




Uptake of Clinical Prognostic Tools in COPD Exacerbations Requiring Hospitalisation

Nicholas D. Lane, Sarah M. Gillespie, John Steer & Stephen C. Bourke


To cite this article: Nicholas D. Lane, Sarah M. Gillespie, John Steer & Stephen C. Bourke (2021) Uptake of Clinical Prognostic Tools in COPD Exacerbations Requiring Hospitalisation, COPD: Journal of Chronic Obstructive Pulmonary Disease, 18:4, 406-410, DOI: [10.1080/15412555.2021.1959540](https://doi.org/10.1080/15412555.2021.1959540)

To link to this article: <https://doi.org/10.1080/15412555.2021.1959540>

 View supplementary material [↗](#)

 Published online: 06 Aug 2021.

 Submit your article to this journal [↗](#)

 Article views: 90

 View related articles [↗](#)

 View Crossmark data [↗](#)



Uptake of Clinical Prognostic Tools in COPD Exacerbations Requiring Hospitalisation

Nicholas D. Lane^{a,b},  Sarah M. Gillespie^{a,b},  John Steer^{a,b},  and Stephen C. Bourke^{a,b} 

^aNorthumbria Healthcare NHS Foundation Trust, Research and Development, North Tyneside General Hospital, Rake Lane, North Shields, UK;

^bTranslational and Clinical Research Institute, Newcastle University, Newcastle upon Tyne, UK

ABSTRACT

Clinical prognostic tools are used to objectively predict outcomes in many fields of medicine. Whilst over 400 have been developed for use in chronic obstructive pulmonary disease (COPD), only a minority have undergone full external validation and just one, the DECAF score, has undergone an implementation study supporting use in clinical practice. Little is known about how such tools are used in the UK. We distributed surveys at two time points, in 2017 and 2019, to hospitals included in the Royal College of Physicians of London national COPD secondary care audit program. The survey assessed the use of prognostic tools in routine care of hospitalized COPD patients. Hospital response rates were 71/196 in 2017 and 72/196 in 2019. The use of the DECAF and PEARL scores more than doubled in decisions about unsupported discharge (7%–15.3%), admission avoidance (8.1%–17%) and readmission avoidance (4.8%–13.1%); it more than tripled (8.8%–27.8%) in decisions around hospital-at-home or early supported discharge schemes. In other areas, routine use of clinical prognostic tools was uncommon. In palliative care decisions, the use of the Gold Standards Framework Prognostic Indicator Guidance fell (5.6%–1.4%). In 2017, 43.7% of hospitals used at least one clinical prognostic tool in routine COPD care, increasing to 52.1% in 2019. Such tools can help challenge prognostic pessimism and improve care. To integrate these further into routine clinical care, future research should explore current barriers to their use and focus on implementation studies.

ARTICLE HISTORY

Received 16 May 2021

Accepted 18 July 2021

KEYWORDS

COPD;
prognosis;
prediction models;
outcome;
prognostic tools

Introduction

The accurate prediction of patient outcome is fundamental to the decision to provide medical interventions, obtain informed consent and provide patient centered care [1,2]. However, the prediction of outcome is complex and can be affected by cognitive biases. In chronic obstructive pulmonary disease (COPD), prognostic pessimism is common, which may have a pervasive effect on the treatment options afforded to patients [3,4]. Clinical prognostic tools combine, and apply weighting to, a number of independent risk factors to estimate or predict outcome; they may additionally categorize patients into risk groups. Such tools are not designed to act as a replacement for clinical judgment, but are commonly used to aid clinical reasoning and decision making in a number of fields of medicine, and can help inform discussions with patients. Many have become integrated into care pathways [5,6]. Common examples include the CHA₂DS₂-VASc score for stroke risk in Atrial Fibrillation [7], the HAS-BLED score for bleeding risk with anticoagulation [8], the Glasgow-Blatchford Score for acute gastrointestinal bleed management [9], and the Wells criteria for risk stratification in Pulmonary Embolism [10].

To date, over 400 different clinical prognostic tools have been derived for use in various aspects of COPD patient care, but few have undergone full external validation [11]. Moreover, only one has so far been investigated in an implementation RCT to assess its clinical utility [12,13]. The volume of tools suggests they are of clear interest to researchers but, despite their widespread availability, it is currently unclear if and how clinical prognostic tools are used to inform COPD care in day-to-day clinical practice. We aimed to assess the use of clinical tools for assisting decision making in various aspects of care for patients with exacerbations of COPD being treated in hospital. In addition, we assessed the change in the use of tools over time.

Methods

A survey examining structure of care and use of prognostic scores was distributed to 196 hospitals on the Royal College of Physicians of London national COPD audit program mailing list in 2017 and was repeated in 2019. The initial distribution was electronic with physical copies then posted to non-responding hospitals after four weeks; surveys were

addressed to the COPD lead for each site. The survey is available ([supplementary material](#)), and examined the availability of, and selection of patients for, schemes such as admission avoidance, hospital at home (HaH) and early supported discharge (ESD). It also queried the utility of clinical prognostic tools in other areas such as readmission avoidance, noninvasive ventilation decisions and palliative care referral.

HaH and ESD were defined in the survey because there is overlap between these services. HaH provides treatment in the home which would otherwise require hospital admission, such as 24/7 on-call clinician availability, controlled Oxygen and nebulized treatments. ESD facilitates earlier discharge from hospital than may have otherwise been possible, but is not supported by 24/7 services. For the full definitions, see the [supplementary material](#).

Nine existing tools (APACHE-II, BAP-65, BODE, CAPS, CURB-65, DECAF, LACE, PEARL and Gold Standards Framework-Prognostic Indicator Guidance: GSF-PIG) [14–22] were identified in the survey, with users having the freedom to include others as they wished. Responses were collated and anonymised. Comparisons of findings between 2017 and 2019 are made with Fisher's exact test or Mann-Whitney-U for categorical or non-parametric data respectively. Statistical analysis was performed on tools used by $\geq 5\%$ or more of responding hospitals at either timepoint. Structures of care are likely to have changed significantly due to the COVID-19 pandemic and are therefore described without statistical inference. Data are presented as Mean (SD), Median (IQR) or percentage of respondents as appropriate.

Results

Of 196 hospitals 71 (36.2%) responded in 2017 and 72 (36.7%) in 2019. Median (IQR) Length of stay was 5 (4–6) days in 2017 and 4.4 (4–5.9) days in 2019 ($p=0.068$).

In the two years between each survey, there was a three-fold clinically important and statistically significant increase in the use of DECAF/PEARL for HaH or ESD selection. Use of clinical risk stratification tools for selection for other services, with the exception of palliative care, similarly increased but did not reach statistical significance. The consistence of trend and magnitude of increase suggests they are clinically important (see [Table 1](#)) changes.

Overall, in 2017, 43.7% of responding hospitals used a clinical prognostic tool for one or more aspect(s) of routine COPD care compared to 52.1% in 2019 ($p=0.401$).

Admission avoidance schemes

Access to such schemes remained similar between the time points. The use of either the DECAF or PEARL scores in selecting patients for admission avoidance doubled, from 8.2% to 17.0%. Whilst this trend is likely to be clinically important, it did not reach statistical significance ($p=0.240$, [Table 1](#)).

Admission avoidance was primarily undertaken by community teams (with or without specialist hospital input), or

integrated care teams (65.2% in 2017 and 67.4% in 2019). There was a doubling, from 16.3% to 32.6%, of specialist input into community-based teams between surveys. In 2019, hospital led admission avoidance was provided in a minority of hospitals; where offered, this was performed *via* specialist nursing review (15.2%), urgent outpatient review (4.3%), ambulatory care review (4.3%) or HaH schemes (8.7%).

Hospital at home and early supported discharge

Most hospitals provided a form of HaH/ESD and the proportion of hospitals offering both schemes increased from 25% to 32% between surveys. The use of the DECAF or PEARL scores in this setting has more than tripled from 8.8% to 27.8%, $p=0.013$ ([Table 1](#)).

Hospital/specialist services appear to have increased their footprint into early supported discharge schemes between 2017 and 2019; community based ESD fell from 35.7% to 26% with a corresponding rise in hospital based ESD (8.9%–14%), and integrated care teams providing ESD (19.6%–24%). A minority of hospitals (4%) offered only HaH (without ESD) in 2019, down from 10.7% in 2017.

Readmission avoidance

Readmission avoidance schemes were provided in around 50% of hospitals. Similar to HaH/ESD and admission avoidance, use of the PEARL or DECAF scores has more than doubled (4.8%–13.1%, $p=0.252$) in this setting, though did not reach statistical significance. The use of other tools almost tripled from 7.3% to 21% (see [Table 1](#)).

In 2019, 32% of these were run by community teams (vs. 40.6% in 2017), 24% by integrated care teams (21.9% in 2017), 32% by hospital based multidisciplinary team member review (15.7% in 2017), 12% by early outpatient clinic review (12.5% in 2017) and 0% by virtual clinic (6.3% in 2017).

Noninvasive ventilation, escalation, palliative care and other tool use

Noninvasive ventilation (NIV) was offered by 98.6% of responding hospitals in 2019. The most common area NIV was provided was on a respiratory ward (46.5%), followed by respiratory support units/dedicated respiratory high dependency units (40.8%). 9.9% of hospitals stated critical care was the most common place of NIV delivery for exacerbations of COPD. A similar proportion of hospitals (2017=54.4%; 2019=56.3%) provided NIV to patients with exacerbations of COPD (requiring NIV) complicated by pneumonia. Clinical prognostic tools were not routinely used to guide treatment with NIV in either 2017 or 2019, although the ReSPECT process [23] developed by the resuscitation council UK was specified by 1.4% of respondents in 2019.

Escalation decisions remained primarily based on clinical judgment alone (93% in 2017 and 84.5% in 2019). The NEWS/NEWS2 score, whilst not strictly a prognostic clinical tool,

Table 1. Comparison of survey results in 2017 and 2019.

Clinical service area and most common tool used	2017	2019
Survey response rate	36.2%	36.7%
Admission avoidance schemes		
Is this available at your hospital?	Yes, 69%	Yes, 73.6%
If yes, can this be accessed?	Pre-hospital? 98%	86.8%
	Emergency department? 79.6%	58.5%
	Medical admissions unit? 87.8%	64.2%
How are patients selected? ^a	Clinical judgment alone 81.6%	77.4%
	DECAF/PEARL 8.2%	17.0%
	Other tools 10.2%	5.6%
Hospital at home or early supported discharge schemes		
Is this available at your hospital?	Yes, 80.3%	Yes, 75%
If yes, can this be accessed?	Medical admissions unit? 94.7%	92.6%
	Respiratory ward(s)? 98.2%	100%
	Any ward? 84.2%	81.5%
How are patients selected? ^b	Clinical judgment alone 84.2%	68.5%
	DECAF/PEARL 8.8%	27.8%
	Other tools 7.1%	3.8%
Readmission avoidance schemes		
Is this available at your hospital?	Yes, 56.3%	Yes, 52.8%
If yes, can this be accessed?	Medical admissions unit? 87.5%	94.7%
	Respiratory ward(s)? 87.5%	97.4%
	Any ward? 72.5%	89.5%
How are patients selected? ^c	Clinical judgment alone 87.8%	65.8%
	DECAF/PEARL 4.8%	13.1%
	Other tools 7.3%	21%
Early unsupported discharge		
How are patients selected? ^d	Clinical judgment alone 88.7%	69.4%
	DECAF 7%	15.3%
	Other tools 4.2%	15.3%

The most common tool response(s) for each area is specified.

^aDECAF/PEARL change $p=0.240$. Bespoke hospital criteria used in 8.2% (2017) and 5.6% (2019), $p=0.708$; Not specified in 2% (2017) and 0% (2019).

^bDECAF/PEARL change $p=0.013$. NEWS/NEWS2 1.8% (2017) and 1.9% (2019); CURB-65 1.9% (2019); Not specified in 5.3% (2017) and 0% (2019), $p=0.244$.

^cDECAF/PEARL change $p=0.252$. Not specified in 7.3% (2017) and 10.5% (2019), $p=0.705$; NEWS/NEWS2 in 2.6% (2019); 'all patients referred' 0% (2017) and 7.9% (2019), $p=0.107$.

^dDECAF change $p=0.184$. Not specified in 4.2% (2017) and 9.7% (2019), $p=0.326$; in 2019 CURB-65 used in 1.4%, NEWS/NEWS2 in 1.4% and AMBS-2 in 2.8%. Breakdown of DECAF and PEARL scoring.

Admission avoidance: DECAF 6.1% (2017) and 13.2% (2019). PEARL 2.0% (2017) and 0% (2019). "DECAF & PEARL" specified rather than individual tools 0% (2017) and 3.8% (2019). *Hospital at home/Early Supported Discharge:* DECAF 7.0% (2017) and 25.9% (2019). PEARL 1.8% (2017) and 0% (2019). "DECAF & PEARL" specified rather than individual tools 0% (2017) and 1.9% (2019). *Readmission avoidance scheme:* DECAF 2.4% (2017) and 2.6% (2019). PEARL 2.4% (2017) and 10.5% (2019).

was used to guide escalation in 14.1% in 2019 (2.8% in 2017; $p=0.031$), and the ReSPECT process in 1.4% (0% in 2017).

Similarly, cardiopulmonary resuscitation decisions were almost wholly founded on clinical judgment (100% in 2017, 94.3% in 2019) with use of the ReSPECT process increasing to 4.3% and NEWS/NEWS2 to 1.4%.

Specialist palliative care referrals were guided by clinical judgment alone in 87.3% of hospitals in 2017 and 93.1% in 2019. The most commonly used tool to help aid these referral decisions was the GSF-PIG, though there was a numerical fall in its use from 5.6% to 1.4% ($p=0.209$) over the time period. In 2019, other tools specified to aid palliative care referral decisions were DECAF (1.4%) and ReSPECT (1.4%).

Various clinical tools were used to help guide other aspects of COPD care in 2019. These included: the BODE score [16], the CAT score [24], The Hospital Anxiety and Depression (HADS) score [25], Karnofsky performance status [26], GAD-7 score [27] and CRQ [28]. Unfortunately, most respondents did not state the specific situations these tools were used in, with the notable exception of BODE to assist transplantation referral decisions. In 2019, 41.7% of responding hospitals stated they were planning on newly integrating the use of clinical prognostic tools into their routine treatment of COPD patients including: DECAF (14

sites), PEARL (11 sites), BODE (1 site), GSF-PIG (1 site) and others (tool not specified, 6 sites).

Discussion

To the authors knowledge, this is the first description of the routine use of clinical risk-stratification tools in COPD secondary care in England and Wales. A minority of hospitals use the DECAF or PEARL scores to guide admission avoidance or unsupported hospital discharge, but their use doubled over two years; for HaH and ESD decisions this has more than tripled. The PEARL score [21] was published shortly prior to distribution of the 2017 survey, and the RCT of Hospital at Home selected by DECAF (showing that this model of care was clinically and cost-effective, and preferred by 90% of patients) [13] was published between the two surveys. These publications probably contributed to the increased use of the DECAF and PEARL scores.

NIV, escalation of care decisions and cardiopulmonary resuscitation decisions were generally not influenced by clinical tools but by clinical judgment and/or patient preference. Of note, the surveys were performed prior to development of the Noninvasive Ventilation Outcomes (NIVO) score [29]. Despite a number of clinical prognostic tools predicting short to

medium term mortality, few were routinely used to aid palliative care decisions at either time point, and use of the GSF-PIG fell over the period between surveys. The burden of symptoms in COPD patients is high and prognostic awareness among patients and their families is poor. Patients may benefit from specialist palliative care input, informed discussion and advance care planning in their management, but identifying the appropriate time for this can be challenging. The fall in the use of clinical tools in this setting is perhaps surprising and therefore suggests either little confidence amongst secondary care clinicians in the predictive ability of the available tools, an absence of consideration of palliative care decisions in the acute inpatient setting, or simply reflect that specialist palliative care teams do not require a specific prognostic tool threshold to facilitate referral. Another potential barrier to use could be difficulty in selecting which, of the many clinical tools available, is appropriate to use in this setting. The MoSHCOPD trial (clinicaltrials.gov reference: NCT03657121) hopes to help answer this question by assessing multiple tools' performance, alongside clinician rated ease of completion of the tools, and should report later this year.

Whilst the use of clinical prognostic tools has generally increased over the time between surveys, further work is required to embed them into routine clinical practice. Unfortunately, the scope of the latest UK National Institute for health and Care Excellence (NICE) COPD guidance excluded assessment of clinical risk-stratification tools in severe exacerbations of COPD. NICE only assessed BODE in stable patients; routine use was not supported [30]. Prognostic pessimism already occurs in COPD and objectifying outcome with clinical prognostic tools may help challenge this. A clinician who relies too heavily on any individual clinical feature or finding, or with cognitive bias obscuring objective assessment, may grossly under or overestimate the likelihood of an outcome, and this may influence the treatment options offered or provided. Predicting a likely outcome is even more challenging for a clinician to undertake when multiple, complex variables need to be accounted for and assimilated. The authors therefore strongly encourage the use of clinical tools in daily clinical care of patients with COPD, as is routine in other medical conditions. We also strongly urge NICE to conduct an evaluation of the use of clinical risk-stratification in COPD exacerbations requiring hospital admission, and to reassess use of such tools in stable COPD, expanding the remit to include all eligible tools, including ADO [31]. This could help to challenge prognostic pessimism, improve equity of care, and improve safety and clinical outcomes.

In COPD, the DECAF Score offers superior performance to other scores and is the only clinical prediction tool to have undergone an implementation RCT [13,32]. Using low risk DECAF scores to direct patients into HaH treatment is safe, cost effective and preferred by 90% of patients compared to being treated in hospital. Of importance, approximately half of patients admitted with COPD exacerbation are DECAF 0-1 (mortality 1-1.4%), thus potentially suitable for HaH to replace most or all of the inpatient stay. Assessment of mortality risk can also be used to inform suitability for admission avoidance and ESD in low risk patients, and inform clinical decisions in those with a high mortality risk. The integration

of clinical prediction tools would be improved with further implementation studies, alongside work exploring barriers to their use in routine clinical care [33].

This survey result, and statistical analysis, is limited by the modest response rate of 36-37%, despite multimodal (digital and paper) distribution of the survey. However, this is similar to many surveys of clinical practice and reflects usual care across over 70 acute hospitals in England and Wales. Inclusion of Scottish and Northern Irish hospitals would have facilitated a more reflective picture of UK practice, but these countries were not included in the National Asthma and COPD Audit Program, which provided the mailing list. These results could be influenced by the individual responding clinician. Whilst surveys were addressed to the lead of the COPD service at each hospital and asked to be reflective of practice within the hospital, it is possible that the responses would vary depending on the individual responding to the survey. Of course, the use of clinical prognostic tools in the non-responding hospitals remains unknown.

Nevertheless, these survey data are of interest to both clinicians working in COPD care, and to researchers in this field; both in demonstrating how clinical prognostic tools are being used around the country, and how we could better integrate them into future practice.

Acknowledgements

Many thanks to the British Lung Foundation and Royal College of Physicians of London National Asthma and COPD audit (NACAP) team for supporting this work and assistance with distribution. Thanks to Mrs. Victoria Ferguson for assistance with admin and Northumbria Healthcare NHS Foundation Trust Research and Development department for assistance with printing and postage costs. Many thanks to colleagues at centres who responded to the surveys.

Declarations of interest

SCB reports research grants from Philips Respironics, Pfizer Open Air, Bright Northumbria and The ResMed Foundation during the conduct of the study, and an NIHR (Research for Patient Benefit) grant; personal fees from AstraZeneca, Pfizer, and ResMed; and non-financial support from Boehringer Ingelheim, Chiesi and GlaxoSmithKline. All of these are outside the submitted work. JS reports research grants from Chiesi Ltd and Menarini, outside of the submitted work. NDL and SMG were employed and funded by Northumbria Healthcare NHS Foundation Trusts Research Fellowship program during the conduct of the study. NDL reports research grants from Bright Northumbria and The ResMed Foundation, and non-financial support from Chiesi during the study. All of these are outside of the submitted work. SMG has nothing to disclose.

Funding

This work was funded by Northumbria Healthcare NHS Foundation Trust research and development and Newcastle University IMPACT team.

ORCID

Nicholas D. Lane  <http://orcid.org/0000-0002-9954-6366>
 Sarah M. Gillespie  <http://orcid.org/0000-0003-3352-0937>
 John Steer  <http://orcid.org/0000-0003-4415-8814>
 Stephen C. Bourke  <http://orcid.org/0000-0003-0228-0854>

Data availability

Reasonable requests for access to the original data will be considered by the corresponding author.

References

- Madia V, Chidwick P. Prognosis: Important information when obtaining informed consent. *J Palliat Care Med*. 2011;1(101). DOI:10.4172/2165-7386.1000101
- Wieseemann C. The significance of prognosis for a theory of medical practice. *Theor Med Bioeth*. 1998;19(3):253–261. DOI:10.1023/A:1009913915839
- Wildman MJ, O’Dea J, Kostopoulou O, et al. Variation in intubation decisions for patients with chronic obstructive pulmonary disease in one critical care network. *QJM*. 2003;96(8):583–591. DOI:10.1093/qjmed/hcg104
- Wildman MJ, Sanderson C, Groves J, et al. Implications of prognostic pessimism in patients with chronic obstructive pulmonary disease (COPD) or asthma admitted to intensive care in the UK within the COPD and asthma outcome study (CAOS): multi-centre observational cohort study. *BMJ*. 2007;335(7630):1132. DOI:10.1136/bmj.39371.524271.55
- Wright C, Dent T. Quality standards in risk prediction: summary of an expert meeting. Cambridge (UK): PHG Foundation; 2011. ISBN 978-1-907198-05-2
- Moons KGM, Kengne AP, Woodward M, et al. Risk prediction models: I. Development, internal validation, and assessing the incremental value of a new (bio)marker. *Heart*. 2012;98(9):683–690. DOI:10.1136/heartjnl-2011-301246
- Lip GYH, Nieuwlaat R, Pisters R, et al. Refining clinical risk stratification for predicting stroke and thromboembolism in atrial fibrillation using a novel risk factor-based approach: the euro heart survey on atrial fibrillation. *Chest*. 2010;137(2):263–272. DOI:10.1378/chest.09-1584
- Lip GYH, Frison L, Halperin JL, et al. Comparative validation of a novel risk score for predicting bleeding risk in anticoagulated patients with atrial fibrillation: the HAS-BLED (hypertension, abnormal renal/liver function, stroke, bleeding history or predisposition, labile INR, elderly, drugs/alcohol concomitantly) score. *J Am Coll Cardiol*. 2011;57(2):173–180. DOI:10.1016/j.jacc.2010.09.024
- Chen IC, Hung MS, Chiu TF, et al. Risk scoring systems to predict need for clinical intervention for patients with nonvariceal upper gastrointestinal tract bleeding. *Am J Emerg Med*. 2007;25(7):774–779. DOI:10.1016/j.ajem.2006.12.024
- Wolf SJ, McCubbin TR, Feldhaus KM, et al. Prospective validation of wells criteria in the evaluation of patients with suspected pulmonary embolism. *Ann Emerg Med*. 2004;44(5):503–510. DOI:10.1016/j.annemergmed.2004.04.002
- Bellou V, Belbasis L, Konstantinidis AK, et al. Prognostic models for outcome prediction in patients with chronic obstructive pulmonary disease: systematic review and critical appraisal. *BMJ*. 2019;367:l5358. DOI:10.1136/bmj.l5358
- Echevarria C, Steer J, Heslop-Marshall K, et al. Validation of the DECAF score to predict hospital mortality in acute exacerbations of COPD. *Thorax*. 2016;71(2):133–140. DOI:10.1136/thoraxjnl-2015-207775
- Echevarria C, Gray J, Hartley T, et al. Home treatment of COPD exacerbation selected by DECAF score: a non-inferiority, randomised controlled trial and economic evaluation. *Thorax*. 2018;73(8):713–722. DOI:10.1136/thoraxjnl-2017-211197
- Knaus WA, Draper EA, Wagner DP, et al. APACHE II: a severity of disease classification system. *Crit Care Med*. 1985;13(10):818–829. DOI:10.1097/00003246-198510000-00009
- Tabak YP, Sun X, Johannes RS, et al. Mortality and need for mechanical ventilation in acute exacerbations of chronic obstructive pulmonary disease. *Arch Intern Med*. 2009;169(17):1595–1602. DOI:10.1001/archinternmed.2009.270
- Celli BR, Cote CG, Marin JM, et al. The Body-Mass index, airflow obstruction, dyspnea, and exercise capacity index in chronic obstructive pulmonary disease. *N Engl J Med*. 2004;350(10):1005–1012. DOI:10.1056/NEJMoa021322
- Wildman MJ, Harrison DA, Welch CA, et al. A new measure of acute physiological derangement for patients with exacerbations of obstructive airways disease: the COPD and asthma physiology score. *Respir Med*. 2007;101(9):1994–2002. DOI:10.1016/j.rmed.2007.04.002
- Lim WS, van der Eerden MM, Laing R, et al. Defining community acquired pneumonia severity on presentation to hospital: an international derivation and validation study. *Thorax*. 2003;58(5):377–382. DOI:10.1136/thorax.58.5.377
- Steer J, Gibson J, Bourke SC. The DECAF score: predicting hospital mortality in exacerbations of chronic obstructive pulmonary disease. *Thorax*. 2012;67(11):970–976. DOI:10.1136/thoraxjnl-2012-202103
- van Walraven C, Dhalla IA, Bell C, et al. Derivation and validation of an index to predict early death or unplanned readmission after discharge from hospital to the community. *CMAJ*. 2010;182(6):551–557. DOI:10.1503/cmaj.091117
- Echevarria C, Steer J, Heslop-Marshall K, et al. The PEARL score predicts 90-day readmission or death after hospitalisation for acute exacerbation of COPD. *Thorax*. 2017;72(8):686–693. DOI:10.1136/thoraxjnl-2016-209298
- Thomas K, Armstrong WJ. Gold standards framework proactive identification guidance. 6th ed. London: Gold Standards Framework and Royal College of General Practitioners; 2016. Available at <https://goldstandardsframework.org.uk/PIG>.
- Hawkes CA, Fritz Z, Deas G, ReSPECT working group orators, et al. Development of the recommended summary plan for emergency care and treatment (ReSPECT). *Resuscitation*. 2020;148:98–107. DOI:10.1016/j.resuscitation.2020.01.003
- Jones PW, Harding G, Berry P, et al. Development and first validation of the COPD assessment test. *Eur Respir J*. 2009;34(3):648–654. DOI:10.1183/09031936.00102509
- Dowson C, Laing R, Barraclough R, et al. The use of the hospital anxiety and depression scale (HADS) in patients with chronic obstructive pulmonary disease: a pilot study. *N Z Med J*. 2001. 1141;114:447–449.
- Schag CC, Heinrich RL, Ganz PA. Karnofsky performance status revisited: reliability, validity, and guidelines. *J Clin Oncol*. 1984;2(3):187–193. DOI:10.1200/JCO.1984.2.3.187
- Spitzer RL, Kroenke K, Williams JBW, et al. A brief measure for assessing generalized anxiety disorder: the GAD-7. *Arch Intern Med*. 2006;166(10):1092–1097. DOI:10.1001/archinte.166.10.1092
- Wijkstra PJ, TenVergert EM, Van Altena R, et al. Reliability and validity of the chronic respiratory questionnaire (CRQ). *Thorax*. 1994;49(5):465–467. DOI:10.1136/thx.49.5.465
- Hartley T, Lane ND, Steer J, et al. The NIV outcomes (NIVO) score: prediction of in-hospital mortality in exacerbations of COPD requiring assisted ventilation. *Eur Respir J*. 2021;2004042. DOI:10.1183/13993003.04042-2020
- National Institute for Health and Care Excellent (NICE). Chronic obstructive pulmonary disease in over 16s: diagnosis and management [NG115]. London: NICE; 2018 (NICE guidance reference NG115).
- Athlin A, Giezeman M, Hasselgren M, et al. Prediction of mortality using different COPD risk Assessments - A 12-Year Follow-Up. *Int J Chron Obstruct Pulmon Dis*. 2021;16:665–675. DOI:10.2147/COPD.S282694
- Huang O, He C, Xiong H, et al. DECAF score as a mortality predictor for acute exacerbation of chronic obstructive pulmonary disease: a systematic review and Meta-analysis. *BMJ Open*. 2020;10(10):e037923. DOI:10.1136/bmjopen-2020-037923
- Dismore LL, Echevarria C, van Wersch A, et al. What are the positive drivers and potential barriers to implementation of hospital at home selected by low-risk DECAF score in the UK: a qualitative study embedded within a randomised controlled trial. *BMJ Open*. 2019;9(4):e026609. DOI:10.1136/bmjopen-2018-026609