self-report bias, an inherent flaw of all surveys (35).

CONCLUSIONS

Our survey provides for the first time insight into the frequency of use and rule acceptability of two well validated CPRs for PE, the RGS and the PESI. Although the diagnostic RGS was more frequently used than the prognostic PESI, both rules had good acceptability. Besides rule acceptability, several factors, such as prior training in emergency medicine, availability of internal guidelines, and rule taught at medical school were associated

with rule use and are potential targets for future interventions to increase the use of these well validated CPRs.

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CONFLICTS OF INTEREST

The authors have no conflict of interest.

REFERENCES

1. Wasson JH, Sox HC, Neff RK, et al. Clinical prediction rules. Applications and methodological standards. N Engl J Med 1985; 313(13): 793-9.
2. Toll DB, Janssen KJ, Vergouwe Y, et al. Validation, updating and impact of clinical prediction rules: a review. J Clin Epidemiol 2008; 61(11): 1085-94.
3. Reilly BM, Evans AT. Translating clinical research into clinical practice: impact of using prediction rules to make decisions. Ann Intern Med 2006; 144(3): 201-9.
4. McGinn TG, Guyatt GH, Wyer PC, et al. Users' guides to the medical literature: XXII: how to use articles about clinical decision rules. Evidence-Based Medicine Working Group. JAMA 2000; 284(1): 79-84.
5. Laupacis A, Sekar N, Stiell IG. Clinical prediction rules. A review and suggested modifications of methodological standards. JAMA 1997; 277(6): 488-94.
6. Hendriksen JM, Geersing GJ, Moons KG, et al. Diagnostic and prognostic prediction models. J Thromb Haemost 2013; 11 Suppl 1: 129-41.
7. Roy PM, Meyer G, Vielle B, et al. Appropriateness of diagnostic management and outcomes of suspected pulmonary embolism. Ann Intern Med 2006; 144(3): 157-64.
8. Drescher FS, Chandrika S, Weir ID, et al. Effectiveness and acceptability of a computerized decision support system using modified Wells criteria for evaluation of suspected pulmonary embolism. Ann Emerg Med 2011; 57(6): 613-21.
9. Karlin-Zysman C, Zeitoun N, Belletti L, et al. Struggling to bring clinical prediction rules to the point of care: missed opportunities to impact patient care. J Comp Eff Res 2012; 1(5): 421-9.
10. Brehaut JC, Stiell IG, Visentin L, et al. Clinical decision rules "in the real world": how a widely disseminated rule is used in everyday practice. Acad Emerg Med 2005; 12(10): 948-56.
11. Blackmore CC. Clinical prediction rules in trauma imaging: who, how, and why? Radiology 2005; 235(2): 371-4.
12. Bessen T, Clark R, Shakib S, et al. A multifaceted strategy for implementation of the Ottawa ankle rules in two emergency departments. BMJ 2009; 339: b3056.
13. Ceriani E, Combescure C, Le Gal G, et al. Clinical prediction rules for pulmonary embolism: a systematic review and meta-analysis. J Thromb Haemost 2010; 8(5): 957-70.
14. Squizzato A, Donadini MP, Galli L, et al. Prognostic clinical prediction rules to identify a low-risk pulmonary embolism: a systematic review and meta-analysis. J Thromb Haemost 2012; 10(7): 1276-90.
15. Righini M, Le Gal G, Aujesky D, et al. Diagnosis of pulmonary embolism by multidetector CT alone or combined with venous ultrasonography of the leg: a randomised non-inferiority trial. Lancet 2008; 371(9621): 1343-52.
16. Aujesky D, Roy PM, Verschuren F, et al. Outpatient versus inpatient treatment for patients with acute pulmonary embolism: an international, open-label, randomised, non-inferiority trial. Lancet 2011; 378(9785): 41-8.
17. Kearon C, Akl EA, Comerota AJ, et al. Antithrombotic therapy for VTE disease: Antithrombotic Therapy and Prevention of Thrombosis, 9th ed: American College of Chest Physicians Evidence-Based Clinical Practice Guidelines. Chest 2012; 141(2 Suppl): e419S-94S.
18. Konstantinides SV. 2014 ESC Guidelines on the diagnosis and management of acute pulmonary embolism. Eur Heart J 2014; 35(45): 3145-6.
19. Le Gal G, Righini M, Roy PM, et al. Prediction of pulmonary embolism in the emergency department: the revised Geneva score. Ann Intern Med 2006; 144(3): 165-71.
20. Klok FA, Mos IC, Nijkeuter M, et al. Simplification of the revised Geneva score for assessing clinical probability of pulmonary embolism. Arch Intern Med 2008; 168(19): 2131-6.
21. Aujesky D, Obrosky DS, Stone RA, et al. Derivation and validation of a prognostic model for pulmonary embolism. Am J Respir Crit Care Med 2005; 172(8): 1041-6.

22. Aujesky D, Perrier A, Roy PM, et al. Validation of a clinical prognostic model to identify low-risk patients with pulmonary embolism. J Intern Med 2007; 261(6): 597-604.
23. Donze J, Le Gal G, Fine MJ, et al. Prospective validation of the Pulmonary Embolism Severity Index. A clinical prognostic model for pulmonary embolism. Thromb Haemost 2008; 100(5): 943-8.
24. Brehaut JC, Graham ID, Wood TJ, et al. Measuring acceptability of clinical decision rules: validation of the Ottawa acceptability of decision rules instrument (OADRI) in four countries. Med Decis Making 2010; 30(3): 398-408.
25. Runyon MS, Richman PB, Kline JA, et al. Emergency medicine practitioner knowledge and use of decision rules for the evaluation of patients with suspected pulmonary embolism: variations by practice setting and training level. Acad Emerg Med 2007; 14(1): 53-7.
26. Squizzato A, Micieli E, Galli M, et al. Diagnosis and management of venous thromboembolism: Results of a survey on current clinical practice. Thromb Res 2010; 125(2): 134-6.
27. Gibson NS, Douma RA, Squizzato A, et al. Application of a decision rule and a D-dimer assay in the diagnosis of pulmonary embolism. Thromb Haemost 2010; 103(4): 849-54.
28. Pluddemann A, Wallace E, Bankhead C, et al. Clinical prediction rules in practice: review of clinical guidelines and survey of GPs. Br J Gen Pract 2014; 64(621): e233-42.
29. Planquette B, Maurice D, Peron J, et al. Knowledge of the diagnostic algorithm for pulmonary embolism in primary care. Eur J Intern Med 2015; 26(1): 18-22.
30. Halim MU, Maruthappu M, Christian A, et al. The pulmonary embolism severity index: underused despite its clinical merits. J Emerg Med 2015; 48(5): 609.
31. Jimenez D, Aujesky D, Moores L, et al. Simplification of the pulmonary embolism severity index for prognostication in patients with acute symptomatic pulmonary embolism. Arch Intern Med 2010; 170(15): 1383-9.
32. Chagnon I, Bounameaux H, Aujesky D, et al. Comparison of two clinical prediction rules and implicit assessment among patients with suspected pulmonary embolism. Am J Med 2002; 113(4): 269-75.
33. Asch DA, Jedrziewski MK, Christakis NA. Response rates to mail surveys published in medical journals. J Clin Epidemiol 1997; 50(10): 1129-36.
34. Graham ID, Stiell IG, Laupacis A, et al. Emergency physicians' attitudes toward and use of clinical decision rules for radiography. Acad Emerg Med 1998; 5(2): 134-40.
35. Adams AS, Soumerai SB, Lomas J, et al. Evidence of self-report bias in assessing adherence to guidelines. Int J Qual Health Care 1999; 11(3): 187-92.

HIGHLIGHTS

-The use of the Revised Geneva score (RGS)/Pulmonary Embolism Severity Index (PESI) is unknown.

-We conducted an online survey among Swiss general internal medicine residents.

-The RGS was more often used than the PESI (61% vs. 36%).

- Both the RGS and the PESI were considered acceptable.

- Educational factors were related with rule use and are targets for interventions.