BMJ Open

Potential solutions for triage, screening, and severity scoring of potentially-positive COVID-19 patients in low-resource settings: A scoping review

Journal:	*BMJ Open*
Manuscript ID	bmjopen-2020-046130
Article Type:	Original research
Date Submitted by the Author:	21-Oct-2020
Complete List of Authors:	Pigoga, Jennifer; University of Cape Town, Division of Emergency Medicine Hirner, Sarah; University of Colorado Denver School of Medicine Naidoo, Antoinette; University of Cape Town Division of Emergency Medicine Calvello, Emilie; University of Colorado Denver School of Medicine, Emergency Medicine Omer, Yasein; Sudan Medical Specialization Board Wallis, Lee; University of Cape Town, Emergency Medicince Bills, Corey; University of Colorado Denver School of Medicine, Emergency Medicine
Keywords:	Infection control < INFECTIOUS DISEASES, ACCIDENT & EMERGENCY MEDICINE, PUBLIC HEALTH

I, the Submitting Author has the right to grant and does grant on behalf of all authors of the Work (as defined in the below author licence), an exclusive licence and/or a non-exclusive licence for contributions from authors who are: i) UK Crown employees; ii) where BMJ has agreed a CC-BY licence shall apply, and/or iii) in accordance with the terms applicable for US Federal Government officers or employees acting as part of their official duties; on a worldwide, perpetual, irrevocable, royalty-free basis to BMJ Publishing Group Ltd ("BMJ") its licensees and where the relevant Journal is co-owned by BMJ to the co-owners of the Journal, to publish the Work in this journal and any other BMJ products and to exploit all rights, as set out in our licence.

The Submitting Author accepts and understands that any supply made under these terms is made by BMJ to the Submitting Author unless you are acting as an employee on behalf of your employer or a postgraduate student of an affiliated institution which is paying any applicable article publishing charge ("APC") for Open Access articles. Where the Submitting Author wishes to make the Work available on an Open Access basis (and intends to pay the relevant APC), the terms of reuse of such Open Access shall be governed by a Creative Commons licence – details of these licences and which Creative Commons licence will apply to this Work are set out in our licence referred to above.

Other than as permitted in any relevant BMJ Author's Self Archiving Policies, I confirm this Work has not been accepted for publication elsewhere, is not being considered for publication elsewhere and does not duplicate material already published. I confirm all authors consent to publication of this Work and authorise the granting of this licence.

Potential solutions for triage, screening, and severity scoring of potentially-positive COVID-19 patients in low-resource settings: A scoping review

Pigoga, JL[1], MPH; Hirner, S[2], MS; Naidoo, AV[1], FCEM(SA); Calvello Hynes, EJ[3], MD; Omer, YO[1,4], MBBS; Wallis, LA[1], MD; Bills, CB[3], MD

Author affiliations

1. Division of Emergency Medicine, University of Cape Town, Cape Town, South Africa
2. University of Colorado School of Medicine, Denver, CO, USA
3. Department of Emergency Medicine, University of Colorado School of Medicine, Denver, CO, USA
4. Sudan Medical Specialization Board, Khartoum, Sudan

Correspondence to:
Jennifer L Pigoga, Division of Emergency Medicine, University of Cape Town, Cape Town, 7935, South Africa
jennpigoga@gmail.com

Word count: 3565

Abstract

Introduction

Purposefully designed and validated screening, triage, and severity scoring tools are needed to reduce mortality of COVID-19 in low-resource settings (LRS). This review aimed to identify currently proposed and/or implemented methods of screening, triaging, and severity scoring suspected COVID-19 patients upon initial presentation to the healthcare system, and to evaluate the utility of these tools in LRS.

Design

A scoping review was conducted to identify studies describing screening, triage, and severity scoring of suspected COVID-19 patients published between December 12, 2019 and September 01, 2020. Extracted information included clinical features, use of laboratory and imaging studies, and relevant tool validation data.

Results

The initial search strategy yielded 14,350 articles. A total of 93 manuscripts met inclusion criteria. Most studies were from China (n=37, 39.8%) or the United States (n=15, 16·1%). In total, 51 screening, 39 severity scoring tools, and 20 triage tools were described; 13 of these – nine for screening, two for triage, and two for severity scoring – were identified as feasible in LRS and were being used in such settings. A total of 31 studies provided validation data: four prospective and 27 retrospective, with none from low-income and lower-middle-income countries.

Conclusions

This study identified a wide range of screening, triage, and severity scoring tools implemented and proposed for suspected COVID-19 patients. No tools were designed and validated in LRS. A tool specific to resource limited context is crucial to reducing mortality in the current pandemic.

Strengths and limitations of this study

- We provide the first scoping review of screening, triage, and severity scoring tools both proposed and implemented among patients initial presentation to the healthcare system. This review evaluates the features of these tools and their potential utility in LRS.
- Many screening, triage, and severity scoring tools have been proposed and implemented, but none purposefully designed for, and validated in, LRS.
- We identified 13 tools - nine for screening, two for triage, and two for severity scoring – that were feasible in LRS.
- Feasibility, however, does not predict that a tool will be accurate or effective, and tools must be validated in the setting of intended use.
- It is likely that many of the screening and prognostication tools being used in healthcare systems worldwide that are not published and thus cannot be describe in this review.

Introduction

SARS-CoV-2 was declared a global public health emergency on January 30, 2020.(1) In the time since, more than 38 million people have been infected and over 1.1 million have died.(2) While many low- and middle-income countries (LMICs) were relatively spared from high mortality rates, public health measures to contain the virus have put enormous strains on health systems and the ability of countries to care for existing disease burdens.(3-5) The influx of Coronavirus Disease 2019 (COVID-19) patients stressed healthcare systems worldwide by increasing demand for personal protective equipment (PPE), diagnostics, oxygen, and mechanical ventilators.(6) Low-resource settings (LRS) have limited access to these resources and remain disproportionately challenged during the COVID-19 pandemic.(7, 8) Even in regions where viral transmission remains low, suspected COVID-19 patients require precautions, and confirmed cases require costly treatment and care. As the pandemic endures, continued resource demands have the potential to overwhelm LRS healthcare systems.(3)

Early recognition and treatment of acute conditions are integral to reducing general mortality in LRS.(9) Previous evidence suggests three specific processes - screening, triage, and severity scoring of patients - improve patient outcomes in LRS. (10, 11) These practises reduce resource utilisation across a variety of settings and inform ongoing patient management,(12) but, appropriate implementation during public health emergencies can be challenging. The need for screening, triage, and severity scoring tools in real-time may lead to the use of both unvalidated and potentially ineffective protocols.

Although emergency care has developed rapidly in LMICs over the past two decades, it remains nascent in many regions, particularly outside of urban areas.(13) Many healthcare systems lack formal emergency units (EUs), and those with dedicated spaces for emergency and acute care may not routinely screen or triage patients. Implementing these tools can be challenging in LRS, where equipment and staff are lacking.(7) Despite the limitations, the exceptional risks of COVID-19 have placed screening and triage procedures at the forefront: Practical screening and triage protocols maximise use of limited available resources and keep patients and providers safe.

Screening refers to the process of identifying and isolating patients with COVID-19 risk factors on initial presentation to the healthcare system, such as to outpatient clinics and EUs.(9) It is a rapid process to evaluate potential risk of infection, typically using basic clinical and historical information. In order to be successful, it must be based on easily understood case definitions, as it is frequently performed by non-healthcare personnel (such as security guards). With screening, high sensitivity is typically prioritised over specificity, so that all cases are identified. This process is fundamentally different from diagnostic testing, which is also referred to as screening in some literature. **Triage** – a systematic method of sorting patients into priority groups based on the severity of their clinical syndrome, and matching these groups with available resources – is usually conducted following screening.(14) Triage is seen as a fundamental component of effective emergency care (15): In order for triage to improve patient outcomes, the triage protocol must effectively prioritise the sickest patients for emergency interventions and direct patients to the appropriate levels of care.(16) **Severity scoring** stratifies patients with a diagnosis (e.g. confirmed or suspected COVID-19) based on risk of poor outcomes, such as mortality or admission to the intensive care unit, and can complement the triage process and further inform resource allocation.

To date, there have been no published reviews detailing available tools for identification and triage of COVID-19 patients. This review aimed to identify currently proposed and/or implemented methods of screening, triaging, and early severity scoring of suspected COVID-19 patients upon initial presentation to the healthcare system, and to evaluate the utility of these tools in LRS.

Methods

Search strategy

A systematic search was conducted to identify literature describing screening, triage, and severity scoring practices that have been implemented or proposed for use with suspected COVID-19 patients upon first presentation to emergency or acute care settings.

Five electronic databases (Embase, Ovid, PubMed, Scopus, and Web of Science) were searched using keywords, with adaptations made based on controlled vocabulary standards for each database. Search terms included "screening," "triage," "severity," "risk," "stratification," "prediction," "tool," "index," "score," "COVID," "COVID-19," and "SARS-CoV-2". Refer to Appendix 1 for full search strategy. Directed searches were conducted to identify grey literature through Google Scholar and Open Grey. Websites of key regional and international health organisations were also searched, including the European Centre for Disease Prevention and Control, Infection Control Africa Network, International Committee of the Red Cross, Medecins Sans Frontières.

UNICEF, United States Agency for International Development, United States Centers for Disease Control and Prevention, and World Health Organization.

Inclusion and exclusion criteria

All studies published in English between December 01, 2019 and September 01, 2020 were eligible for inclusion. Multiple forms of literature, including published and preprint manuscripts, correspondence, reports, and published guidelines, were considered. Studies were required to describe screening, triage, and/or severity scoring of suspected-positive or confirmed COVID-19 patients performed by general practitioners or emergency care providers in the prehospital, hospital, or clinic setting. Both previously existing tools applied to COVID-19 patients and novel tools developed specifically for the COVID-19 response were eligible for inclusion. A description of the tool, including inputs (e.g. hypoxia) and any relevant parameters (e.g. value of input, such as oxygen saturation < 93%), was required. As this review aims to describe all tools that may be in use, outcomes data from implementation and/or validation studies were not requisite. Tools could be either proposed or in use, with or without validation. There were no restrictions on the populations that tools may be used in.

Studies in languages other than English or published prior to December 01, 2019 were excluded. Studies describing screening, triage, and/or severity scoring only by specialist physicians and those lacking a complete description of the tool were not included. Community- and population-based screening efforts, performed by healthcare providers or otherwise, were excluded, as were at-home self-triage tools. Descriptions of physical screening or triage infrastructure (e.g. a walk-up or drive-through facility) and methods of administering screening (e.g. telehealth) were not included.

Data extraction and analysis

Two reviewers (SH, JLP) independently assessed studies for eligibility at the title, abstract, and full-text levels. Any discrepancies were resolved via discussion and a third independent reviewer (AVN) where necessary. Information was then extracted from eligible texts. Extracted data included year of publication, country and setting in which the tool was proposed or implemented, status of a tool as proposed or implemented, and any tool inputs (e.g. comorbidities, clinical symptoms and findings, and diagnostic and laboratory results). A second researcher reviewed all data extractions to ensure accuracy.

Descriptive analyses were performed, and the Preferred Reporting Items for Systematic Reviews and Meta-Analyses – Extension for Scoping Reviews checklist was used to guide analysis and reporting of these results.(17) Feasibility of inputs for use in LRS was determined based on investigation of key literature, including the Disease Control Priorities, Third Edition, and the African Federation for Emergency Medicine's 2013 consensus statement describing the status of emergency care capacity on the continent (18, 19). As with any other setting, LRS have hospitals of varying capacities. In this review, feasibility was targeted towards district level hospitals, as it is these facilities that the majority of LRS populations are likely to initially present to.(18)

Patient and public involvement

Given the nature of this review, it was not appropriate to involve patients or the public in this study's design or execution.

Results

The search strategy yielded a total of 14,350 articles (Figure 1). After duplicates were removed, 2541 unique titles were assessed for inclusion. Following title and abstract screening, 324 articles remained eligible. Full-text review resulted in 93 articles (Supplementary Tables 1-3).

Most articles were published peer-reviewed (n=69, 74·2%) or preprint manuscripts (n=10, 10·8%). Articles came from 24 countries. The majority of the studies were published or conducted in China (n=37, 39·8%), followed by the United States (n=15, 16·1%) and Italy (n=8, 8·6%). International recommendations were described in four articles (4·3%).

More than half of the available literature described screening tools (n=50, 53·8%). Severity scoring tools were described in 35 articles (37·6%) and triage in 18 (19·4%). Some studies described more than one triage or severity scoring tool. In eight studies, both screening and triage were described. In total, 51 screening, 20 triage, and 39 severity scoring tools were described (Table 1).

Table 1: Overview of tools used to screen, triage, and evaluate the severity of COVID-19 patients.

	Screening tools (n=51)		Triage tools (n=20)		Severity scoring tools (n=39)		All tools (N=110)	
	n	%	n	%	n	%	n	%
SETTING								
Hospital	15	29·4%	3	15·0%	24	61·5%	42	38·2%
Hospital-based emergency care	11	21·6%	4	20·0%	0	0·0%	15	13·6%
Outpatient / general practitioner	8	15·7%	1	5·0%	0	0·0%	9	8·2%
Prehospital emergency care	2	3·9%	0	0·0%	0	0·0%	2	1·8%
Not specified	15	29·4%	12	60·0%	15	38·5%	42	38·2%
COUNTRY INCOME LEVEL								
High-income country	24	47·1%	11	55·0%	18	46·2%	53	48·2%
Upper-middle-income country	22	43·1%	6	30·0%	21	53·8%	49	44·5%
Lower-middle-income country	2	3·9%	2	10·0%	0	0·0%	4	3·6%
Low-income country	1	2·0%	0	0·0%	0	0·0%	1	0·9%
Not applicable	2	3·9%	1	5·0%	0	0·0%	3	2·7%
AGE GROUP								
Adults	1	2·0%	3	15·0%	1	2·6%	5	4·5%
Paediatrics	5	9·8%	2	10·0%	0	0·0%	7	6·4%
All ages	3	5·9%	1	5·0%	0	0·0%	4	3·6%
Not specified	42	82·4%	14	70·0%	38	97·4%	94	85·5%
IMPLEMENTATION								
Proposed	17	33·3%	12	60·0%	39	100·00%	68	61·8%
Implemented	34	66·7%	8	40·0%	0	0·00%	42	38·2%
VALIDATION SETTING								
High-income country	2	3·9%	1	5·0%	10	25·6%	13	11·8%
Upper-middle-income country	1	2·0%	1	5·0%	16	41·0%	18	16·4%
Lower-middle-income country	0	0·0%	0	0·0%	0	0·0%	0	0·0%
Low-income country	0	0·0%	0	0·0%	0	0·0%	0	0·0%
Not validated	48	94·1%	18	90·0%	13	33·3%	79	71·8%
FEASIBILITY IN LOW-RESOURCE SETTINGS								
Likely	29	56·9%	5	25·0%	9	23·1%	43	39·1%
Unlikely	22	43·1%	15	75·0%	30	76·9%	67	60·9%

Many tools were designed for hospital-wide (n=42, 38·2%) or EU (n=15, 13·6%) use. More than one-third (n=42, 38·2%) did not have a specified setting and were considered to be designed for broad use throughout the healthcare system. Seven tools (6·4%) – five for screening and two for triage – were specific to paediatric settings; nearly all others (n=94, 85·5%) lacked age specifications.

More than one quarter of tools (n=31, 28·2%) provided validation data supporting their use (Supplementary Table 4), with four (3·6%) validated prospectively. Most tools were validated against the following outcomes: diagnosis of severe COVID-19 disease (n=8, 25·8%), confirmation of COVID-19 via RT-PCR (n=4, 12·9%), or 30-day mortality (n=4. 12·9%). Only three screening tools (5·9%) and two triage tools (10·0%) had associated validation data, while 26 severity scoring tools (66·6%) did. All of these tools were validated in high-income (n=13, 41·9%) or upper-middle-income (n=18, 58·1%) country settings. Of those validated in upper-middle-income countries, 16 were validated in China (88·9%) and two in Turkey (11·1%).

A total of 171 unique inputs were included in the screening, triage, and severity scoring algorithms (Table 2 and Supplementary Table 5).

Table 2: Overview of inputs in tools used to screen, triage, and evaluate the severity of COVID-19 patients.

	Screening tools (n=51)		Triage tools (n=19)		Severity scoring tools (n=39)	
	No. unique inputs	%	No. unique inputs	%	No. unique inputs	%
Clinical interventions received	0	0·0%	5	5·2%	1	1·1%
Comorbidities	5	7·1%	15	15·6%	23	25·0%
Concurrent acute conditions	2	2·9%	17	17·7%	7	7·6%
Demographics	2	2·9%	3	3·1%	5	5·4%
Imaging investigations	3	4·3%	3	3·1%	3	3·3%
Laboratory investigations	20	28·6%	20	20·8%	33	35·9%
Other characteristics	3	4·3%	3	3·1%	3	3·3%
Signs and symptoms	27	38·6%	16	16·7%	7	7·6%
Vital signs	8	11·4%	14	14·6%	10	10·9%
All inputs	70	100·0%	96	100·0%	92	100·0%

Screening tools had a median of four (IQR: 3-6) inputs. Most (n=32, 64·0%) included epidemiologic risk factors. Fever was commonly included as a reported symptom (n=28, 54·9%) or a measured vital sign (n=17, 33·3%). Triage tools had a median of five (IQR: 1·75-11) inputs. Oxygen saturation was the vital sign most commonly used (n=12, 60·0%), followed by tachypnoea (n=11, 55·0%). Concurrently diagnosed acute conditions were present in multiple triage tools (n=12, 60·0%). Severity scoring tools had a median of five inputs (IQR: 1-7). The most frequently used inputs in these tools were age (n=21, 53.8%), respiratory rate (n=13, 33·3%), temperature (n=12, 30·8%), and lactate dehydrogenase (n=11, 28·2%).

A number of studies used pre-existing severity tools to stratify potentially-positive COVID-19 patients - one for triage and 11 for severity scoring (Supplementary Table 6). The most common tools for severity scoring were the CURB-65 and qSOFA scores, which were each used in four studies. One score – the Korean Triage and Acuity Scale – was used for triage of confirmed COVID-19 patients.

Tool inputs that rely on imaging and nearly all laboratory testing are largely impractical for routine use in many frontline EUs in LRS.(7, 8) In the context of these restrictions, just over half of screening tools (n=29, 56·9%) are viable for use in LRS EUs; a smaller number (n=5, 25·0%) of triage and severity scoring (n=9, 23·1%) tools are also feasible. Many studies describing tools inappropriate for LRS EUs included imaging: 12 screening tools (23·5%), 11 triage tools (55·0%), and 10 (25·6%) severity scoring tools required a chest X-ray, chest CT and/or lung ultrasound. At least one laboratory value was included in 12 screening (10·0%), seven (35·0%) triage, and 25 severity scoring (64·1%) tools. Screening tools were proposed or implemented in five LMICs - 18 in China, and one each in India, Timor-Leste, Turkey, and Uganda - with only nine (45·0%) of these tools were deemed feasible for LRS settings. Triage tools were proposed or implemented in four LMICs - three in China, and one each in India, Timor-Leste, and Turkey – with only two (33·3%) deemed feasible for LRS. Of the 19 severity scoring tools proposed or implemented in LMICs, 18 were from China and one was from Argentina; just two (10·5%) are likely feasible in LRS.

Discussion

This scoping review identified a wide range of tools being used to screen, triage, and predict the severity of potentially-positive COVID-19 patients worldwide. A disproportionate share of tools were described in three countries – China, the United States, and Italy; a reflection of the combination of disease burden in these nations as well as host country research capacities. While more than half of screening tools provided some information about implementation, less than half of triage tools and no severity scoring tools did so. Overall manuscript quality was high, with nearly three-quarters from peer-reviewed publications. Uncertainty remains in regards to the accuracy of these tools: Only one-quarter were validated, and variations in settings and reporting make it difficult to generalise and compare these data. Almost all studies providing both training and prospective validations showed substantial decreases in accuracy with prospective cohorts. There was also variance in accuracy of the same tools – such as NEWS (National Early Warning Score) and NEWS2 – across different high-income and upper-middle-income settings.

A majority of the tools identified were for screening, followed by severity scoring and triage. Tool length varied, though most were short (between four and five inputs). Identified tools with fewer inputs likely have more utility

in EUs, but, only a small number of tools were purpose-designed for EUs. Available articles provide information on only eight screening tools for EUs, and one triage tool. Despite the impact of severity scoring tools on informing appropriate patient interventions and disposition,(10) there was no literature available to guide the use of severity scoring tools in EUs. And, although there is substantial variance in presentations in children versus adults,(20) very few tools specified a target age group for utilisation. This, in combination with a lack of paediatric-specific tools, suggests a need for additional investigation into appropriate tools for identification and risk of poor outcomes in suspected COVID-19 in paediatric populations.

Screening is an essential means of separating patients with suspected illness from the general population on presentation to the health system. This is particularly critical in LRS, where laboratory testing for COVID-19 is limited (21), and PPE and other resources need to be conserved for positive cases. Most of screening tools found in this review recommended conducting screening on patients using epidemiologic risk factors and symptoms consistent with the case definition of suspected COVID-19, such as cough and fever. Non-validated use of such tools could be problematic for multiple reasons. Firstly, it is well documented that there is poor, inaccurate self-reporting of epidemiologic risk factors, including exposure to other patients and travel history.(22) The impact of epidemiologic data in a tool is also limited by the establishment of widespread community transmission, since such transmission indicates that nearly all patients are at risk of exposure. Compounding this is the fact that a substantial portion of COVID-19 cases present atypically, without the commonplace symptoms that providers are screening for using these tools (23). For example, one study of 1099 confirmed COVID-19 cases demonstrated that only 43.8% of COVID-19 positive cases presented with fever.(24) More than half of screening tools included fever as a symptom, and many of them considered it requisite to meet the suspect case definition. These challenges in capturing the correct epidemiologic data and meeting "typical" case definitions suggests that many screening tools may not effectively identify patients with COVID-19, lacking sensitivity. Also of concern is that, despite the intention of screening as a rapid, first-pass method of identifying potentially positive COVID-19 patients, many published screening tools relied on laboratory investigations. It is likely that intensive precautions must be taken with these patients while awaiting diagnostic results since, even in the highest-resource settings, laboratory results take time. The resources to take these precautions are almost universally limited, and inaccurate screening may place healthcare workers and patients at unnecessary risk.

After screening, suspected COVID-19 patients should be triaged to determine symptom severity using a standard triage tool contextually validated.(25) Following this, patients should be further risk stratified using a severity scoring tool in order to guide clinical management and hospital disposition. Among both triage and severity scoring tools, there was a general lack of consensus about key inputs for prognosticating COVID-19 patients. This is unsurprising, given the novelty of SARS-CoV-2 and the numerous typical and atypical presentations of COVID-19 disease. Despite emerging evidence that any comorbidity, as well as cerebrovascular disease, chronic obstructive pulmonary disease, diabetes, hypertension, and smoking history correlate with the likelihood of more severe COVID-19 disease, (26, 27) there was little agreement on which comorbidities to include in tools. Many triage and severity scoring tools included age as an input, congruent with large-scale data that age is a severity modifier. Fewer tools included male sex , despite similar evidence of its predictive value.(26, 27) Shortness of breath, cough, and fever were used in many tools. A concurrent meta-analysis identified that fever and shortness of breath were significant predictors of severe COVID-19 disease, while cough was not.(27) A core set of five vital signs – heart rate, oxygen saturation, respiratory rate, systolic blood pressure, and temperature – were seen across triage and severity scoring tools. Although limited data are available on the utility of mental status in predicting COVID-19 illness severity, a majority of reporting studies do indicate that abnormal oxygen saturation, respiratory rate, systolic blood pressure, and temperature are significant predictors of poor outcome.(27)

Although a large number of screening, triage, and severity scoring tools were described in the literature, LRS use is likely to be limited . More than half of the screening tools identified in this review are likely feasible in LRS, but only a small number of triage and severity scoring tools are. Of the 41 tools proposed for use in LMICs, only 13 – nine for screening, two for triage, and two for severity scoring – were deemed feasible in LRS. The most notable of these was the integrated screening and triage process used by Howitt *et al*. in Timor-Leste.(28) The algorithm was adapted from Ayebare *et al.* (Uganda) with the removal laboratory testing for COVID-19.(29) It uses well-supported inputs, including oxygen saturation and respiratory symptoms, to identify and prognosticate potentially positive COVID-19 patients in a rapid manner. While many LRS EUs lack pulse oximeters needed to evaluate for hypoxia,(8) these devices are becoming increasingly available. As such this review considered pulse oximetry feasible in LRS.

Limitations

Feasibility does not predict that a tool will be accurate or effective. Tools should be validated in the setting of intended use. This review found no tools validated in low- and lower-middle-income countries. Of those validated

in upper-middle-income countries, nearly all were in well-resourced areas of China, substantially limiting generalisability to LRS. Without contextually appropriate validation data, it is difficult to predict if feasible tools are effective in identifying and risk stratifying COVID-19 patients.

Most of the tools discussed in this review were peer-reviewed publications or guidelines by reputable international organisations, with a smaller number in the form of editorials, published correspondence, and preprints. The latter forms of publication often lack peer-review and may be of lower quality. Furthermore, this review is likely missing a number of tools. Almost every health system worldwide maintains some form of screening and triage processes, along with processes for further decision-making around admission. While in use, both before and during the COVID-19 pandemic, these tools have not been formally published and cannot be described here.

In nearly all studies, tools did not provide specific case definitions or diagnostic guidance for assessing concurrent acute conditions; this may in turn lead to variance in clinical evaluation and diagnosis based on available resources. Feasibility in LRS was acknowledged if there was a well-described and low-input method of diagnosis available – even if it was not necessarily the gold standard of diagnosis is high-resource settings.

Risk of bias assessments could not be performed because most articles were in the form of descriptive reviews, rather than presentations of primary data.

Conclusions

In LRS, where definitive diagnostic tests for COVID-19, such as RT-PCR, may not be available, screening, triage, and scoring of potential COVID-19 patients are critical. Rapid identification and prognostication of suspected COVID-19 patients in LRS EUs will allow for appropriate precautions and care to be rendered to all patients,. resulting in conservation of resources and reductions in morbidity and mortality . At present, no screening, triage, or severity scoring tools have been designed and validated specifically for LRS. In the face of an enduring pandemic, it is critical that such tools be developed, validated, and made available, so that limited resources can be conserved for those in greatest need and unnecessary loss of life is prevented.

Funding: No funding was received for this study.

Competing interests: All authors have completed the ICMJE uniform disclosure form at www.icmje.org/coi_disclosure.pdf and declare: no support from any organisation for the submitted work; no financial relationships with any organisations that might have an interest in the submitted work in the previous three years; no other relationships or activities that could appear to have influenced the submitted work.

Contributorship: SH, CB, and EJCH designed the study. SH and JLP performed the literature searches. SH, JLP, and VN screened article titles, abstracts, and full-texts for inclusion, and extracted data. SH and JLP cross-checked all data extractions. SH, JLP, and VN drafted the manuscript. All authors contributed to revising the manuscript and have approved of the final version. EJCH is the guarantor.

Ethical approval: Not applicable.

Data sharing statement: Extracted data are available on request to the corresponding author.

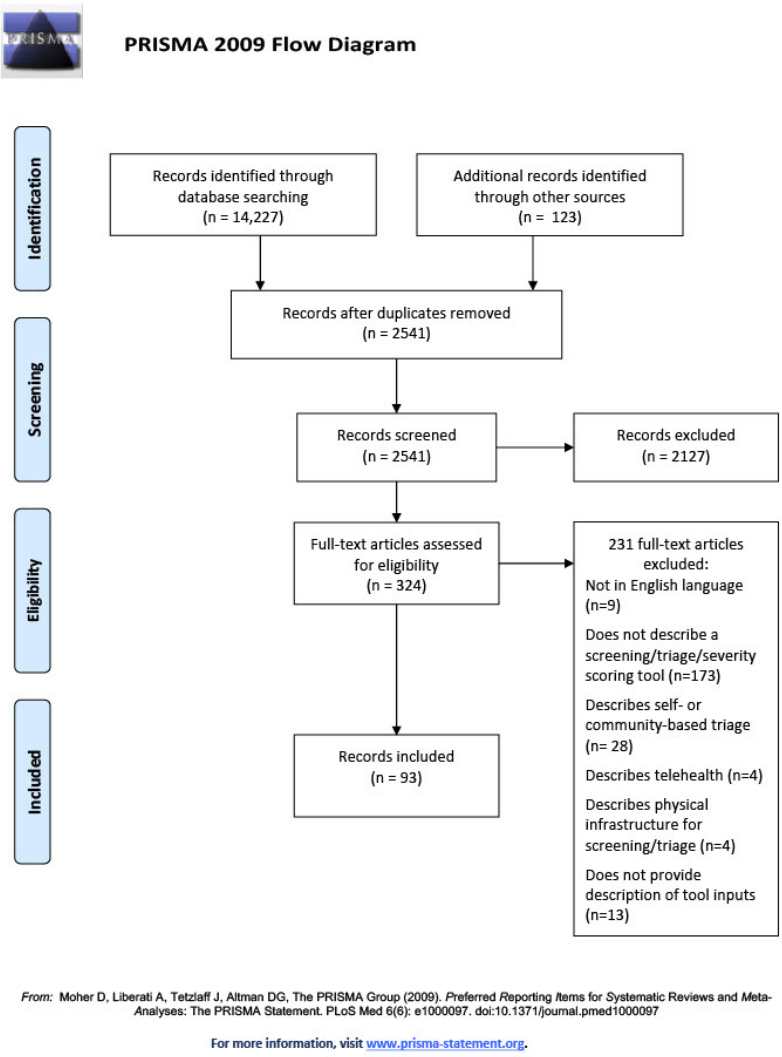
Transparency: The lead author affirms that the manuscript is an honest, accurate, and transparent account of the study being reported; that no important aspects of the study have been omitted; and that any discrepancies from the study as planned (and, if relevant, registered) have been explained.

Dissemination to participants and related patient and public communities: Not applicable.

REFERENCES

1. Timeline of WHO's response to COVID-19 Geneva: World Health Organization; 2020 [Available from: https://www.who.int/news-room/detail/29-06-2020-covidtimeline.
2. WHO Coronavirus Disease (COVID-19) Dashboard Geneva: World Health Organization; 2020 [Available from: https://covid19.who.int/.
3. Bong C-L, Brasher C, Chikumba E, McDougall R, Mellin-Olsen J, Enright A. The COVID-19 Pandemic: Effects on Low- and Middle-Income Countries. Anesthesia & Analgesia. 2020;131(1).
4. Massinga Loembe M, Tshangela A, Salyer SJ, Varma JK, Ouma AEO, Nkengasong JN. COVID-19 in Africa: the spread and response. Nat Med. 2020;26(7):999-1003.
5. Lone SA, Ahmad A. COVID-19 pandemic - an African perspective. Emerg Microbes Infect. 2020;9(1):1300-8.
6. Carenzo L, Costantini E, Greco M, Barra FL, Rendiniello V, Mainetti M, et al. Hospital surge capacity in a tertiary emergency referral centre during the COVID-19 outbreak in Italy. Anaesthesia. 2020;n/a(n/a).
7. Chavula C, Pigoga JL, Kafwamfwa M, Wallis LA. Cross-sectional evaluation of emergency care capacity at public hospitals in Zambia. Emerg Med J. 2019.
8. Bitter CC, Rice B, Periyanayagam U, Dreifuss B, Hammerstedt H, Nelson SW, et al. What resources are used in emergency departments in rural sub-Saharan Africa? A retrospective analysis of patient care in a district-level hospital in Uganda. BMJ Open. 2018;8(2):e019024.
9. Reynolds TA, Mfinanga JA, Sawe HR, Runyon MS, Mwafongo V. Emergency care capacity in Africa: a clinical and educational initiative in Tanzania. J Public Health Policy. 2012;33 Suppl 1:S126-37.
10. Dalwai M, Tayler-Smith K, Twomey M, Nasim M, Popal AQ, Haqdost WH, et al. Inter-rater and intrarater reliability of the South African Triage Scale in low-resource settings of Haiti and Afghanistan. Emerg Med J. 2018;35(6):379-83.
11. Gostic K, Gomez AC, Mummah RO, Kucharski AJ, Lloyd-Smith JO. Estimated effectiveness of symptom and risk screening to prevent the spread of COVID-19. Elife. 2020;9.
12. Hansoti B, Jenson A, Kironji AG, Katz J, Levin S, Rothman R, et al. SCREEN: A simple layperson administered screening algorithm in low resource international settings significantly reduces waiting time for critically ill children in primary healthcare clinics. PLoS One. 2017;12(8):e0183520.
13. Jenson A, Hansoti B, Rothman R, de Ramirez SS, Lobner K, Wallis L. Reliability and validity of emergency department triage tools in low- and middle-income countries: a systematic review. European Journal of Emergency Medicine. 2018;25(3).
14. Organization WH. Emergency Triage Assessment and Treatment (ETAT) Manual for Participants. 2005.
15. Oredsson S, Jonsson H, Rognes J, Lind L, Goransson KE, Ehrenberg A, et al. A systematic review of triage-related interventions to improve patient flow in emergency departments. Scand J Trauma Resusc Emerg Med. 2011;19:43.
16. Venkatesan S, Myles PR, McCann G, Kousoulis AA, Hashmi M, Belatri R, et al. Development of processes allowing near real-time refinement and validation of triage tools during the early stage of an outbreak in readiness for surge: the FLU-CATs Study. (2046-4924 (Electronic)).
17. Tricco AC, Lillie E, Zarin W, O'Brien KK, Colquhoun H, Levac D, et al. PRISMA Extension for Scoping Reviews (PRISMA-ScR): Checklist and Explanation. (1539-3704 (Electronic)).
18. Reynolds T, Sawe H, Rubiano A, Shin S, Wallis L, Mock C. Strengthening Health Systems to Provide Emergency Care. Disease Control Priorities: Improving Health and Reducing Poverty. 3 ed. Washington (DC): The International Bank for Reconstruction and Development / The World Bank; 2017. p. 247-65.
19. Calvello EJ, Tenner AG, Broccoli MC, Skog AP, Muck AE, Tupesis JP, et al. Operationalising emergency care delivery in sub-Saharan Africa: consensus-based recommendations for healthcare facilities. Emerg Med J. 2016;33(8):573-80.
20. Wang Z, Zhou Q, Wang C, Shi Q, Lu S, Ma Y, et al. Clinical characteristics of children with COVID-19: a rapid review and meta-analysis. Ann Transl Med. 2020;8(10):620.
21. Seidu AA, Hagan JE, Jr., Ameyaw EK, Ahinkorah BO, Schack T. The role of testing in the fight against COVID-19: Current happenings in Africa and the way forward. Int J Infect Dis. 2020;98:237-40.
22. Smith B, Chu LK, Smith TC, Amoroso PJ, Boyko EJ, Hooper TI, et al. Challenges of self-reported medical conditions and electronic medical records among members of a large military cohort. BMC Med Res Methodol. 2008;8:37.
23. Burke R, Killerby M, Newton S, Ashworth C, Berns A, Brennan S, et al. Symptom Profiles of a Convenience Sample of Patients with COVID-19 — United States, January–April 2020. MMWR Morb Mortal Wkly Rep. 2020(64):904-8.
24. Vilke G, Brennan J, Cronin A, Castillo E. Clinical features of covid-19 patients: is temperature screening useful? J Emerg Med. 2020.
25. Organization WH. Clinical Management of COVID-19 Interim Guidance. 2020:1-58.

26. Fang X, Li S, Yu H, Wang P, Zhang Y, Chen Z, et al. Epidemiological, comorbidity factors with severity and prognosis of COVID-19: a systematic review and meta-analysis. Aging (Albany NY). 2020;12(13):12493-503.
27. Pigoga J, Friedman A, Broccoli M, Hirner S, Naidoo A, Singh S, et al. Clinical and historical features associated with severe COVID-19 infection: a systematic review and meta-analysis. Paired paper submission. 2020.
28. Howitt R, de Jesus GA, Araujo F, Francis J, Marr I, McVean M, et al. Screening and triage at health-care facilities in Timor-Leste during the COVID-19 pandemic. Lancet Respir Med. 2020;8(6):e43.
29. Ayebare RR, Flick R, Okware S, Bodo B, Lamorde M. Adoption of COVID-19 triage strategies for low-income settings. Lancet Respir Med. 2020;8(4):e22.



PRISMA flow diagram

279x361mm (72 x 72 DPI)

Appendix 1: Search strategy

Search date: 01/06/20

Search limits: 01/12/19 to 01/09/20, English only, publications only

Database	Search string	No. results
PubMed	(“COVID-19” [TIAB] **OR** “SARS-CoV-2” [TIAB]) **AND** (Triage [MeSH] **OR** “Triage” [TIAB] **OR** “Screening” [TIAB] **OR** ((“Risk” [TIAB] **OR** “Severity” [TIAB]) **AND** (“Stratification” [TIAB] **OR** “Prediction” [TIAB] **OR** “Tool” [TIAB] **OR** “Index” [TIAB] **OR** “Scor*” [TIAB])))	3044
Scopus	TITLE-ABS-KEY("COVID-19" **OR** "SARS-CoV-2") **AND** TITLE-ABS-KEY("triage" **OR** "screening" **OR** ((“Risk” **OR** “Severity”) **AND** (“Stratification” **OR** “Prediction” **OR** “Tool” **OR** “Index” **OR** “Scor*”)))	3753
Web of Science	TS=("COVID-19" **OR** "SARS-CoV-2") **AND** TS=("triage" **OR** "screening" **OR** ((“Risk” **OR** “Severity”) **AND** (“Stratification” **OR** “Prediction” **OR** “Tool” **OR** “Index” **OR** “Scor*”)))	1536
Embase	('covid 19'/exp **OR** 'covid 19' **OR** 'sars cov 2'/exp **OR** 'sars cov 2') **AND** ('triage'/exp **OR** ‘triage’ **OR** 'screening'/exp **OR** screening **OR** ((‘Risk’ **OR** ‘Severity’) **AND** (‘Stratification’ **OR** ‘Prediction’ **OR** ‘Tool’ **OR** ‘Index’ **OR** ‘Scor*’)))	5488
Ovid	("COVID-19" OR "SARS-CoV-2") AND ("Triage" **OR** "Screening" **OR** ((“Risk’” **OR** “Severity”) **AND** (“Stratification” **OR** “Prediction” **OR** “Tool” **OR** “Index” **OR** “Scor*”))). ti, ab	405

Appendix 2: Supplementary Tables

Supplementary Table 1: Screening tool study characteristics (n=51).

Title	First author	Year	Study location	Study setting income level	Study setting	Age group	No. tool inputs	Has the tool been proposed or implemented?
Preparing for emerging respiratory pathogens such as SARS-CoV, MERS-CoV, and SARS-CoV-2(1)	Al-Tawfiq	2020	Dhahran, Saudi Arabia	High-income	Not specified	All ages	7	Proposed
Guidance for building a dedicated health facility to contain the spread of the 2019 novel coronavirus outbreak(2)	Argawal	2020	Pune, India	Lower-middle-income	Not specified	Not specified	4	Proposed
Rapid response infrastructure for pandemic preparedness in a tertiary care hospital: lessons learned from the COVID-19 outbreak in Cologne, Germany, February to March 2020(3)	Augustin	2020	Cologne, Germany	High-income	Not specified	Not specified	3	Implemented
Adoption of COVID-19 triage strategies for low-income settings(4)	Ayebare	2020	Uganda	Low-income	Outpatient / general practitioner	Not specified	6	Proposed
Hospital Emergency Management Plan During the COVID-19 Epidemic(5)	Cao	2020	Chengdu, China	Upper-middle-income	Hospital	Not specified	3	Implemented
Hospital surge capacity in a tertiary emergency referral centre during the COVID-19 outbreak in Italy(6)	Carenzo	2020	Milan, Italy	High-income	Hospital	Not specified	4	Implemented
Standard Operating Procedure for Triage of suspected COVID-19 patients in non-US Healthcare settings(7)	Centers for Disease Control and Prevention	2020	United States	High-income	Not specified	Not specified	4	Proposed
Enhancing the triage and cohort of patients in public primary care clinics in response to the coronavirus disease 2019 (COVID-19) in Hong Kong: an experience from a hospital cluster(8)	Chan	2020	Hong Kong, China	Upper-middle-income	Outpatient / general practitioner	Not specified	3	Implemented
Infection control measures of a Taiwanese hospital to confront the COVID-19 pandemic(9)	Chang	2020	Kaohsiun, Taiwan	High-income	Hospital	Not specified	3	Implemented

Fangcang shelter hospitals: a novel concept for responding to public health emergencies(10)	Chen	2020	Wuhan, China	Upper-middle-income	Hospital	Not specified		Implemented
Escalating infection control response to the rapidly evolving epidemiology of the coronavirus disease 2019 (COVID-19) due to SARS-CoV-2 in Hong Kong(11)	Cheng	2020	Hong Kong, China	Upper-middle-income	Not specified	Not specified	4	Implemented
Onsite telemedicine strategy for coronavirus (COVID-19) screening to limit exposure in ED(12)	Chou	2020	Texas, United States	High-income	Hospital-based emergency care	Not specified	3	Implemented
Mobilization and Preparation of a Large Urban Academic Center During the COVID-19 Pandemic(13)	Chowdhury	2020	Pennsylvania, United States	High-income	Hospital	Not specified	13	Implemented
Revised Triage and Surveillance Protocols for Temporary Emergency Department Closures in Tertiary Hospitals as a Response to COVID-19 Crisis in Daegu Metropolitan City(14)	Chung	2020	Daegu, Korea	High-income	Hospital-based emergency care	Not specified	7	Proposed
Infection control practices in children during COVID-19 pandemic: differences from adults(15)	Devrim	2020	Izmir, Turkey	Upper-middle-income	Not specified	Paediatric	4	Implemented
Calculated Decisions: Brescia-COVID Respiratory Severity Scale (BCRSS)/Algorithm(16)	Duca	2020	United States	High-income	Hospital-based emergency care	Not specified	1	Implemented
Triage decision-making at the time of COVID-19 infection: the Piacenza strategy(17)	Erika	2020	Piacenza, Italy	High-income	Hospital-based emergency care	Not specified	4	Implemented
Immersion in an emergency department triage center during the Covid-19 outbreak: first report of the Liège University hospital experience(18)	Gilbert	2020	Liège, Belgium	High-income	Hospital-based emergency care	Not specified	5	Implemented
An effective screening and management process in the outpatient clinic for patients requiring hospitalization during the COVID-19 pandemic(19)	Guo	2020	Beijing, China	Upper-middle-income	Outpatient / general practitioner	Not specified	4	Proposed
How to transform a general hospital into an "infectious disease hospital" during the epidemic of COVID-19(20)	He	2020	China	Upper-middle-income	Hospital	Not specified	2	Implemented
Screening and triage at health-care facilities in Timor-Leste during the COVID-19 pandemic(21)	Howitt	2020	Timor-Leste	Lower-middle income	Not specified	Not specified	2	Implemented

Application and effects of fever screening system in the prevention of nosocomial infection in the only designated hospital of coronavirus disease 2019 (COVID-19) in Shenzhen, China(22)	Huang	2020	Shenzhen, China	Upper-middle-income	Hospital	Not specified	5	Implemented
The role of emergency medical services in containing COVID-19(23)	Jaffe	2020	Israel	High-income	Prehospital emergency care	Not specified	2	Implemented
An algorithmic approach to diagnosis and treatment of coronavirus disease 2019 (COVID-19) in children: Iranian expert's consensus statement(24)	Karimi	2020	Tehran, Iran	Upper-middle-income	Not specified	Paediatric	9	Proposed
2019-nCoV: The Identify-Isolate-Inform (3I) Tool Applied to a Novel Emerging Coronavirus(25)	Koenig	2020	United states	High-income	Not specified	Not specified	3	Proposed
Diagnosis and clinical management of severe acute respiratory syndrome Coronavirus 2 (SARS-CoV-2) infection: an operational recommendation of Peking Union Medical College Hospital (V2.0): Working Group of 2019 Novel Coronavirus, Peking Union Medical College Hospital(26)	Li	2020	Beijing, China	Upper-middle-income	Not specified	Not specified	1	Proposed
A Double Triage and Telemedicine Protocol to Optimize Infection Control in an Emergency Department in Taiwan During the COVID-19 Pandemic: Retrospective Feasibility Study(27)	Lin	2020	Taipei, Taiwan	High-income	Hospital	Adult	3	Implemented
Optimizing screening strategies for coronavirus disease 2019: A study from Middle China(28)	Liu	2020	Changsa, China	Upper-middle-income	Not specified	Not specified	3	Proposed
A COVID-19 Risk Assessment Decision Support System for General Practitioners: Design and Development Study(29)	Liu	2020	Hangzhou, China	Upper-middle-income	Outpatient / general practitioner	Not specified	36	Proposed
Reorganization of a large academic hospital to face COVID-19 outbreak: The model of Parma, Emilia-Romagna region, Italy(30)	Meschi	2020	Parma, Italy	High-income	Hospital-based emergency care	Not specified	3	Implemented
How emergency departments prepare for virus disease outbreaks like COVID-19(31)	Möckel	2020	Germany	High-income	Hospital-based emergency care	Not specified	3	Implemented
A Pediatric Emergency Department Protocol to Avoid Interhospital Spread of SARS-CoV-2 during the Outbreak in Bergamo, Italy(32)	Nicastro	2020	Bergamo, Italy	High-income	Hospital	Paediatric	3	Implemented

The ultrasound guided triage: a new tool for prehospital management of COVID-19 pandemic(33)	Piliego	2020	Italy	High-income	Not specified	Not specified	7	Proposed
Screening and managing of suspected or confirmed novel coronavirus (COVID-19) patients: experiences from a tertiary hospital outside Hubei province(34)	Pu	2020	Chengdu, China	Upper-middle-income	Hospital	Not specified	2	Implemented
Reorganising the emergency department to manage the COVID-19 outbreak(35)	Quah	2020	Singapore	High-income	Hospital-based emergency care	Not specified	7	Implemented
Can You Catch It? Lessons Learned and Modification of ED Triage Symptom- and Travel-Screening Strategy(36)	Schwedhelm	2020	Nebraska, United States	High-income	Hospital-based emergency care	Not specified	4	Implemented
Emergency Responses to Covid-19 Outbreak: Experiences and Lessons from a General Hospital in Nanjing, China(37)	Shen	2020	Nanjing, China	Upper-middle-income	Hospital	Not specified	5	Implemented
A quickly, effectively screening process of novel corona virus disease 2019 (COVID-19) in children in Shanghai, China(38)	Shi	2020	Shanghai, China	Upper-middle-income	Hospital	Paediatric	3	Implemented
The response of Milan's Emergency Medical System to the COVID-19 outbreak in Italy(39)	Spina	2020	Milan, Italy	High-income	Prehospital emergency care	Not specified	2	Implemented
Reducing hospital admissions for COVID-19 at a dedicated screening centre in Singapore(40)	Tan	2020	Singapore	High-income	Hospital	Not specified	3	Implemented
The role of triage in the prevention and control of COVID-19(41)	Wang	2020	Xi'an, China	Upper-middle-income	Hospital	Not specified	7	Implemented
Providing uninterrupted care during COVID-19 pandemic: experience from Beijing Tiantan Hospital(42)	Wang	2020	Beijing, China	Upper-middle-income	Hospital	Not specified	4	Implemented
Containing COVID-19 in the Emergency Department: The Role of Improved Case Detection and Segregation of Suspect Cases(43)	Wee	2020	Singapore	High-income	Hospital-based emergency care	All ages	2	Implemented
Redesigning emergency department operations amidst a viral pandemic(44)	Whiteside	2020	United States	High-income	Hospital-based emergency care	Not specified	3	Proposed
Clinical Management of COVID-19 Interim Guidance(45)	World Health Organization	2020	Not applicable	Not applicable	Not specified	All ages	4	Proposed
Strategies for qualified triage stations and fever clinics during the outbreak of COVID-2019 in the county hospitals of Western Chongqing(46)	Wu	2020	Western Chongqing, China	Upper-middle-income	Outpatient / general practitioner	Not specified	17	Implemented

Therapeutic and triage strategies for 2019 novel coronavirus disease in fever clinics(47)	Zhang	2020	Wuhan, China	Upper-middle-income	Outpatient / general practitioner	Not specified	10	Implemented
Analysis and suggestions for the preview and triage screening of children with suspected COVID-19 outside the epidemic area of Hubei Province(48)	Zhang	2020	Chongqing, China	Upper-middle-income	Outpatient / general practitioner	Paediatric	5	Implemented
COVID19: A Systematic Approach to Early Identification and Healthcare Worker Protection(49)	Zhao	2020	Shanghai, China	Upper-middle-income	Not specified	Not specified	4	Proposed
Primary stratification and identification of suspected Corona virus disease 2019 (COVID-19) from clinical perspective by a simple scoring proposal(50)	Zhou	2020	Gansu, China	Upper-middle-income	Not specified	Not specified	10	Proposed
Proposed Clinical Indicators for Efficient Screening and Testing for COVID-19 Infection from Classification and Regression Trees (CART) Analysis(51)	Zimmerman	2020	Pennsylvania, United States	High-income	Outpatient / general practitioner	Not specified	5	Proposed

Supplementary Table 2: Triage tool study characteristics (n=18).

Title	First author	Year	Study location	Study setting income level	Study setting	Age group	No. tool inputs	Has the tool been proposed or implemented?
Emergency Department COVID-19 Severity Classification(52)	American College of Emergency Physicians	2020	USA	High-income	Not specified	Adults	41	Proposed
Fangcang shelter hospitals: a novel concept for responding to public health emergencies(10)	Chen	2020	Wuhan, China	Upper-middle-income	Hospital	Not specified	12	Implemented
Mobilization and Preparation of a Large Urban Academic Center During the COVID-19 Pandemic(13)	Chowdhury	2020	Pennsylvania, United States	High-income	Hospital	Not specified	16	Implemented
Revised Triage and Surveillance Protocols for Temporary Emergency Department Closures in Tertiary Hospitals as a Response to COVID-19 Crisis in Daegu Metropolitan City(14)	Chung	2020	Daegu, Korea	High-income	Hospital-based emergency care	Not specified	8	Proposed
Early prediction of the risk of severe coronavirus disease 2019: A key step in therapeutic decision making(53)	Côté	2020	Quebec, Canada	High-income	Not specified	Not specified	21	Proposed
Infection control practices in children during COVID-19 pandemic: differences from adults(15)	Devrim	2020	Izmir, Turkey	Upper-middle-income	Not specified	Paediatric	5	Implemented
How is COVID-19 affecting South Korea? What is our current strategy?(54)	Her	2020	South Korea	High-income	Not specified	Not specified	2	Implemented
Screening and triage at health-care facilities in Timor-Leste during the COVID-19 pandemic(21)	Howitt	2020	Timor-Leste	Lower-middle income	Not specified	Not specified	4	Implemented
An algorithmic approach to diagnosis and treatment of coronavirus disease 2019 (COVID-19) in children: Iranian expert's consensus statement(24)	Karimi	2020	Tehran, Iran	Upper-middle-income	Not specified	Paediatric	15	Proposed
Diagnosis and clinical management of severe acute respiratory syndrome Coronavirus 2 (SARS-CoV-2) infection: an operational	Li	2020	Beijing, China	Upper-middle-income	Hospital	Not specified	11	Proposed

recommendation of Peking Union Medical College Hospital (V2.0): Working Group of 2019 Novel Coronavirus, Peking Union Medical College Hospital(26)								
A Double Triage and Telemedicine Protocol to Optimize Infection Control in an Emergency Department in Taiwan During the COVID-19 Pandemic: Retrospective Feasibility Study(27)	Lin	2020	Taipei, Taiwan	High-income	Hospital	Adult	8	Implemented
CLUE: COVID-19 lung ultrasound in emergency department(55)	Manivel	2020	Sydney, Australia	High-income	Hospital-based emergency care	Not specified	1	Proposed
Proposed Modifications in the 6-minutue Walk Test for Potential Application in Patients with mild Coronavirus Disease 2019 (COVID-19): A Step to Optimize Triage Guidelines(56)	Mantha	2020	India	Lower-middle income	Not specified	Not specified	6	Proposed
Reorganization of a large academic hospital to face COVID-19 outbreak: The model of Parma, Emilia-Romagna region, Italy(30)	Meschi	2020	Parma, ltaly	High-income	Hospital-based emergency care	Not specified	8	Implemented
The ultrasound guided triage: a new tool for prehospital management of COVID-19 pandemic(33)	Piliego	2020	Italy	High-income	Not specified	Not specified	9	Proposed
COVID-19 Outpatient Screening: A Prediction Score for Adverse Events(57)	Sun	2020	Massachusetts, United States	High-income	Outpatient / general practitioner	Adult	20	Proposed
Lower mortality of COVID-19 by early recognition and intervention: experience from Jiangsu Province(58)	Sun	2020	Nanjing, China	Upper-middle-income	Not specified	Not specified	6	Implemented
Clinical Management of COVID-19 Interim Guidance(45)	World Health Organization	2020	Not applicable	Not applicable	Not specified	All ages	18	Proposed

Supplementary Table 3: Severity scoring / prognostication tool study characteristics (n=36).

Title	First author	Year	Study location	Study setting income level	Study setting	Age group	No. tool inputs	Has the tool been proposed or implemented?
Development and validation of a prediction model for severe respiratory failure in hospitalized patients with SARS-Cov-2 infection: a multicenter cohort study (PREDI-CO study)(59)	Bartoletti	2020	Bologna, Italy	High-income	Hospital	Not specified	8	Proposed
Prediction of severe illness due to COVID-19 based on an analysis of initial fibrinogen to albumin ratio and platelet count(60)	Bi	2020	Taizhou, China	Upper-middle-income	Hospital	Not specified	2	Proposed
Chest X-ray in new Coronavirus Disease 2019 (COVID-19) infection: findings and correlation with clinical outcome(61)	Cozzi	2020	Florence, Italy	High-income	Hospital	Not specified	1	Proposed
A novel simple scoring model for predicting severity of patients with SARS-CoV-2 infection(62)	Dong	2020	Wuhan, China	Upper-middle-income	Hospital	Not specified	3	Proposed
The utility of established prognostic scores in COVID-19 hospital admissions: a multicentre prospective evaluation of CURB-65, NEWS2, and qSOFA(63)	Frost	2020	Liverpool, England	High-income	Hospital	Not specified	2	Proposed
A clinical risk score to identify patients with COVID-19 at high risk of critical care admission or death: An observational cohort study(64)	Galloway	2020	London, United Kingdom	High-income	Hospital	Not specified	10	Proposed
Prognostic Accuracy of the SIRS, qSOFA, and NEWS for Early Detection of Clinical Deterioration in SARS-CoV-2 Infected Patients(65)	Jang	2020	Daegu, Korea	High-income	Not specified	Not specified	3	Proposed
Predictive value of National Early Warning Score 2 (NEWS2) for intensive care unit admission in patients with SARS-CoV-2 infection(66)	Gidari	2020	Perugia, Italy	High-income	Hospital	Not specified	1	Proposed
A Tool for Early Prediction of Severe Coronavirus Disease 2019 (COVID-19): A Multicenter Study Using the Risk Nomogram in Wuhan and Guangdong, China(67)	Gong	2020	Guangzhou, China	Upper-middle-income	Hospital	Not specified	7	Proposed

Development and validation of the quick COVID-19 severity index (qCSI): a prognostic tool for early clinical decompensation(68)	Haimovich	2020	Connecticut, United States	High-income	Not specified	Not specified	3	Proposed
COVID-19 Severity Index: predictive score for hospitalized patients(69)	Huespe	2020	Buenos Aires, Argentina	Upper-middle-income	Hospital	Not specified	16	Proposed
COVID-19: Symptoms, course of illness and use of clinical scoring systems for the first 42 patients admitted to a Norwegian local hospital(70)	Ihle-Hansen	2020	Viken county, Norway	High-income	Hospital	Not specified	1	Proposed
Development and validation of a model for individualized prediction of hospitalization risk in 4,536 patients with COVID-19(71)	Jehi	2020	Guangzhou, China	Upper-middle-income	Not specified	Not specified	8	Proposed
Clinical Frailty Scale for risk stratification in patients with SARS-CoV-2 infection(72)	Labenz	2020	Mainz, Germany	High-income	Hospital	Not specified	1	Proposed
Triage tool for suspected COVID-19 patients in the emergency room: AIFELL score(73)	Levenfus	2020	Zurich, Switzerland	High-income	Hospital	Not specified	6	Proposed
A simple algorithm helps early identification of SARS-CoV-2 infection patients with severe progression tendency(74)	Li	2020	Shanghai, China	Upper-middle-income	Not specified	Not specified	3	Proposed
Development and Validation of a Clinical Risk Score to Predict the Occurrence of Critical Illness in Hospitalized Patients With COVID-19(75)	Liang	2020	Guangzhou, China	Upper-middle-income	Not specified	Not specified	10	Proposed
Early triage of critically ill COVID-19 patients using deep learning(76)	Liang	2020	Guangzhou, China	Upper-middle-income	Not specified	Not specified	10	Proposed
Development and validation of a risk stratification model for screening suspected cases of COVID-19 in China(77)	Ma	2020	Wuhan, China	Upper-middle-income	Not specified	Not specified	23	Proposed
National Early Warning Score 2 (NEWS2) on admission predicts severe disease and in-hospital mortality from Covid-19 - a prospective cohort study(78)	Myrstad	2020	Oslo, Norway	High-income	Hospital	Not specified	1	Proposed
A nomogram to predict the risk of unfavourable outcome in COVID-19: a retrospective cohort of 279 hospitalized patients in Paris area(79)	Nguyen	2020	Paris, France	High-income	Hospital	Not specified	7	Proposed

Automated EHR score to predict COVID-19 outcomes at US Department of Veterans Affairs(80)	Osborne	2020	California, United States	High-income	Not specified	Adult	25	Proposed
NEWS can predict deterioration of patients with COVID-19(81)	Peng	2020	Huazhong, China	Upper-middle-income	Not specified	Not specified	2	Proposed
Performance of pneumonia severity index and CURB-65 in predicting 30-day mortality in patients with COVID-19(82)	Satici	2020	Istanbul, Turkey	Upper-middle-income	Hospital	Not specified	2	Proposed
Model-based Prediction of Critical Illness in Hospitalized Patients with COVID-19(83)	Schalekamp	2020	Amersfoort, The Netherlands	High-income	Not specified	Not specified	7	Proposed
Scoring systems for predicting mortality for severe patients with COVID-19(84)	Shang	2020	Wuhan, China	Upper-middle-income	Hospital	Not specified	5	Proposed
Evaluating a Widely Implemented Proprietary Deterioration Index Model Among Hospitalized COVID-19 Patients(85)	Singh	2020	Michigan, United States	High-income	Not specified	Not specified	1	Proposed
Development of a data-driven COVID-19 prognostication tool to inform triage and step-down care for hospitalised patients in Hong Kong: A population based cohort study(86)	Tsui	2020	Hong Kong, China	Upper-middle-income	Hospital	Not specified	7	Proposed
Development of a Clinical Decision Support System for Severity Risk Prediction and Triage of COVID-19 Patients at Hospital Admission: An International Multicenter Study(87)	Wu	2020	Maastricht, the Netherlands	High-income	Hospital	Not specified	7	Proposed
Development and validation of the HNC-LL score for predicting the severity of coronavirus disease 2019(88)	Xiao	2020	Guangzhou, China	Upper-middle-income	Not specified	Not specified	5	Proposed
A Novel Scoring System for Prediction of Disease Severity in COVID-19(62)	Zhang	2020	Beijing, China	Upper-middle-income	Hospital	Not specified	5	Proposed
Development and validation of a risk factor-based system to predict short-term survival in adult hospitalized patients with COVID-19: a multicenter, retrospective, cohort study(89)	Zhang	2020	Honghu, China	Upper-middle-income	Hospital	Not specified	1	Proposed
Lung Ultrasound Score in Evaluating the Severity of Coronavirus Disease 2019 (COVID-19) Pneumonia(90)	Zhao	2020	Shanghai, China	Upper-middle-income	Hospital	Not specified	1	Proposed

Development and validation a nomogram for predicting the risk of severe COVID-19: A multi-center study in Sichuan, China(91)	Zhou	2020	Sichuan, China	Upper-middle-income	Not specified	Not specified	6	Proposed
Deep-learning artificial intelligence analysis of clinical variables predicts mortality in COVID-19 patients(92)	Zhu	2020	New York, United States	High-income	Not specified	Not specified	5	Proposed
Acute Physiology and Chronic Health Evaluation II Score as a Predictor of Hospital Mortality in Patients of Coronavirus Disease 2019(93)	Zou	2020	Wuhan, China	Upper-middle-income	Hospital	Not specified	1	Proposed

Supplementary Table 4: Summary of validation data for tools being used to screen, triage, and prognosticate COVID-19 patients.

		Tool training/development validation data					Other validation data				
Title	Validation endpoint	AUC	Sensitivity	Specificity	PPV	NPV	Validation type	AUC	Sensitivity	Specificity	PPV	NPV
A Novel Scoring System for Prediction of Disease Severity in COVID-19(94)	ICU admission						Retro-spective	0·91	0·71	0·89		
A novel simple scoring model for predicting severity of patients with SARS-CoV-2 infection(62)	COVID-19 confirmed by RT-PCR						Retro-spective		0·8	0·79		
A quickly, effectively screening process of novel corona virus disease 2019 (COVID-19) in children in Shanghai, China(38)	COVID-19 diagnosis		1	0·71	0·18	1						
A simple algorithm helps early identification of SARS-CoV-2 infection patients with severe progression tendency(74)	Severe COVID-19 disease						Retro-spective		0·18	0·93	0·49	0·98
A Tool for Early Prediction of Severe Coronavirus Disease 2019 (COVID-19): A Multicenter Study Using the Risk Nomogram in Wuhan and Guangdong, China(67)	Severe COVID-19 disease	0·91	0·86	0·88								
Acute Physiology and Chronic Health Evaluation II Score as a Predictor of Hospital Mortality in Patients of Coronavirus Disease 2019(93)	In-hospital mortality	0·97	0·96	0·86								
Containing COVID-19 in the Emergency Department: The Role of Improved Case Detection and Segregation of Suspect Cases(43)	COVID-19 confirmed by RT-PCR		0·842 (95% CI [0·736-0·919])	0·648 (95% CI [0·625-0·670])								

COVID-19 Outpatient Screening: A Prediction Score for Adverse Events(57)	Hospitalisation, ICU care, need for mechanical ventilation, or death within 7 days of an outpatient medical encounter	0·80 (hospitalisation); 0·82 (critical illness); 0·87 (death)					Pro-spective	0·76 (hospitalisation); 0·79 (critical illness); 0·93 (death)				
Development and Validation of a Clinical Risk Score to Predict the Occurrence of Critical Illness in Hospitalized Patients With COVID-19(75)	Critical COVID-19 disease		72% (95% CI [65%-79%]) (at risk score >3)	86% (95% CI [89%-92%]) (at risk score >3)	74% (95% CI [67%-80%]) (at risk score >3)	89% (95% CI [85%-91%]) (at risk score >3)	Retro-spective		80% (95% CI [73%-85%]) (at risk score >3)	76% (95% CI [70%-81%]) (at risk score >3)	69% (95% CI [60%-74%]) (at risk score >3)	85% (95% CI [80%-89%]) (at risk score >3)
Development and validation of a prediction model for severe respiratory failure in hospitalized patients with SARS-Cov-2 infection: a multicenter cohort study (PREDI-CO study)(59)	Severe respiratory failure	0·89 (95% CI [0·86-0·92])										
Development and validation of a risk factor-based system to predict short-term survival in adult hospitalized patients with COVID-19: a multicenter, retrospective, cohort study(89)	28-day mortality						Retro-spective	0.879 (95% CI [0.856-0.900)				
Development and validation of a risk stratification model for screening suspected cases of COVID-19 in China(77)	COVID-19 confirmed by RT-PCR	0·86	0·83	0·78	0·32	0·97	Retro-spective	0·87	0·82	0·77	0·26	0·98
Development and validation of the HNC-LL score for predicting the severity of coronavirus disease 2019(88)	Severe COVID-19 disease						Retro-spective	0·86	0·85	0·76		

Development and validation of the quick COVID-19 severity index (qCSI): a prognostic tool for early clinical decompensation(68)	Respiratory failure within 24 hours of admission						Retro-spective	0·91	0·94	0·82		
Development of a Clinical Decision Support System for Severity Risk Prediction and Triage of COVID-19 Patients at Hospital Admission: An International Multicenter Study(87)	Severe or critical COVID-19 disease	0·88	0·85	0·74	0·75	0·85						
Development of a data-driven COVID-19 prognostication tool to inform triage and step-down care for hospitalised patients in Hong Kong: A population based cohort study(86)	Severe COVID-19 disease			0·913 (Day-1 model) and 0·942 (Day-5 model)								
Evaluating a Widely Implemented Proprietary Deterioration Index Model Among Hospitalized COVID-19 Patients(85)	ICU-level care, mechanical ventilation, or in-hospital death						Retro-spective	0·79	0·39	0·91	0·74	0·9
Lower mortality of COVID-19 by early recognition and intervention: experience from Jiangsu Province(58)	Severe COVID-19 disease	0·96	0·955 (95% CI [0·772-0·999])	0·899 (95% CI [0·863-0·928])								
Lung Ultrasound Score in Evaluating the Severity of Coronavirus Disease 2019 (COVID-19) Pneumonia(90)	Refractory COVID-19 disease						Retro-spective	0·52	1	0·74		
Model-based Prediction of Critical Illness in Hospitalized Patients with COVID-19(83)	Critical COVID-19 disease						Retro-spective	0·77	0·5	0·88	0·79	0·66

National Early Warning Score 2 (NEWS2) on admission predicts severe disease and in-hospital mortality from Covid-19 - a prospective cohort study(78)	Severe COVID-19 disease	0·82	0·8	0·84							
NEWS can predict deterioration of patients with COVID-19(81)	Severe and critical COVID-19 disease						Pro-spective	0·84	1	0·51	
Performance of pneumonia severity index and CURB-65 in predicting 30-day mortality in patients with COVID-19(82)	30-day mortality						Retro-spective	0·79 (CURB-65); 0·85 (PSI)	0·73 (CURB-65); 0·80 (PSI)	0·85 (CURB-65); 0·89 (PSI)	0·31 (CURB-65), 0·39 (PSI)	0·97 (CURB-65), 0·98 (PSI)
Prediction of severe illness due to COVID-19 based on an analysis of initial Fibrinogen to Albumin Ratio and Platelet count(60)	Severe COVID-19 disease		0·863 (95% CI [0·640–0·964])	0·593 (95% CI [0·485–0·694])	0·339 (95% CI [0·222–0·0·479])	0·9474 (95% CI [0·845–0·986])	Pro-spective		0·857 (95% CI [0·420–0·992])	0·429 (95% CI [0·226–0·556])	0·333 (95% CI [0·143–0·588])	0·9 (95% CI [0·541–0·994])
Predictive value of National Early Warning Score 2 (NEWS2) for intensive care unit admission in patients with SARS-CoV-2 infection(66)	Severe COVID-19 disease						Retro-spective		0·89	0·66	0·63	0·9
Prognostic Accuracy of the SIRS, qSOFA, and NEWS for Early Detection of Clinical Deterioration in SARS-CoV-2 Infected Patients(84)	28-day mortality						Retro-spective	0·918 (NEWS); 0·760 (qSOFA); 0·744 (SIRS)	0·867 (NEWS≥ 5)	0·905 (NEWS≥ 5)	0·591 (NEWS≥ 5)	0·977 (NEWS≥ 5)
Proposed Clinical Indicators for Efficient Screening and Testing for COVID-19 Infection from Classification and Regression Trees (CART) Analysis(51)	COVID-19 confirmed by RT-PCR	0·78	0·96	0·53	0·14	0·99						

The utility of established prognostic scores in COVID-19 hospital admissions: a multicentre prospective evaluation of CURB-65, NEWS2, and qSOFA(63)	30-day mortality		Pro-spective	0·75 (CURB-65 2); 0·61 (CURB-65 ≥3); 0·78 (NEWS2 ≥5); 0·66 (qSOFA ≥2)	0·85 (CURB-65 ≥2); 0·61 (CURB-65 ≥3); 0·92 (NEWS2 ≥5); 0·45 (qSOFA ≥2)	0·47 (CURB-65 ≥2); 0·73 (CURB-65 ≥3); 0·31 (NEWS2 ≥5); 0·484(qSOFA ≥2)	0·12 (CURB-65 ≥2); 0·17 (CURB-65 ≥3); 0·10 (NEWS2 ≥5); 0·19 (qSOFA ≥2)	0·97 (CURB-65 ≥2); 0·96 (CURB-65 ≥3); 0·98 (NEWS2 ≥5); 0·94 (qSOFA ≥2)

Note: Only common, standardised measures of validation were extracted.
AUC = area under curve score; PPV = positive predictive value; NPV = negative predictive value

Supplementary Table 5: Breakdown of inputs used tools used to screen, triage, and prognosticate COVID-19 patients.

Input	Feasible to evaluate or perform in low-resource setting emergency units?	Screening tools (n=51)		Triage tools (n=19)		Severity scoring tools (n=39)	
		No. tools using input	%	No. tools using input	%	No. tools using input	%
CONCURRENT ACUTE CONDITIONS (n=20)							
Acute renal failure	No	0	0·0%	0	0·0%	2	5·1%
Acute respiratory distress syndrome	No	0	0·0%	3	15·0%	0	0·0%
Animal/insect bites	Yes	0	0·0%	1	5·0%	0	0·0%
Bacterial coinfection	No	0	0·0%	2	10·0%	0	0·0%
Cardiac arrest	Yes	0	0·0%	2	10·0%	0	0·0%
Current level of physical fitness	Yes	0	0·0%	0	0·0%	2	5·1%
Encephalopathy	Yes	0	0·0%	1	5·0%	0	0·0%
Major trauma	Yes	0	0·0%	1	5·0%	0	0·0%
Metabolic acidosis	No	0	0·0%	1	5·0%	0	0·0%
Multilobe infiltrate	Yes	0	0·0%	2	10·0%	0	0·0%
Organ failure	No	0	0·0%	2	10·0%	2	5·1%
Pericarditis	No	0	0·0%	1	5·0%	0	0·0%
Pleural effusion	Yes	0	0·0%	0	0·0%	1	2·6%
Pneumonia	Yes	3	5·9%	3	15·0%	1	2·6%
Respiratory distress	Yes	1	2·0%	3	15·0%	0	0·0%
Pneumothorax	No	0	0·0%	3	15·0%	0	0·0%
Respiratory failure	Yes	0	0·0%	3	15·0%	4	10·3%
Septic shock	Yes	0	0·0%	4	20·0%	0	0·0%
Systemic inflammatory response syndrome (SIRS)	Yes	0	0·0%	1	5·0%	0	0·0%
Unknown clinical inputs (proprietary algorithm)	No	0	0·0%	0	0·0%	1	2·6%
CLINICAL INTERVENTIONS RECEIVED (n=5)							
Nasal intermittent positive pressure ventilation	No	0	0·0%	1	5·0%	0	0·0%
Need for supplemental oxygen	Yes	0	0·0%	1	5·0%	7	17·9%
High-flow nasal canula	No	0	0·0%	1	5·0%	0	0·0%
Mechanical ventilation	No	0	0·0%	1	5·0%	0	0·0%

Vasopressors	No	0	0·0%	1	5·0%	0	0·0%
DEMOGRAPHICS (n=5)							
Age	Yes	3	5·9%	6	30·0%	21	53·8%
Sex	Yes	1	2·0%	2	10·0%	8	20·5%
Ethnicity	Yes	0	0·0%	0	0·0%	2	5·1%
Marital status	Yes	0	0·0%	0	0·0%	1	2·6%
Race	Yes	0	0·0%	1	5·0%	1	2·6%
COMORBIDITIES (n=29)							
Amyotrophic lateral sclerosis	Yes	0	0·0%	1	5·0%	0	0·0%
Any comorbidity	Yes	1	2·0%	1	5·0%	2	5·1%
Asthma	Yes	0	0·0%	0	0·0%	1	2·6%
Atrial fibrillation	Yes	0	0·0%	0	0·0%	1	2·6%
Body mass index	Yes	0	0·0%	2	10·0%	4	10·3%
Chronic kidney disease	Yes	1	2·0%	1	5·0%	3	7·7%
Chronic obstructive lung disease	Yes	0	0·0%	1	5·0%	6	15·4%
Connective tissue disease	Yes	0	0·0%	0	0·0%	1	2·6%
Coronary artery disease / congestive heart failure	Yes	1	2·0%	1	5·0%	6	15·4%
Cystic fibrosis	Yes	0	0·0%	1	5·0%	0	0·0%
Dementia	Yes	0	0·0%	0	0·0%	1	2·6%
Depression	Yes	0	0·0%	0	0·0%	1	2·6%
Diabetes	Yes	0	0·0%	1	5·0%	4	10·3%
Functional disorder	Yes	0	0·0%	0	0·0%	1	2·6%
Hypertension	Yes	0	0·0%	3	15·0%	4	10·3%
Immunocompromise	Yes	2	3·9%	0	0·0%	3	7·7%
Liver disease	Yes	0	0·0%	0	0·0%	2	5·1%
Malignancy	Yes	0	0·0%	2	10·0%	5	12·8%
Malnutrition	Yes	0	0·0%	0	0·0%	1	2·6%
Myasthenia gravis	Yes	0	0·0%	1	5·0%	0	0·0%
Pancreatitis	Yes	0	0·0%	1	5·0%	0	0·0%
Peripheral vascular disease	Yes	0	0·0%	0	0·0%	1	2·6%
Psychiatric disorder	Yes	1	2·0%	0	0·0%	1	2·6%
Seizure disorder	Yes	0	0·0%	1	5·0%	0	0·0%
Smoking history	Yes	0	0·0%	2	10·0%	1	2·6%
Spinal muscular atrophy	Yes	0	0·0%	0	0·0%	1	2·6%

Stroke	Yes	0	0·0%	1	5·0%	1	2·6%
Transplant history	Yes	0	0·0%	0	0·0%	1	2·6%
Valvular heart disease	Yes	0	0·0%	0	0·0%	1	2·6%
LABORATORY INVESTIGATIONS (n=51)							
Albumin	No	0	0·0%	0	0·0%	2	5·1%
Alanine aminotransferase	No	0	0·0%	2	10·0%	0	0·0%
Albumin/globulin ratio	No	0	0·0%	0	0·0%	1	2·6%
Aspartate aminotransferase	No	0	0·0%	1	5·0%	1	2·6%
Basophil count	No	2	3·9%	0	0·0%	0	0·0%
Blood urea nitrogen	No	0	0·0%	2	10·0%	5	12·8%
C-reactive protein	No	2	3·9%	4	20·0%	10	25·6%
Calcium	No	0	0·0%	0	0·0%	1	2·6%
Cardiovascular abnormalities	No	0	0·0%	2	10·0%	0	0·0%
CD4	No	0	0·0%	0	0·0%	1	2·6%
Chloride	No	0	0·0%	0	0·0%	1	2·6%
Complete blood count	No	0	0·0%	1	5·0%	0	0·0%
Creatine kinase	No	0	0·0%	0	0·0%	2	5·1%
Creatinine	No	0	0·0%	4	20·0%	4	10·3%
D-dimer	No	0	0·0%	3	15·0%	4	10·3%
Direct bilirubin	No	0	0·0%	0	0·0%	4	10·3%
Eosinophil count	No	1	2·0%	0	0·0%	0	0·0%
Erythrocyte sedimentation rate	No	0	0·0%	0	0·0%	1	2·6%
Ferritin	No	0	0·0%	1	5·0%	0	0·0%
Fibrinogen to albumin ratio	No	0	0·0%	0	0·0%	1	2·6%
Glomerular filtration rate	No	0	0·0%	0	0·0%	1	2·6%
Glucose	Yes	0	0·0%	0	0·0%	1	2·6%
Haematocrit	No	1	2·0%	0	0·0%	3	7·7%
Haemoglobin	No	1	2·0%	0	0·0%	0	0·0%
Immature granulocyte percentage	No	1	2·0%	0	0·0%	0	0·0%
Influenza test	No	1	2·0%	0	0·0%	0	0·0%
Lactate	No	0	0·0%	1	5·0%	0	0·0%
Lactate dehydrogenase	No	0	0·0%	3	15·0%	11	28·2%
Leukocyte count	No	2	3·9%	1	5·0%	1	2·6%
Lymphocyte count	No	4	7·8%	2	10·0%	7	17·9%

Lymphocyte percentage	No	0	0·0%	0	0·0%	1	2·6%
Mean corpuscular haemoglobin	No	1	2·0%	0	0·0%	0	0·0%
Mean corpuscular volume	No	1	2·0%	0	0·0%	0	0·0%
Mean platelet volume	No	1	2·0%	0	0·0%	0	0·0%
Comprehensive metabolic panel	No	0	0·0%	3	15·0%	0	0·0%
Mononuclear cell count	No	1	2·0%	0	0·0%	1	2·6%
Neutrophil count	No	1	2·0%	2	10·0%	3	7·7%
Neutrophil to lymphocyte ratio	No	0	0·0%	2	10·0%	5	12·8%
Nucleated red blood cells	No	1	2·0%	0	0·0%	0	0·0%
pH	No	0	0·0%	0	0·0%	3	7·7%
Platelet count	No	2	3·9%	2	10·0%	4	10·3%
Platelet distribution width	No	2	3·9%	0	0·0%	0	0·0%
Platelet haematocrit	No	2	3·9%	0	0·0%	0	0·0%
Potassium	No	0	0·0%	0	0·0%	3	7·7%
Procalcitonin	No	0	0·0%	0	0·0%	1	2·6%
Red cell distribution width	No	1	2·0%	0	0·0%	1	2·6%
SARS-CoV-2 RT-PCR	No	9	17·6%	1	5·0%	0	0·0%
Sodium	No	0	0·0%	0	0·0%	3	7·7%
Troponin	No	0	0·0%	2	10·0%	1	2·6%
Urea	No	0	0·0%	0	0·0%	1	2·6%
White blood cell count	No	0	0·0%	2	10·0%	2	5·1%
IMAGING INVESTIGATIONS (n=3)							
Chest X-ray	No	4	7·8%	6	30·0%	6	15·4%
Chest CT	No	9	17·6%	8	40·0%	2	5·1%
Lung ultrasound	No	3	5·9%	6	30·0%	1	2·6%
SIGNS AND SYMPTOMS (n=37)							
Abdominal pain	Yes	0	0·0%	1	5·0%	0	0·0%
Anosmia / agueisa	Yes	2	3·9%	0	0·0%	1	2·6%
Any COVID-related symptoms	Yes	7	13·7%	1	5·0%	0	0·0%
Any respiratory symptoms	Yes	26	51·0%	0	0·0%	0	0·0%
Arthralgia	Yes	1	2·0%	0	0·0%	0	0·0%
Chest distress	Yes	2	3·9%	0	0·0%	0	0·0%
Chest pain	Yes	3	5·9%	0	0·0%	0	0·0%
Chest tightness	Yes	1	2·0%	0	0·0%	0	0·0%

Chills	Yes	5	9·8%	0	0·0%	0	0·0%
Conjunctival congestion	Yes	1	2·0%	0	0·0%	0	0·0%
Constipation	Yes	0	0·0%	1	5·0%	0	0·0%
Convulsions	Yes	0	0·0%	1	5·0%	0	0·0%
Cough	Yes	19	37·3%	0	0·0%	1	2·6%
Cyanosis	Yes	0	0·0%	1	5·0%	0	0·0%
Diarrhoea	Yes	2	3·9%	1	5·0%	0	0·0%
Dizziness	Yes	1	2·0%	0	0·0%	0	0·0%
Duration of fever	Yes	2	3·9%	0	0·0%	0	0·0%
Duration of symptoms	Yes	0	0·0%	2	10·0%	1	2·6%
Fatigue	Yes	1	2·0%	0	0·0%	0	0·0%
Fever	Yes	28	54·9%	2	10·0%	1	2·6%
Frequency of cough	Yes	1	2·0%	0	0·0%	0	0·0%
Gastrointestinal symptoms	Yes	2	3·9%	0	0·0%	0	0·0%
Haematemesis	Yes	0	0·0%	2	10·0%	0	0·0%
Haemoptysis	Yes	0	0·0%	0	0·0%	2	5·1%
Headache	Yes	1	2·0%	1	5·0%	0	0·0%
Inability to breastfeed or drink	Yes	0	0·0%	1	5·0%	0	0·0%
Myalgia	Yes	4	7·8%	0	0·0%	0	0·0%
Nasal congestion	Yes	2	3·9%	0	0·0%	0	0·0%
Nausea	Yes	1	2·0%	1	5·0%	0	0·0%
Rash	Yes	1	2·0%	0	0·0%	0	0·0%
Rhinorrhoea	Yes	2	3·9%	1	5·0%	0	0·0%
Shortness of breath	Yes	12	23·5%	0	0·0%	5	12·8%
Sore throat	Yes	5	9·8%	0	0·0%	0	0·0%
Sputum production	Yes	2	3·9%	0	0·0%	0	0·0%
Unconsciousness	Yes	0	0·0%	1	5·0%	1	2·6%
Unspecified signs and symptoms	Yes	1	2·0%	1	5·0%	0	0·0%
Vomiting	Yes	0	0·0%	1	5·0%	0	0·0%
VITAL SIGNS (n=16)							
Altered mental status	Yes	1	2·0%	2	10·0%	5	12·8%
AVPU scale	Yes	0	0·0%	1	5·0%	0	0·0%
Clinical gestalt	Yes	1	0·0%	1	5·0%	1	0·0%
Diastolic blood pressure	Yes	0	0·0%	3	15·0%	1	2·6%

Exertional oxygen saturation	Yes	0	0·0%	1	5·0%	0	0·0%
FiO2	Yes	0	0·0%	0	0·0%	1	2·6%
Glasgow Coma Scale	Yes	0	0·0%	4	20·0%	4	10·3%
Haemodynamic instability	Yes	1	2·0%	1	5·0%	0	0·0%
Heart rate	Yes	1	2·0%	4	20·0%	7	17·9%
Hypercapnia	No	1	2·0%	0	0·0%	0	0·0%
Oxygen saturation	Yes	7	13·7%	12	60·0%	7	17·9%
Pain severity	Yes	0	0·0%	1	5·0%	0	0·0%
PaO2/FIO2 < 300	No	0	0·0%	4	20·0%	0	0·0%
Respiratory rate	Yes	2	3·9%	11	55·0%	13	33·3%
Systolic blood pressure	Yes	1	2·0%	9	45·0%	9	23·1%
Temperature	Yes	17	33·3%	4	20·0%	12	30·8%
Altered mental status	Yes	1	2·0%	2	10·0%	5	12·8%
OTHER CHARACTERISTICS (n=5)							
Ability to live and walk independently	Yes	1	2·0%	0	0·0%	0	0·0%
Epidemiological history	Yes	33	64·7%	2	10·0%	1	2·6%
Nursing home resident	Yes	0	0·0%	1	5·0%	1	2·6%
Status as a healthcare worker	Yes	2	3·9%	0	0·0%	0	0·0%
Use of prescription medications	Yes	0	0·0%	1	5·0%	0	0·0%

Supplementary Table 6: Overview of use of established prognostication tools for COVID-19.

Tool	No. inputs	Inputs	Feasible in low-resource settings?	No. studies using tool
APACHE II Score(95)	15	• Acute renal failure • Age • Creatinine • FiO2 • Glasgow Coma Scale • Haematocrit • Heart rate • History of severe organ failure or immunocompromise • Mean arterial pressure • pH • Potassium • Respiratory rate • Sodium • Temperature • White blood cell count	No	2
Clinical Frailty Score	1	• Level of physical fitness	Yes	2
CURB-65 Score for Pneumonia Severity	5	• Age • Blood urea nitrogen • Confusion • Respiratory rate • Systolic or diastolic blood pressure	No	4
Deyo-Charlson Score(96)	17	• AIDS • Any malignancy • Cerebrovascular disease • Chronic pulmonary disease • Congestive heart failure • Dementia • Diabetes with complications • Diabetes without chronic complications • Hemiplegia or paraplegia • Metastatic solid tumour • Mild liver disease • Moderate/severe liver disease • Myocardial infarction • Peptic ulcer disease • Peripheral vascular disease • Renal disease • Rheumatoid disease	Yes	1
Korean Triage and Acuity Scale(97)	17	• Abdominal pain • Bites • Cardiac arrest • Chest pain • Constipation • Diarrhoea • Glasgow Coma Scale • Haematemesis • Headache • Major trauma • Nausea and/or vomiting	Yes	1

		• Prescription medications • Respiratory failure • Systolic blood pressure • Systemic inflammatory response syndrome (SIRS) • Temperature • Urinary tract infection		
Modified 6-Minute Walk Test(98)	1	• Distance walked in 6 minutes	Yes	1
Modified Early Warning Score (MEWS) for Clinical Deterioration(99)	5	• AVPU score • Heart rate • Respiratory rate • Systolic blood pressure • Temperature	Yes	1
MuLBSTA Score for Viral Pneumonia Mortality(100)	6	• Absolute lymphocyte count • Age • Bacterial coinfection • History of hypertension • Multilobe infiltrate • Smoking history	No	2
National Early Warning Score (NEWS)(101)	5	• Need for supplemental oxygen • Oxygen saturation • Respiratory rate • Systolic blood pressure • Temperature	Yes	3
National Early Warning Score 2 (NEWS2)(102)	7	• Consciousness • Heart rate • Hypercapnic respiratory failure • Need for supplemental oxygen • Respiratory rate • Systolic blood pressure • Temperature	Yes	2
Pneumonia Severity Index for Community Acquired Pneumonia(103)	19	• Age • Altered mental status • Blood urea nitrogen • Glucose • Haematocrit • Heart rate • History of congestive heart failure • History of liver disease history • History of renal disease • Neoplastic disease • Nursing home resident • Partial pressure of oxygen • pH • Pleural effusion on X-ray • Respiratory rate • Sex • Sodium • Systolic blood pressure • Temperature	No	1
qSOFA (Quick SOFA) Score for Sepsis(104)	3	• Glasgow Coma Scale • Respiratory rate • Systolic blood pressure	Yes	4

REFERENCES

1. Al-Tawfiq JA, Garout MA, Gautret P. Preparing for emerging respiratory pathogens such as SARS-CoV, MERS-CoV, and SARS-CoV-2. Infez Med. 2020;28(suppl 1):64-70.
2. Agarwal A, Nagi N, Chatterjee P, Sarkar S, Mourya D, Sahay RR, et al. Guidance for building a dedicated health facility to contain the spread of the 2019 novel coronavirus outbreak. Indian J Med Res. 2020;151(2 & 3):177-83.
3. Augustin M, Schommers P, Suarez I, Koehler P, Gruell H, Klein F, et al. Rapid response infrastructure for pandemic preparedness in a tertiary care hospital: lessons learned from the COVID-19 outbreak in Cologne, Germany, February to March 2020. Euro Surveill. 2020;25(21).
4. Ayebare RR, Flick R, Okware S, Bodo B, Lamorde M. Adoption of COVID-19 triage strategies for low-income settings. Lancet Respir Med. 2020;8(4):e22.
5. Cao Y, Li Q, Chen J, Guo X, Miao C, Yang H, et al. Hospital Emergency Management Plan During the COVID-19 Epidemic. Acad Emerg Med. 2020;27(4):309-11.
6. Carenzo L, Costantini E, Greco M, Barra FL, Rendiniello V, Mainetti M, et al. Hospital surge capacity in a tertiary emergency referral centre during the COVID-19 outbreak in Italy. Anaesthesia. 2020;75(7):928-34.
7. Standard Operating Procedure for Triage of suspected COVID-19 patients in non-US Healthcare settings. Atlanta: Centers for Disease Control and Prevention.
8. Chan PF, Lai KPL, Chao DVK, Fung SCK. Enhancing the triage and cohort of patients in public primary care clinics in response to the coronavirus disease 2019 (COVID-19) in Hong Kong: an experience from a hospital cluster. BJGP Open. 2020;4(2).
9. Chang YT, Lin CY, Tsai MJ, Hung CT, Hsu CW, Lu PL, et al. Infection control measures of a Taiwanese hospital to confront the COVID-19 pandemic. Kaohsiung J Med Sci. 2020;36(5):296-304.
10. Chen S, Zhang Z, Yang J, Wang J, Zhai X, Barnighausen T, et al. Fangcang shelter hospitals: a novel concept for responding to public health emergencies. Lancet. 2020;395(10232):1305-14.
11. Cheng VCC, Wong SC, Chen JHK, Yip CCY, Chuang VWM, Tsang OTY, et al. Escalating infection control response to the rapidly evolving epidemiology of the coronavirus disease 2019 (COVID-19) due to SARS-CoV-2 in Hong Kong. Infect Control Hosp Epidemiol. 2020;41(5):493-8.
12. Chou E, Hsieh YL, Wolfshohl J, Green F, Bhakta T. Onsite telemedicine strategy for coronavirus (COVID-19) screening to limit exposure in ED. Emerg Med J. 2020;37(6):335-7.
13. Chowdhury JM, Patel M, Zheng M, Abramian O, Criner GJ. Mobilization and Preparation of a Large Urban Academic Center during the COVID-19 Pandemic. Ann Am Thorac Soc. 2020;17(8):922-5.
14. Chung HS, Lee DE, Kim JK, Yeo IH, Kim C, Park J, et al. Revised Triage and Surveillance Protocols for Temporary Emergency Department Closures in Tertiary Hospitals as a Response to COVID-19 Crisis in Daegu Metropolitan City. J Korean Med Sci. 2020;35(19):e189.
15. Devrim I, Bayram N. Infection control practices in children during COVID-19 pandemic: Differences from adults. Am J Infect Control. 2020;48(8):933-9.
16. Duca A, Piva S, Foca E, Latronico N, Rizzi M. Calculated Decisions: Brescia-COVID Respiratory Severity Scale (BCRSS)/Algorithm. Emerg Med Pract. 2020;22(5 Suppl):CD1-CD2.
17. Erika P, Andrea V, Cillis MG, Ioannilli E, Iannicelli T, Andrea M. Triage decision-making at the time of COVID-19 infection: the Piacenza strategy. Intern Emerg Med. 2020;15(5):879-82.

18. Gilbert A, Brasseur E, Petit M, Donneau AF, Diep A, Hetzel Campbell S, et al. Immersion in an emergency department triage center during the Covid-19 outbreak: first report of the Liege University hospital experience. Acta Clin Belg. 2020:1-7.
19. Guo F, Du Z, Wang T. An effective screening and management process in the outpatient clinic for patients requiring hospitalization during the COVID-19 pandemic. J Med Virol. 2020.
20. He H, Hu C, Xiong N, Liu C, Huang X. How to transform a general hospital into an "infectious disease hospital" during the epidemic of COVID-19. Crit Care. 2020;24(1).
21. Howitt R, de Jesus GA, Araujo F, Francis J, Marr I, McVean M, et al. Screening and triage at health-care facilities in Timor-Leste during the COVID-19 pandemic. Lancet Respir Med. 2020;8(6):e43.
22. Huang T, Guo Y, Li S, Zheng Y, Lei L, Zeng X, et al. Application and effects of fever screening system in the prevention of nosocomial infection in the only designated hospital of coronavirus disease 2019 (COVID-19) in Shenzhen, China. Infect Control Hosp Epidemiol. 2020;41(8):978-81.
23. Jaffe E, Stugo R, Bin E, Blustein O, Rosenblat I, Alpert E, et al. The role of emergency medical services in containing COVID-19. J Emerg Med. 2020;38:1526-7.
24. Karimi A, Tabatabaei S, Rajabnejad, Pourmoghaddas Z, Rahimi H, Armin S, et al. An algorithmic approach to diagnosis and treatment of coronavirus disease 2019 (COVID-19) in children: Iranian expert's consensus statement. Arch Pediatr Infect Dis. 2020.
25. Koenig KL, Bey CK, McDonald EC. 2019-nCoV: The Identify-Isolate-Inform (3I) Tool Applied to a Novel Emerging Coronavirus. West J Emerg Med. 2020;21(2):184-90.
26. Li T. Diagnosis and clinical management of severe acute respiratory syndrome Coronavirus 2 (SARS-CoV-2) infection: an operational recommendation of Peking Union Medical College Hospital (V2.0). Emerg Microbes Infect. 2020;9(1):582-5.
27. Lin CH, Tseng WP, Wu JL, Tay J, Cheng MT, Ong HN, et al. A Double Triage and Telemedicine Protocol to Optimize Infection Control in an Emergency Department in Taiwan During the COVID-19 Pandemic: Retrospective Feasibility Study. J Med Internet Res. 2020;22(6):e20586.
28. Liu L, Hong X, Su X, Chen H, Zhang D, Tang S, et al. Optimizing screening strategies for coronavirus disease 2019: A study from Middle China. J Infect Public Health. 2020;13(6):868-72.
29. Liu Y, Wang Z, Ren J, Tian Y, Zhou M, Zhou T, et al. A COVID-19 Risk Assessment Decision Support System for General Practitioners: Design and Development Study. J Med Internet Res. 2020;22(6):e19786.
30. Meschi T, Rossi S, Volpi A, Ferrari C, Sverzellati N, Brianti E, et al. Reorganization of a large academic hospital to face COVID-19 outbreak: The model of Parma, Emilia-Romagna region, Italy. Eur J Clin Invest. 2020;50(6):e13250.
31. Mockel M, Bachmann U, Behringer W, Pfafflin F, Stegemann MS. How emergency departments prepare for virus disease outbreaks like COVID-19. Eur J Emerg Med. 2020;27(3):161-2.
32. Nicastro E, Mazza A, Gervasoni A, Di Giorgio A, D'Antiga L. A Pediatric Emergency Department Protocol to Avoid Intrahospital Spread of SARS-CoV-2 during the Outbreak in Bergamo, Italy. J Pediatr. 2020;222:231-5.
33. Piliego C, Strumia A, Stone MB, Pascarella G. The ultrasound guided triage: a new tool for prehospital management of COVID-19 pandemic. Anesth Analg. 2020.
34. Pu H, Xu Y, Doig G, Zhou Y. Screening and managing of suspected or confirmed novel coronavirus (COVID-19) patients: experiences from a tertiary hospital outside Hubei province. 2020.

35. Quah LJJ, Tan BKK, Fua TP, Wee CPJ, Lim CS, Nadarajan G, et al. Reorganising the emergency department to manage the COVID-19 outbreak. Int J Emerg Med. 2020;13(1):32.
36. Schwedhelm MM, Herstein JJ, Watson SM, Mead AL, Maddalena L, Liston DD, et al. Can You Catch It? Lessons Learned and Modification of ED Triage Symptom- and Travel-Screening Strategy. J Emerg Nurs. 2020.
37. Shen Y, Cui Y, Li N, Tian C, Chen M, Zhang YW, et al. Emergency Responses to Covid-19 Outbreak: Experiences and Lessons from a General Hospital in Nanjing, China. Cardiovasc Intervent Radiol. 2020;43(6):810-9.
38. Shi Y, Wang X, Liu G, Zhu Q, Wang J, Yu H, et al. A quickly, effectively screening process of novel corona virus disease 2019 (COVID-19) in children in Shanghai, China. Ann Transl Med. 2020;8(5):241.
39. Spina S, Marrazzo F, Migliari M, Stucchi R, Sforza A, Fumagalli R. The response of Milan's Emergency Medical System to the COVID-19 outbreak in Italy. Lancet. 2020;395(10227):e49-e50.
40. Tan GSE, Ang H, Manauis CM, Chua JM, Gao CQ, Ng FKK, et al. Reducing hospital admissions for COVID-19 at a dedicated screening centre in Singapore. Clin Microbiol Infect. 2020;26(9):1278-9.
41. Wang Q, Wang X, Lin H. The role of triage in the prevention and control of COVID-19. Infect Control Hosp Epidemiol. 2020:1-5.
42. Wang X, Chen Y, Li Z, Wang D, Wang Y. Providing uninterrupted care during COVID-19 pandemic: experience from Beijing Tiantan Hospital. Stroke Vasc Neurol. 2020;5(2):180-4.
43. Wee LE, Fua TP, Chua YY, Ho AFW, Sim XYJ, Conceicao EP, et al. Containing COVID-19 in the Emergency Department: The Role of Improved Case Detection and Segregation of Suspect Cases. Acad Emerg Med. 2020;27(5):379-87.
44. Whiteside T, Kane E, Aljohani B, Alsamman M, Pourmand A. Redesigning emergency department operations amidst a viral pandemic. Am J Emerg Med. 2020;38(7):1448-53.
45. Clinical management of severe acute respiratory infection (SARI) when COVID-19 disease is suspected. Interim guidance, 13 March 2020. . Geneva: World Health Organization; 2020.
46. Wu X, Zhou H, Wu X, Huang W, Jia B. Strategies for qualified triage stations and fever clinics during the outbreak of COVID-2019 in the county hospitals of Western Chongqing. J Hosp Infect. 2020;105(2):128-9.
47. Zhang J, Zhou L, Yang Y, Peng W, Wang W, Chen X. Therapeutic and triage strategies for 2019 novel coronavirus disease in fever clinics. Lancet Respir Med. 2020;8(3):e11-e2.
48. Zhang N, Deng Y, Li W, Liu J, Li H, Liu E, et al. Analysis and suggestions for the preview and triage screening of children with suspected COVID-19 outside the epidemic area of Hubei Province. Transl Pediatr. 2020;9(2):126-32.
49. Zhao Y, Cui C, Zhang K, Liu J, Xu J, Nisenbaum E, et al. COVID19: A Systematic Approach to Early Identification and Healthcare Worker Protection. Front Public Health. 2020;8:205.
50. Zhou TT, Wei FX. Primary stratification and identification of suspected Corona virus disease 2019 (COVID-19) from clinical perspective by a simple scoring proposal. Mil Med Res. 2020;7(1):16.
51. Zimmerman RK, Nowalk MP, Bear T, Taber R, Sax TM, Eng H, et al. Proposed Clinical Indicators for Efficient Screening and Testing for COVID-19 Infection from Classification and Regression Trees (CART) Analysis. medRxiv. 2020.

52. Emergency Department COVID-19 Severity Classi-cation: American College of Emergency Physicians; [Available from: https://www.acep.org/globalassets/sites/acep/media/covid-19-main/acep_evidencecare_covid19severitytool.pdf.
53. Cote A, Ternacle J, Pibarot P. Early prediction of the risk of severe coronavirus disease 2019: A key step in therapeutic decision making. EBioMedicine. 2020;59:102948.
54. Her M. How Is COVID-19 Affecting South Korea? What Is Our Current Strategy? Disaster Med Public Health Prep. 2020:1-3.
55. Manivel V, Lesnewski A, Shamim S, Carbonatto G, Govindan T. CLUE: COVID-19 lung ultrasound in emergency department. Emerg Med Australas. 2020;32(4):694-6.
56. Mantha S, Tripuraneni SL, Roizen MF, Fleisher LA. Proposed Modifications in the 6-Minute Walk Test for Potential Application in Patients With Mild COVID-19: A Step to Optimize Triage Guidelines. Anesth Analg. 2020;131(2):398-402.
57. Sun H, Jain A, Leone MJ, Alabsi HS, Brenner LN, Ye E, et al. COVID-19 Outpatient Screening: a Prediction Score for Adverse Events. medRxiv. 2020.
58. Sun Q, Qiu H, Huang M, Yang Y. Lower mortality of COVID-19 by early recognition and intervention: experience from Jiangsu Province. Ann Intensive Care. 2020;10(1):33.
59. Bartoletti M, Giannella M, Scudeller L, Tedeschi S, Rinaldi M, Bussini L, et al. Development and validation of a prediction model for severe respiratory failure in hospitalized patients with SARS-CoV-2 infection: a multicentre cohort study (PREDI-CO study). Clin Microbiol Infect. 2020.
60. Bi X, Su Z, Yan H, Du J, Wang J, Chen L, et al. Prediction of severe illness due to COVID-19 based on an analysis of initial Fibrinogen to Albumin Ratio and Platelet count. Platelets. 2020;31(5):674-9.
61. Cozzi D, Albanesi M, Cavigli E, Moroni C, Bindi A, Luvara S, et al. Chest X-ray in new Coronavirus Disease 2019 (COVID-19) infection: findings and correlation with clinical outcome. Radiol Med. 2020;125(8):730-7.
62. Dong Y, Zhou H, Li M, Zhang Z, Guo W, Yu T, et al. A novel simple scoring model for predicting severity of patients with SARS-CoV-2 infection. Transbound Emerg Dis. 2020.
63. Frost F, Bradley P, Tharmaratnam K, Wootton D. The utility of established prognostic scores in COVID-19 hospital admissions: a multicentre prospective evaluation of CURB-65, NEWS2, and qSOFA. 2020.
64. Galloway J, Norton S, Barker R, Brookes A, Carey I, Xlarke B, et al. A clinical risk score to identify patients with COVID-19 at high risk of critical care admission or death: An observational cohort study. J Infect. 2020;81(2):282-8.
65. Jang JG, Ahn JH. The Author's Response: Prognostic Accuracy of the SIRS, qSOFA, and NEWS for Early Detection of Clinical Deterioration in SARS-CoV-2 Infected Patients. J Korean Med Sci. 2020;35(30):e275.
66. Gidari A, De Socio GV, Sabbatini S, Francisci D. Predictive value of National Early Warning Score 2 (NEWS2) for intensive care unit admission in patients with SARS-CoV-2 infection. Infect Dis (Lond). 2020;52(10):698-704.
67. Gong J, Ou J, Qui X, Jie Y, Chen Y, Yuan L, et al. A Tool for Early Prediction of Severe Coronavirus Disease 2019 (COVID-19): A Multicenter Study Using the Risk Nomogram in Wuhan and Guangdong, China Clinical Infectious Diseases. 2020;71(15):833-40.
68. Haimovich A, Ravindra N, Stoytchew S, Young H, Wilson F, van Dijk D, et al. Development and validation of the quick COVID-19 severity index (qCSI): a prognostic tool for early clinical decompensation. Ann Emerg Med. 2020.

69. Huespe I, Bisso I, Gemeli N, Terrasa S, Di Stefano S, Biurgos V, et al. COVID-19 Severity Index: predictive score for hospitalized patients. 2020.
70. Ihle-Hansen H, Berge T, Tveita A, Ronning EJ, Erno PE, Andersen EL, et al. COVID-19: Symptoms, course of illness and use of clinical scoring systems for the first 42 patients admitted to a Norwegian local hospital. Tidsskr Nor Laegeforen. 2020;140(7).
71. Jehi L, Ji X, Milinovich A, Erzurum S, Merlino A, Gordon S, et al. Development and validation of a model for individualized prediction of hospitalization risk in 4,536 patients with COVID-19. PLoS One. 2020;15(8):e0237419.
72. Labenz C, Kremer WM, Schattenberg JM, Worns MA, Toenges G, Weinmann A, et al. Clinical Frailty Scale for risk stratification in patients with SARS-CoV-2 infection. J Investig Med. 2020;68(6):1199-202.
73. Levenfus I, Ullmann E, Battegay E, Schuurmans MM. Triage tool for suspected COVID-19 patients in the emergency room: AIFELL score. Braz J Infect Dis. 2020.
74. Li Q, Zhang J, Ling Y, Li W, Zhang X, Lu H, et al. A simple algorithm helps early identification of SARS-CoV-2 infection patients with severe progression tendency. Infection. 2020;48(4):577-84.
75. Liang W, Liang H, Ou L, Chen B, Chen A, Li C, et al. Development and Validation of a Clinical Risk Score to Predict the Occurrence of Critical Illness in Hospitalized Patients With COVID-19. JAMA Intern Med. 2020;180(8):1081-9.
76. Liang W, Yao J, Chen A, Lv Q, Zanin M, Liu J, et al. Early triage of critically ill COVID-19 patients using deep learning. Nat Commun. 2020;11(1):3543.
77. Ma J, Shi X, Xu W, Lv F, Wu J, Pan Q, et al. Development and validation of a risk stratification model for screening suspected cases of COVID-19 in China. Aging (Albany NY). 2020;12(14):13882-94.
78. Myrstad M, Ihle-Hansen H, Tveita AA, Andersen EL, Nygard S, Tveit A, et al. National Early Warning Score 2 (NEWS2) on admission predicts severe disease and in-hospital mortality from Covid-19 - a prospective cohort study. Scand J Trauma Resusc Emerg Med. 2020;28(1):66.
79. Nguyen Y, Corre F, Honsel V, Curac S, Zarrouk V, Burtz CP, et al. A nomogram to predict the risk of unfavourable outcome in COVID-19: a retrospective cohort of 279 hospitalized patients in Paris area. Ann Med. 2020;52(7):367-75.
80. Osborne TF, Veigulis ZP, Arreola DM, Roosli E, Curtin CM. Automated EHR score to predict COVID-19 outcomes at US Department of Veterans Affairs. PLoS One. 2020;15(7):e0236554.
81. Peng X, Subbe CP, Zhang L, Luo Z, Peng L. NEWS can predict deterioration of patients with COVID-19. Resuscitation. 2020;152:26-7.
82. Satici C, Demirkol MA, Sargin Altunok E, Gursoy B, Alkan M, Kamat S, et al. Performance of pneumonia severity index and CURB-65 in predicting 30-day mortality in patients with COVID-19. Int J Infect Dis. 2020;98:84-9.
83. Schalekamp S, Huisman M, van Dijk RA, Boomsma MF, Freire Jorge PJ, de Boer WS, et al. Model-based Prediction of Critical Illness in Hospitalized Patients with COVID-19. Radiology. 2020:202723.
84. Jang JG, Hur J, Hong KS, Lee W, Ahn JH. Prognostic Accuracy of the SIRS, qSOFA, and NEWS for Early Detection of Clinical Deterioration in SARS-CoV-2 Infected Patients. J Korean Med Sci. 2020;35(25):e234.
85. Singh K, Valley T, Tang S, Li B, Kamran F, Sjoding M, et al. Evaluating a Widely Implemented Proprietary Deterioration Index Model Among Hospitalized COVID-19 Patients. 2020.

86. Tsui E, Lui C, Woo P, Cheung A, Lam P, Tang T, et al. Development of a data-driven COVID-19 prognostication tool to inform triage and step-down care for hospitalised patients in Hong Kong: A population based cohort study. 2020.
87. Wu G, Yang P, Xie Y, Woodruff HC, Rao X, Guiot J, et al. Development of a clinical decision support system for severity risk prediction and triage of COVID-19 patients at hospital admission: an international multicentre study. Eur Respir J. 2020;56(2).
88. Xiao LS, Zhang WF, Gong MC, Zhang YP, Chen LY, Zhu HB, et al. Development and validation of the HNC-LL score for predicting the severity of coronavirus disease 2019. EBioMedicine. 2020;57:102880.
89. Zhang S, Guo M, Duan L, Wu F, Hu G, Wang Z, et al. Development and validation of a risk factor-based system to predict short-term survival in adult hospitalized patients with COVID-19: a multicenter, retrospective, cohort study. Crit Care. 2020;24(1):438.
90. Zhao L, Yu K, Zhao Q, Tian R, Xie H, Xie L, et al. Lung Ultrasound Score in Evaluating the Severity of Coronavirus Disease 2019 (COVID-19) Pneumonia. Ultrasound Med Biol. 2020.
91. Zhou Y, He Y, Yang H, Yu H, Wang T, Chen Z, et al. Development and validation a nomogram for predicting the risk of severe COVID-19: A multi-center study in Sichuan, China. PLoS One. 2020;15(5):e0233328.
92. Zhu JS, Ge P, Jiang C, Zhang Y, Li X, Zhao Z, et al. Deep-learning artificial intelligence analysis of clinical variables predicts mortality in COVID-19 patients. J Am Coll Emerg Physicians Open. 2020.
93. Zou X, Li S, Fang M, Hu M, Bian Y, Ling J, et al. Acute Physiology and Chronic Health Evaluation II Score as a Predictor of Hospital Mortality in Patients of Coronavirus Disease 2019. Crit Care Med. 2020;48(8):e657-e65.
94. Zhang C, Qin L, Li K, Wang Q, Zhao Y, Xu B, et al. A Novel Scoring System for Prediction of Disease Severity in COVID-19. Front Cell Infect Microbiol. 2020;10:318.
95. APACHE II Score: MDCalc; [Available from: https://www.mdcalc.com/apache-ii-score.
96. Ladha KS, Zhao K, Quraishi SA, Kurth T, Eikermann M, Kaafarani HM, et al. The Deyo-Charlson and Elixhauser-van Walraven Comorbidity Indices as predictors of mortality in critically ill patients. BMJ Open. 2015;5(9):e008990.
97. Ryu JH, Min MK, Lee DS, Yeom SR, Lee SH, Wang IJ, et al. Changes in Relative Importance of the 5-Level Triage System, Korean Triage and Acuity Scale, for the Disposition of Emergency Patients Induced by Forced Reduction in Its Level Number: a Multi-Center Registry-based Retrospective Cohort Study. J Korean Med Sci. 2019;34(14):e114.
98. Laboratories ATSCoPSfCPF. ATS statement: guidelines for the six-minute walk test. Am J Respir Crit Care Med. 2002;166(1):111-7.
99. Modified Early Warning Score (MEWS) for Clinical Deterioration: MDCalc; [Available from: https://www.mdcalc.com/modified-early-warning-score-mews-clinical-deterioration.
100. MuLBSTA Score for Viral Pneumonia Mortality: MDCalc; [Available from: https://www.mdcalc.com/mulbsta-score-viral-pneumonia-mortality.
101. National Early Warning Score (NEWS): MDCalc; [Available from: https://www.mdcalc.com/national-early-warning-score-news.
102. National Early Warning Score (NEWS) 2: MDCalc; [Available from: https://www.mdcalc.com/national-early-warning-score-news-2.
103. PSI/PORT Score: Pneumonia Severity Index for CAP: MDCalc; [Available from: https://www.mdcalc.com/psi-port-score-pneumonia-severity-index-cap.

104. qSOFA (Quick SOFA) Score for Sepsis: MDCalc; [Available from: https://www.mdcalc.com/qsofa-quick-sofa-score-sepsis.

1Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR) Checklist

SECTION	ITEM	PRISMA-ScR CHECKLIST ITEM	REPORTED ON PAGE #
TITLE			
Title	1	Identify the report as a scoping review.	1
ABSTRACT			
Structured summary	2	Provide a structured summary that includes (as applicable): background, objectives, eligibility criteria, sources of evidence, charting methods, results, and conclusions that relate to the review questions and objectives.	2
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of what is already known. Explain why the review questions/objectives lend themselves to a scoping review approach.	4
Objectives	4	Provide an explicit statement of the questions and objectives being addressed with reference to their key elements (e.g., population or participants, concepts, and context) or other relevant key elements used to conceptualize the review questions and/or objectives.	4
METHODS			
Protocol and registration	5	Indicate whether a review protocol exists; state if and where it can be accessed (e.g., a Web address); and if available, provide registration information, including the registration number.	4
Eligibility criteria	6	Specify characteristics of the sources of evidence used as eligibility criteria (e.g., years considered, language, and publication status), and provide a rationale.	5
Information sources*	7	Describe all information sources in the search (e.g., databases with dates of coverage and contact with authors to identify additional sources), as well as the date the most recent search was executed.	4
Search	8	Present the full electronic search strategy for at least 1 database, including any limits used, such that it could be repeated.	4
Selection of sources of evidence†	9	State the process for selecting sources of evidence (i.e., screening and eligibility) included in the scoping review.	5
Data charting process‡	10	Describe the methods of charting data from the included sources of evidence (e.g., calibrated forms or forms that have been tested by the team before their use, and whether data charting was done independently or in duplicate) and any processes for obtaining and confirming data from investigators.	5
Data items	11	List and define all variables for which data were sought and any assumptions and simplifications made.	4
Critical appraisal of individual sources of evidence§	12	If done, provide a rationale for conducting a critical appraisal of included sources of evidence; describe the methods used and how this information was used in any data synthesis (if appropriate).	N/A

SECTION	ITEM	PRISMA-ScR CHECKLIST ITEM	REPORTED ON PAGE #
Synthesis of results	13	Describe the methods of handling and summarizing the data that were charted.	5
RESULTS			
Selection of sources of evidence	14	Give numbers of sources of evidence screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally using a flow diagram.	5
Characteristics of sources of evidence	15	For each source of evidence, present characteristics for which data were charted and provide the citations.	5-6
Critical appraisal within sources of evidence	16	If done, present data on critical appraisal of included sources of evidence (see item 12).	N/A
Results of individual sources of evidence	17	For each included source of evidence, present the relevant data that were charted that relate to the review questions and objectives.	6
Synthesis of results	18	Summarize and/or present the charting results as they relate to the review questions and objectives.	6
DISCUSSION			
Summary of evidence	19	Summarize the main results (including an overview of concepts, themes, and types of evidence available), link to the review questions and objectives, and consider the relevance to key groups.	7
Limitations	20	Discuss the limitations of the scoping review process.	8-9
Conclusions	21	Provide a general interpretation of the results with respect to the review questions and objectives, as well as potential implications and/or next steps.	9
FUNDING			
Funding	22	Describe sources of funding for the included sources of evidence, as well as sources of funding for the scoping review. Describe the role of the funders of the scoping review.	9

JBI = Joanna Briggs Institute; PRISMA-ScR = Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews.

* Where *sources of evidence* (see second footnote) are compiled from, such as bibliographic databases, social media platforms, and Web sites.

† A more inclusive/heterogeneous term used to account for the different types of evidence or data sources (e.g., quantitative and/or qualitative research, expert opinion, and policy documents) that may be eligible in a scoping review as opposed to only studies. This is not to be confused with *information sources* (see first footnote).

‡ The frameworks by Arksey and O'Malley (6) and Levac and colleagues (7) and the JBI guidance (4, 5) refer to the process of data extraction in a scoping review as data charting.

§ The process of systematically examining research evidence to assess its validity, results, and relevance before using it to inform a decision. This term is used for items 12 and 19 instead of "risk of bias" (which is more applicable to systematic reviews of interventions) to include and acknowledge the various sources of evidence that may be used in a scoping review (e.g., quantitative and/or qualitative research, expert opinion, and policy document).

From: Tricco AC, Lillie E, Zarin W, O'Brien KK, Colquhoun H, Levac D, et al. PRISMA Extension for Scoping Reviews (PRISMAScR): Checklist and Explanation. Ann Intern Med. 2018;169:467–473. doi: 10.7326/M18-0850.

BMJ Open

Potential solutions for screening, triage, and severity scoring of suspected COVID-19 positive patients in low-resource settings: A scoping review

Journal:	*BMJ Open*
Manuscript ID	bmjopen-2020-046130.R1
Article Type:	Original research
Date Submitted by the Author:	15-May-2021
Complete List of Authors:	Hirner, Sarah; University of Colorado Denver School of Medicine Pigoga, Jennifer; University of Cape Town, Division of Emergency Medicine Naidoo, Antoinette; University of Cape Town Division of Emergency Medicine Calvello Hynes, Emilie; University of Colorado Denver School of Medicine, Emergency Medicine Omer, Yasein; Sudan Medical Specialization Board Wallis, Lee; University of Cape Town Division of Emergency Medicine, Emergency Medicince Bills, Corey; University of Colorado Denver School of Medicine, Emergency Medicine
Primary Subject Heading:	Emergency medicine
Secondary Subject Heading:	Infectious diseases, Global health, Public health
Keywords:	Infection control < INFECTIOUS DISEASES, ACCIDENT & EMERGENCY MEDICINE, PUBLIC HEALTH, COVID-19

I, the Submitting Author has the right to grant and does grant on behalf of all authors of the Work (as defined in the below author licence), an exclusive licence and/or a non-exclusive licence for contributions from authors who are: i) UK Crown employees; ii) where BMJ has agreed a CC-BY licence shall apply, and/or iii) in accordance with the terms applicable for US Federal Government officers or employees acting as part of their official duties; on a worldwide, perpetual, irrevocable, royalty-free basis to BMJ Publishing Group Ltd ("BMJ") its licensees and where the relevant Journal is co-owned by BMJ to the co-owners of the Journal, to publish the Work in this journal and any other BMJ products and to exploit all rights, as set out in our licence.

The Submitting Author accepts and understands that any supply made under these terms is made by BMJ to the Submitting Author unless you are acting as an employee on behalf of your employer or a postgraduate student of an affiliated institution which is paying any applicable article publishing charge ("APC") for Open Access articles. Where the Submitting Author wishes to make the Work available on an Open Access basis (and intends to pay the relevant APC), the terms of reuse of such Open Access shall be governed by a Creative Commons licence – details of these licences and which Creative Commons licence will apply to this Work are set out in our licence referred to above.

Other than as permitted in any relevant BMJ Author's Self Archiving Policies, I confirm this Work has not been accepted for publication elsewhere, is not being considered for publication elsewhere and does not duplicate material already published. I confirm all authors consent to publication of this Work and authorise the granting of this licence.

Potential solutions for screening, triage, and severity scoring of suspected COVID-19 positive patients in low-resource settings: A scoping review

Hirner S, MS (1); Pigoga, JL, MPH (2); Naidoo AV, FCEM(SA) (2); Calvello Hynes EJ, MD (3); Omer YO, MBBS (2, 4); Wallis LA, MD (2); Bills CB, MD MPH (3)

Author affiliations

1. University of Colorado School of Medicine, Denver, CO, USA
2. Division of Emergency Medicine, University of Cape Town, Cape Town, South Africa
3. Department of Emergency Medicine, University of Colorado School of Medicine, Denver, CO, USA
4. Sudan Medical Specialization Board, Khartoum, Sudan

Correspondence to:

*Corresponding author
Corey B Bills
(ORCID: 0000-0002-3456-6008)
University of Colorado
School of Medicine
Department of Emergency Medicine
Leprino Building, 12401 E 17th Ave, Aurora CO 80045
Email: Corey.bills@cuanschutz.edu
Phone: 9174148899

Word count: 3540

Abstract

Objectives: Purposefully designed and validated screening, triage, and severity scoring tools are needed to reduce mortality of COVID-19 in low-resource settings (LRS). This review aimed to identify currently proposed and/or implemented methods of screening, triaging, and severity scoring suspected COVID-19 patients upon initial presentation to the healthcare system, and to evaluate the utility of these tools in LRS.

Design: A scoping review was conducted to identify studies describing acute screening, triage, and severity scoring of suspected COVID-19 patients published between 12 December, 2019 and 01 April, 2020. Extracted information included clinical features, use of laboratory and imaging studies, and relevant tool validation data.

Participant: The initial search strategy yielded 15232 articles; 124 met inclusion criteria.

Results: Most studies were from China (n=41, 33.1%) or the United States (n=23, 18·5%). In total, 57 screening, 54 severity scoring, and 23 triage tools were described. A total of 23 tools--16 screening, four triage, and three severity scoring--were identified as feasible for use in LRS. A total of 37 studies provided validation data: four prospective and 33 retrospective, with none from low-income and lower-middle-income countries.

Conclusions: This study identified a number of screening, triage, and severity scoring tools implemented and proposed for suspected COVID-19 patients. No tools were specifically designed and validated in LRS. A tool specific to resource limited context is crucial to reducing mortality in the current pandemic.

Strengths and limitations

- We provide the first review of Covid-19 screening, triage, and severity scoring tools both proposed and implemented among initial patient presentations to the healthcare system.
- Many screening, triage, and severity scoring tools have been proposed and implemented, but none are specific to LRS.
- We identified 23 tools—16 screening, four triage, and three severity scoring—that have variables feasible for collection in LRS.
- Feasibility, however, does not predict that a tool will be accurate or effective, and no tools from this review were validated in LRS.
- It is likely that many tools being used in healthcare systems worldwide are not published and thus cannot be described in this review.

Introduction

SARS-CoV-2 was declared a global public health emergency on January 30, 2020.(1) In the time since, more than 153 million people have been infected and over 3.2 million have died.(2) While many low- and middle-income countries (LMICs) were relatively spared from high mortality rates, public health measures to contain the virus have put enormous strains on health systems and the ability of countries to care for existing disease burdens.(3-5) The influx of Coronavirus Disease 2019 (COVID-19) patients stressed healthcare systems worldwide by increasing demand for personal protective equipment (PPE), diagnostics, oxygen, and mechanical ventilators.(6) Low-resource settings (LRS) have limited access to these resources and remain disproportionately challenged during the COVID-19 pandemic.(7, 8) Even in regions where viral transmission remains low, suspected COVID-19 patients require precautions, and confirmed cases require costly treatment and care. As the pandemic endures, continued resource demands have the potential to overwhelm LRS healthcare systems.(3)

Early recognition and treatment of acute conditions are integral to reducing general mortality in LRS.(9) Previous evidence suggests three specific processes - screening, triage, and severity scoring of patients - improve patient outcomes in LRS. (10, 11) These practises reduce resource utilisation across a variety of settings and inform ongoing patient management,(12) but, appropriate implementation during public health emergencies can be challenging. The need for screening, triage, and severity scoring tools in real-time may lead to the use of both unvalidated and potentially ineffective protocols.

Although emergency care has developed rapidly in LMICs over the past two decades, it remains undeveloped in many regions, particularly outside of urban areas.(13) Many healthcare systems lack formal emergency units (EUs), and those with dedicated spaces for emergency and acute care may not routinely screen or triage patients. Implementing these tools can be challenging in LRS, where equipment, staff, and systems are lacking.(7) Despite the limitations, the exceptional risks of COVID-19 have placed screening and triage procedures at the forefront: Practical screening and triage protocols maximise use of limited available resources and keep patients and providers safe.

Screening refers to the process of identifying and isolating patients with COVID-19 risk factors on initial presentation to the healthcare system, such as to outpatient clinics and EUs.(9) It is a rapid process to evaluate potential risk of infection, typically using basic clinical and historical information. In order to be successful, it must be based on easily understood case definitions, as it is frequently performed by non-healthcare personnel (such as security guards). With screening, high sensitivity is typically prioritised over specificity, so that all cases are identified. This process is fundamentally different from diagnostic testing, which is also referred to as screening in some literature. **Triage** – a systematic method of sorting patients into priority groups based on the severity of their clinical syndrome, and matching these groups with available resources – is usually conducted following screening.(14) Triage is seen as a fundamental component of effective emergency care (15): In order for triage to improve patient outcomes, the triage protocol must effectively prioritise the sickest patients for emergency interventions and direct patients to the appropriate levels of care.(16) **Severity scoring** stratifies patients with a diagnosis (e.g. confirmed or suspected COVID-19) based on risk of poor outcomes, such as mortality or admission to the intensive care unit, and can complement the triage process and further inform resource allocation.

To date, there have been no published reviews detailing available tools for identification and triage of COVID-19 patients. This review aimed to identify currently proposed and/or implemented methods of screening, triaging, and early severity scoring of suspected COVID-19 patients upon initial presentation to the healthcare system, and to evaluate the utility of these tools in LRS.

Methods

Search strategy

A systematic search was conducted to identify literature describing screening, triage, and severity scoring practices that have been implemented or proposed for use with suspected COVID-19 patients upon first presentation to emergency or acute care settings.

Five electronic databases (Embase, Ovid/Medline, PubMed, and Web of Science) were searched using keywords, with adaptations made based on controlled vocabulary standards for each database. Initial search terms included “COVID,” “COVID-19,” and “SARS-CoV-2”, coupled with “screening,” “triage,” “severity,” “risk,” and

"stratification," "prediction," "tool," "index," "score," (Appendix 1). A secondary search was completed after reviewer comments with the inclusion of emergency specific search terms to help refine the search given the overwhelming growth in the published literature on Covid-19 related topics. Targeted searches were conducted to identify grey literature through Google Scholar and Open Grey. Websites of key regional and international health organisations were also searched, including the European Centre for Disease Prevention and Control, Infection Control Africa Network, International Committee of the Red Cross, Medecins Sans Frontières. UNICEF, United States Agency for International Development, United States Centers for Disease Control and Prevention, and World Health Organization.

Inclusion and exclusion criteria

All studies published in English between 01 December, 2019 and 01 April, 2020 were eligible for inclusion. Multiple forms of literature, including published and preprint manuscripts, correspondence, reports, and published guidelines, were considered. Studies were required to describe screening, triage, and/or severity scoring of suspected-positive or confirmed COVID-19 patients performed by general practitioners or emergency care providers in the prehospital, hospital, or clinic setting. Both previously existing tools applied to COVID-19 patients and novel tools developed specifically for the COVID-19 response were eligible for inclusion. A description of the tool, including inputs (e.g. hypoxia) and any relevant parameters (e.g. value of input, such as oxygen saturation < 93%), was required. As this review aims to describe all tools that may be in use, outcomes data from implementation and/or validation studies were not requisite. Tools could be either proposed or in use, with or without validation. There were no restrictions on the populations that tools may be used in.

Studies in languages other than English or published prior to December 01, 2019 were excluded. Studies describing screening, triage, and/or severity scoring only by specialist physicians and those lacking a complete description of the tool were not included. Community- and population-based screening efforts, performed by healthcare providers or otherwise, were excluded, as were at-home self-triage tools. Descriptions of physical screening or triage infrastructure (e.g. a walk-up or drive-through facility) and methods of administering screening (e.g. telehealth) were not included.

Data extraction and analysis

Multiple reviewers (SH, JLP, CBB, AVN) independently assessed studies for eligibility at the title, abstract, and full-text levels. Any discrepancies were resolved via discussion and a third independent reviewer (AVN, EJCH, CBB) where necessary. Relevant data was extracted from eligible texts, including, year of publication, country and setting in which the tool was proposed or implemented, status of the tool as proposed or implemented, and any tool inputs (e.g. comorbidities, clinical symptoms and findings, and diagnostic and laboratory results). A second researcher reviewed all data extractions to ensure accuracy.

Descriptive analyses were performed, and the Preferred Reporting Items for Systematic Reviews and Meta-Analyses – Extension for Scoping Reviews checklist was used to guide analysis and reporting of these results.(17) Feasibility of inputs for use in LRS was determined based on investigation of key literature, including The World Bank's Disease Control Priorities, Third Edition, and the African Federation for Emergency Medicine's 2013 consensus statement describing facility level specific, expected capacities for emergency care delivery on the continent (18, 19). As with any other setting, LRS have hospitals of varying capacities. In this review, feasibility was targeted towards district level hospitals, as it is these facilities that the majority of LRS populations are likely to initially present to.(18) Additionally, as fully resourced health facilities have struggled with COVID-19 surge, these feasibility inputs may also apply when excess patient volume consumes critical resources or makes imaging difficult.

Patient and public involvement

Given the nature of this review, it was not appropriate to involve patients or the public in this study's design or execution.

Results

The search strategy yielded a total of 15232 articles (Figure 1). After duplicates were removed, 11091 unique titles were assessed for inclusion. Following title and abstract screening, 472 articles remained. Full-text review resulted in 124 articles for full inclusion and data extraction (Appendix 2, Supplementary Tables 1-3).

Most articles were peer-reviewed (n=99, 79·8%) or preprint manuscripts (n=9, 7·3%). Three articles from the grey literature were also included in the review, reporting on three tools. Tools were similar in their lack of feasibility in LRS. Articles originated from 27 countries; with the majority published or conducted in China (n=41, 33·1%), followed by the United States (n=23, 18·5%) and Italy (n=10, 8·1%). International recommendations were described in three articles (2·4%).

More than half of the available literature described screening tools (n=48, 37·1%). Severity scoring tools were described in 54 articles (43·5%) and triage in 12 (9·7%). Some studies described more than one triage or severity scoring tool. In 10 studies, both screening and triage were described. In total, 57 screening, 23 triage, and 54 severity scoring tools were described (Table 1).

Table 1: Overview of tools used to screen, triage, and evaluate the severity of COVID-19 patients.

	Screening tools (n=57)		Triage tools (n=23)		Severity scoring tools (n=54)		All tools* (N=134)	
	n	%	n	%	n	%	n	%
SETTING								
Hospital	16	28·1%	5	21·7%	30	55·6%	51	38·1%
Hospital-based emergency care	12	21·1%	4	17·4%	3	5·6%	19	14·2%
Outpatient / general practitioner	8	14·0%	2	8·7%	0	0·0%	10	7·5%
Prehospital emergency care	2	3·5%	0	0·0%	0	0·0%	2	1·5%
Not specified	19	33·3%	12	52·2%	21	38·9%	52	38·8%
COUNTRY INCOME LEVEL								
High-income country	29	50·9%	14	60·9%	29	53·7%	72	53·7%
Upper-middle-income country	23	40·1%	5	21·7%	22	40·7%	50	37·3%
Lower-middle-income country	3	5·3%	3	13·0%	3	5·6%	9	6·7%
Low-income country	1	1·8%	0	0·0%	0	0·0%	1	0·7%
Not applicable	1	1·8%	1	4·3%	0	0·0%	2	1·5%
AGE GROUP								
Adults	1	1·8%	3	13·0%	4	7·4%	8	6·0%
Paediatrics	5	8·8%	2	8·7%	0	0·0%	7	5·2%
All ages	3	5·3%	1	4·3%	0	0·0%	4	3·0%
Not specified	48	84·2%	17	73·9%	50	92·6%	115	85·8%
IMPLEMENTATION								
Proposed	22	38·6%	15	65·2%	54	100·00%	91	67·9%
Implemented	35	61·4%	8	34·8%	0	0·00%	43	32·1%
VALIDATION SETTING								
High-income country	2	3·5%	1	4·3%	15	27·8%	18	13·4%
Upper-middle-income country	1	1·8%	1	4·3%	17	31·5%	19	14·2%
Lower-middle-income country	0	0·0%	0	0·0%	0	0·0%	0	0·0%
Low-income country	0	0·0%	0	0·0%	0	0·0%	0	0·0%
Not validated	54	94·7%	21	91·3%	22	40·7%	97	72·4%
FEASIBILITY IN LOW-RESOURCE SETTINGS								
Likely	31	54·4%	5	26·1%	15	27·8%	51	38·8%
Unlikely	26	45·6%	18	82·6%	39	72·2%	83	62·7%

*The total number of tools (N=134) does not equal the total number of papers (N=124), as some papers reported on more than one tool

Many tools were designed for hospital-wide (n=51, 38·1%) or EU (n=19, 14·2%) use. More than one-third (n=52, 38·8%) did not have a specified setting and were considered to be designed for broad use throughout the healthcare system. Seven tools (6·4%) – five for screening and two for triage – were specific to paediatric settings; nearly all others (n=115, 85·8%) lacked age specifications.

More than one quarter of tools (n=37, 27·6%) provided validation data supporting their use (Appendix 2, Supplementary Table 4), with four (3·0%) validated prospectively. Most tools were validated against the following outcomes: diagnosis of severe COVID-19 disease (n=8, 23·4%), confirmation of COVID-19 via RT-PCR (n=5, 14·7%), or 30-day mortality (n=4. 11·8%). Only four screening tools (7·0%) and two triage tools (8·7%) had associated validation data, while 29 severity scoring tools (53·7%) did. All of these tools were validated in high-income (n=18, 48·6%) or upper-middle-income (n=19, 51·4%) country settings. Of those validated in upper-middle-income countries, 16 were validated in China (84·2%), two in Turkey (10·5%), and one in Mexico (5·3%).

A total of 204 unique inputs were included in the screening, triage, and severity scoring algorithms (Table 2 and Appendix 2, Supplementary Table 5).

Table 2: Overview of inputs in tools used to screen, triage, and evaluate the severity of COVID-19 patients.

	Screening tools (n=57)		Triage tools (n=23)		Severity scoring tools* (n=54)	
	No. unique inputs	%	No. unique inputs	%	No. unique inputs	%
Total combined inputs**	**76**	**100·0%**	**108**	**100·0%**	**116**	**100·0%**
Clinical interventions received	0	0·0%	5	4·6%	1	0·9%
Comorbid conditions	6	7·9%	15	13·9%	24	20·7%
Concurrent acute conditions	2	2·6%	14	13·0%	9	7·8%
Demographics	2	2·6%	4	3·7%	7	6·0%
Imaging investigations	3	3·9%	3	2·8%	3	2·6%
Laboratory investigations	22	28·9%	32	29·6%	42	36·2%
Other characteristics	3	3·9%	4	3·7%	2	1·7%
Signs and symptoms	28	36·8%	16	14·8%	11	9·5%
Vital signs	10	13·2%	15	13·9%	17	14·7%

*The total number of tools (N=134) does not equal the total number of papers (N=124), as some papers reported on more than one tool

**Percents are out of the total combine inputs, not the number of tools

Screening tools had a median of four (IQR: 3-7) inputs. Most (n=36, 63·2%) included epidemiologic risk factors. Fever was commonly included as a reported symptom (n=31, 54·4%) or a measured vital sign (n=17, 29·8%). Triage tools had a median of eight (IQR: 2·5-13·5) inputs. Oxygen saturation was the vital sign most commonly used (n=22, 16·4%), followed by tachypnoea (n=20, 14·9%). Concurrently diagnosed acute conditions were present in multiple triage tools (n=6, 26·1%). Severity scoring tools had a median of five inputs (IQR: 1-8·5). The most frequently used inputs in these tools were age (n=22, 40.1%), lactate dehydrogenase (n=11, 20·4%), respiratory rate (n=7, 37·0%), and temperature (n=5, 9·3%).

Several studies used pre-existing severity tools to stratify suspected-positive COVID-19 patients: 11 for triage and 19 for severity scoring (Appendix 2, Supplementary Table 6). The most common tools for severity scoring were the qSOFA and CURB-65 scores, were used in five and four studies, respectively.

Tool inputs that rely on imaging and nearly all laboratory testing are largely impractical for routine use in many frontline EUs in LRS.(7, 8) In the context of these restrictions, just over half of screening tools (n=31, 54·4%) are viable for use in LRS EUs; a smaller number (n=6, 26·1%) of triage and severity scoring (n=15, 27·8%) tools are also feasible. Many studies describing tools inappropriate for LRS EUs included imaging: 17 screening tools (29·8%), 16 triage tools (69·6%), and 14 (25·9%) severity scoring tools required a chest X-ray, chest CT and/or lung ultrasound. At least one laboratory value was included in seven screening (12·2%), six (26·0%) triage, and 28 severity scoring (51·9%) tools. Screening tools were proposed or implemented in six LMICs - 19 in China, two in India, and one each in Mexico, Timor-Leste, Turkey, and Uganda - with 16 (55·2%) of these tools were deemed feasible for LRS settings. Triage tools were proposed or implemented in four LMICs - three in China, and three in India, and one each in Timor-Leste and Turkey – with only four (17·4%) deemed feasible for LRS. Of the 25 severity scoring tools proposed or implemented in LMICs, 18 were from China, two were from Pakistan, and there was one each from Argentina, Brazil, Mexico, Turkey, and India; just three (5·6%) are likely feasible in LRS.

Discussion

This scoping review identified a wide range of tools being used to screen, triage, and predict the severity of suspected-positive COVID-19 patients worldwide. A disproportionate share of tools were described in three

countries – China, the United States, and Italy; a reflection of the combination of early disease burden and host country research capacities. While more than half of screening tools provided some information about implementation, less than half of triage tools and no severity scoring tools did so. Overall manuscript quality was high, with nearly three-quarters from peer-reviewed publications. Uncertainty remains in regard to the accuracy of these tools: Only one-quarter were validated, and variations in settings and reporting make it difficult to generalise and compare these data. Almost all studies providing both training and prospective validations showed substantial decreases in accuracy with prospective cohorts. There was also variance in accuracy of the same tools – such as NEWS (National Early Warning Score) and NEWS2 – across different high-income and upper-middle-income settings.

A majority of the tools identified were for screening, followed by severity scoring and triage. Tool length varied, though most were short (between four and five inputs). Identified tools with fewer inputs likely have more utility in EUs, but, only a small number of tools were purpose-designed for EUs. Available articles provide information on only 12 screening tools for EUs, and four triage tools. Despite the impact of severity scoring tools on informing appropriate patient interventions and disposition,(10) there was no literature available to guide the use of severity scoring tools in EUs. And, although there is substantial variance in presentations in children versus adults,(18) very few tools specified a target age group for utilisation. This, in combination with a lack of paediatric-specific tools, suggests a need for additional investigation into appropriate tools for identification and risk of poor outcomes in suspected COVID-19 in paediatric populations.

Screening is an essential means of separating patients with suspected illness from the general population on presentation to the health system. This is particularly critical in LRS, where laboratory testing for COVID-19 is limited (19), and PPE and other resources need to be conserved for positive cases. Most of screening tools found in this review recommended conducting screening on patients using epidemiologic risk factors and symptoms consistent with the case definition of suspected COVID-19, such as cough and fever. Non-validated use of such tools could be problematic for multiple reasons. Firstly, it is well documented that there is poor, inaccurate self-reporting of epidemiologic risk factors, including exposure to other patients and travel history.(20) The impact of epidemiologic data in a tool is also limited by the establishment of widespread community transmission, since such

transmission indicates that nearly all patients are at risk of exposure. Compounding this is the fact that a substantial portion of COVID-19 cases present atypically, without the commonplace symptoms that providers are screening for using these tools (21). For example, one study of 1099 confirmed COVID-19 cases demonstrated that only 43.8% of COVID-19 positive cases presented with fever.(22) More than half of screening tools included fever as a symptom, and many of them considered it requisite to meet the suspect case definition. These challenges in capturing the correct epidemiologic data and meeting "typical" case definitions suggests that many screening tools may not effectively identify patients with COVID-19, lacking sensitivity. In addition, in many LRS settings where the infectious disease burden is high, using fever or cough alone for identification and isolation may be insufficiently specific and create excess burden of suspected cases, leading to delays in care and cross-contamination. (23) Also of concern is that, despite the intention of screening as a rapid, first-pass method of identifying suspected COVID-19 patients, many published screening tools relied on laboratory investigations. It is likely that intensive precautions must be taken with these patients while awaiting diagnostic results since, even in the highest-resource settings, laboratory results take time. The resources to take these precautions are almost universally limited, and inaccurate screening may place healthcare workers and patients at unnecessary risk.

After screening, suspected COVID-19 patients should be triaged to determine symptom severity using a standard triage tool contextually validated.(24) Following this, patients should be further risk stratified using a severity scoring tool in order to guide clinical management and hospital disposition. Among both triage and severity scoring tools, there was a general lack of consensus about key inputs for prognosticating COVID-19 patients. This is unsurprising, given the novelty of SARS-CoV-2 and the numerous typical and atypical presentations of COVID-19 disease. Despite emerging evidence that any comorbidity, as well as obesity, cerebrovascular disease, chronic obstructive pulmonary disease, diabetes, hypertension, and smoking history correlate with the likelihood of more severe COVID-19 disease, (25-27) there was little agreement on which comorbidities to include in tools. Many triage and severity scoring tools included age as an input, congruent with large-scale data that age is a severity modifier. Fewer tools included male sex, despite similar evidence of its predictive value.(26, 27) Shortness of breath, cough, and fever were used in many tools. A concurrent meta-analysis identified that fever and shortness of breath were significant predictors of severe COVID-19 disease, while cough was not.(27) A core set of five vital signs – heart rate, oxygen saturation, respiratory rate, systolic blood pressure, and temperature – were seen across

triage and severity scoring tools. Although limited data are available on the utility of mental status in predicting COVID-19 illness severity, a majority of reporting studies do indicate that abnormal oxygen saturation, respiratory rate, systolic blood pressure, and temperature are significant predictors of poor outcome.(27)

Although a large number of screening, triage, and severity scoring tools were described in the literature, LRS use is likely to be limited. More than half of the screening tools identified in this review are likely feasible in LRS, but only a small number of triage and severity scoring tools are. Of the 58 tools proposed for use in LMICs, only 23 –16 for screening, four for triage, and three for severity scoring – were deemed feasible in LRS. The most notable of these was the integrated screening and triage process used by Howitt et al. in Timor-Leste.(28) The algorithm was adapted from Ayebare et al. (Uganda) with the removal laboratory testing for COVID-19.(29) It uses well-supported inputs, including oxygen saturation and respiratory symptoms, to identify and prognosticate potentially positive COVID-19 patients in a rapid manner. The general lack of tools, specifically those for severity scoring, has led to the development of a contextually-appropriate COVID-19 mortality scale for LRSs. (30) Though not included in this study due to initial search parameters, the AFEM-CMS is a pragmatic tool which makes use of seven demographic, historical, and clinical inputs to evaluate potential risk of death in COVID-19 patients; a second tool includes pulse oximetry. While many LRS EUs lack pulse oximeters needed to evaluate for hypoxia,(8) these devices are becoming increasingly available. As such this review considered pulse oximetry feasible in LRS.

Limitations

Feasibility does not predict that a tool will be accurate or effective. Tools should be validated in the setting of intended use. This review found no tools validated in low- and lower-middle-income countries. Of those validated in upper-middle-income countries, nearly all were from well-resourced areas of China, substantially limiting generalisability to LRS. Without contextually appropriate validation data, it is difficult to predict if feasible tools are effective in identifying and risk stratifying COVID-19 patients.

Most of the tools discussed in this review were peer-reviewed publications or guidelines by reputable international organisations, with a smaller number in the form of editorials, published correspondence, and preprints. The latter forms of publication often lack peer-review and may be of lower quality. Furthermore, this review is likely missing

a number of tools. Almost every health system worldwide maintains some form of screening and triage processes, along with processes for further decision-making around admission. While in use, both before and during the COVID-19 pandemic, these tools have not been formally published and cannot be described here. Feasibility in LRS was acknowledged if there was a well-described and low-input method of diagnosis available (e.g. case definition coupled with vital signs abnormalities) even if it was not necessarily the gold standard of diagnosis in high-resource settings. Risk of bias assessments could not be performed because most articles were in the form of descriptive reviews, rather than presentations of primary data.

Conclusions

In LRS, where definitive diagnostic tests for COVID-19, such as RT-PCR, may not be available, screening, triage, and severity scoring of potential COVID-19 patients are critical. Rapid identification and prognostication of suspected COVID-19 patients in LRS EUs will allow for appropriate precautions and care to be rendered to all patients, resulting in conservation of resources and reductions in morbidity and mortality. At present, no screening, triage, or severity scoring tools have been designed and validated specifically for LRS. In the face of an enduring pandemic, it is critical that such tools be developed, validated, and made available, so that limited resources can be conserved for those in greatest need and unnecessary loss of life is prevented.

Figure 1 Legend: Prisma Flow Chart for Selected Studies

Funding: No funding was received for this study.

Competing interests: There are no competing interests for any author

Contributorship: CBB, EJCH, and SH designed the study. SH and JLP performed the initial literature searches. SH, JLP, CBB, EJCH, and AVN screened article titles, abstracts, and full-texts for inclusion, and extracted data. SH, CBB and JLP cross-checked all data extractions. SH, JLP, and AVN drafted the initial manuscript. SH, JLP, AVN, EJCH, YOO, LAW, and CBB contributed to manuscript structure and revisions, and have approved of the final version. CBB is the guarantor.

Ethical approval: Not applicable.

Data sharing statement: Extracted data are available on request to the corresponding author.

Transparency: The lead author affirms that the manuscript is an honest, accurate, and transparent account of the study being reported; that no important aspects of the study have been omitted; and that any discrepancies from the study as planned (and, if relevant, registered) have been explained.

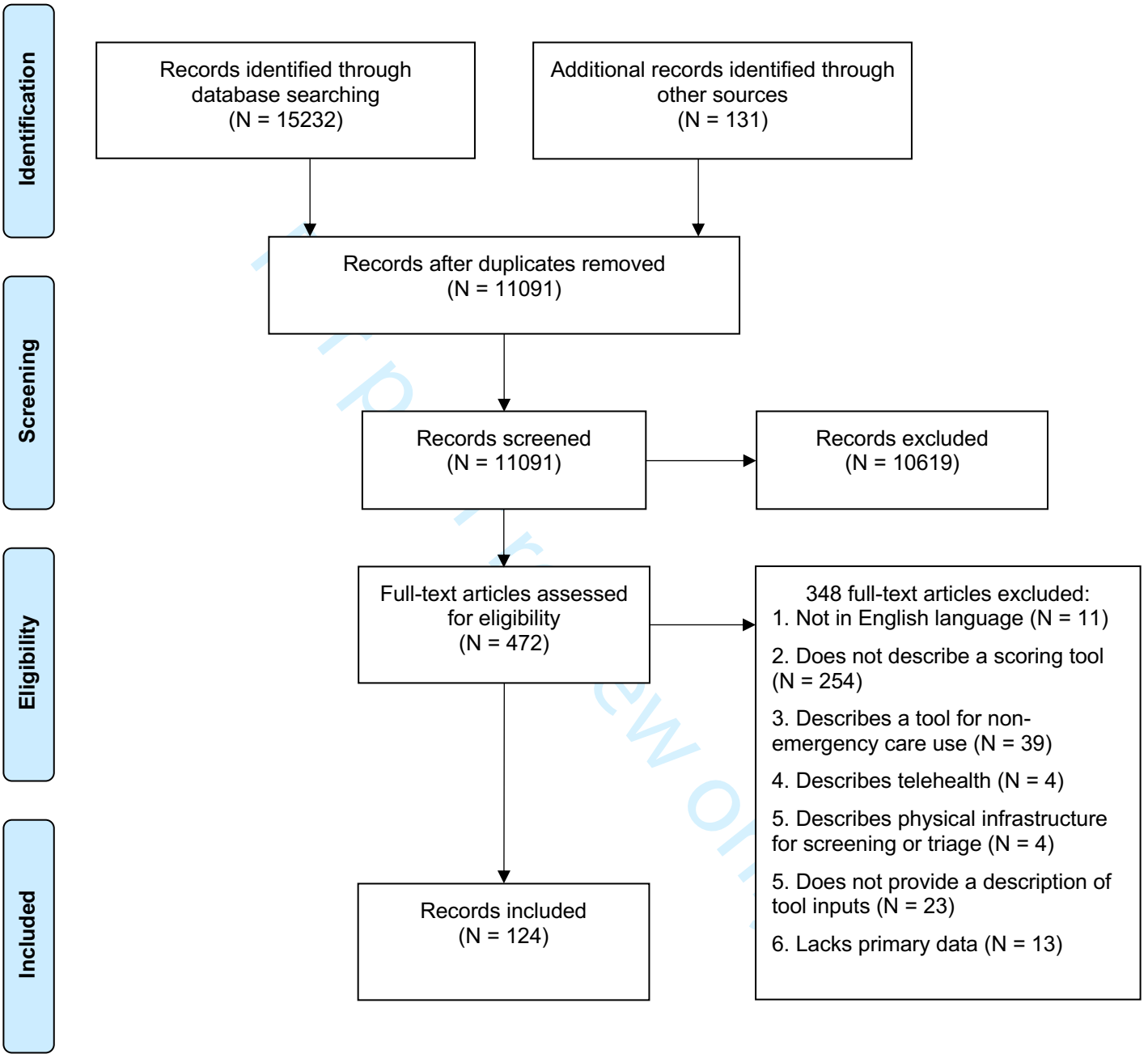
Dissemination to participants and related patient and public communities: Not applicable.

REFERENCES

1. Timeline of WHO's response to COVID-19 Geneva: World Health Organization; 2020 [Available from: https://www.who.int/news-room/detail/29-06-2020-covidtimeline.
2. WHO Coronavirus Disease (COVID-19) Dashboard Geneva: World Health Organization; 2020 [Available from: https://covid19.who.int/.
3. Bong C-L, Brasher C, Chikumba E, McDougall R, Mellin-Olsen J, Enright A. The COVID-19 Pandemic: Effects on Low- and Middle-Income Countries. Anesthesia & Analgesia. 2020;131(1).
4. Massinga Loembe M, Tshangela A, Salyer SJ, Varma JK, Ouma AEO, Nkengasong JN. COVID-19 in Africa: the spread and response. Nat Med. 2020;26(7):999-1003.
5. Lone SA, Ahmad A. COVID-19 pandemic - an African perspective. Emerg Microbes Infect. 2020;9(1):1300-8.
6. Carenzo L, Costantini E, Greco M, Barra FL, Rendiniello V, Mainetti M, et al. Hospital surge capacity in a tertiary emergency referral centre during the COVID-19 outbreak in Italy. Anaesthesia. 2020;n/a(n/a).
7. Chavula C, Pigoga JL, Kafwamfwa M, Wallis LA. Cross-sectional evaluation of emergency care capacity at public hospitals in Zambia. Emerg Med J. 2019.
8. Bitter CC, Rice B, Periyanayagam U, Dreifuss B, Hammerstedt H, Nelson SW, et al. What resources are used in emergency departments in rural sub-Saharan Africa? A retrospective analysis of patient care in a district-level hospital in Uganda. BMJ Open. 2018;8(2):e019024.
9. Reynolds TA, Mfinanga JA, Sawe HR, Runyon MS, Mwafongo V. Emergency care capacity in Africa: a clinical and educational initiative in Tanzania. J Public Health Policy. 2012;33 Suppl 1:S126-37.
10. Dalwai M, Tayler-Smith K, Twomey M, Nasim M, Popal AQ, Haqdost WH, et al. Inter-rater and intrarater reliability of the South African Triage Scale in low-resource settings of Haiti and Afghanistan. Emerg Med J. 2018;35(6):379-83.
11. Gostic K, Gomez AC, Mummah RO, Kucharski AJ, Lloyd-Smith JO. Estimated effectiveness of symptom and risk screening to prevent the spread of COVID-19. Elife. 2020;9.
12. Hansoti B, Jenson A, Kironji AG, Katz J, Levin S, Rothman R, et al. SCREEN: A simple layperson administered screening algorithm in low resource international settings significantly reduces waiting time for critically ill children in primary healthcare clinics. PLoS One. 2017;12(8):e0183520.
13. Jenson A, Hansoti B, Rothman R, de Ramirez SS, Lobner K, Wallis L. Reliability and validity of emergency department triage tools in low- and middle-income countries: a systematic review. European Journal of Emergency Medicine. 2018;25(3).
14. Organization WH. Emergency Triage Assessment and Treatment (ETAT) Manual for Participants. 2005.
15. Oredsson S, Jonsson H, Rognes J, Lind L, Goransson KE, Ehrenberg A, et al. A systematic review of triage-related interventions to improve patient flow in emergency departments. Scand J Trauma Resusc Emerg Med. 2011;19:43.
16. Venkatesan S, Myles PR, McCann G, Kousoulis AA, Hashmi M, Belatri R, et al. Development of processes allowing near real-time refinement and validation of triage tools during the early stage of an outbreak in readiness for surge: the FLU-CATs Study. (2046-4924 (Electronic)).
17. Tricco AC, Lillie E, Zarin W, O'Brien KK, Colquhoun H, Levac D, et al. PRISMA Extension for Scoping Reviews (PRISMA-ScR): Checklist and Explanation. (1539-3704 (Electronic)).
18. Wang Z, Zhou Q, Wang C, Shi Q, Lu S, Ma Y, et al. Clinical characteristics of children with COVID-19: a rapid review and meta-analysis. Ann Transl Med. 2020;8(10):620.
19. Seidu AA, Hagan JE, Jr., Ameyaw EK, Ahinkorah BO, Schack T. The role of testing in the fight against COVID-19: Current happenings in Africa and the way forward. Int J Infect Dis. 2020;98:237-40.
20. Smith B, Chu LK, Smith TC, Amoroso PJ, Boyko EJ, Hooper TI, et al. Challenges of self-reported medical conditions and electronic medical records among members of a large military cohort. BMC Med Res Methodol. 2008;8:37.
21. Burke R, Killerby M, Newton S, Ashworth C, Berns A, Brennan S, et al. Symptom Profiles of a Convenience Sample of Patients with COVID-19 — United States, January–April 2020. MMWR Morb Mortal Wkly Rep. 2020(64):904-8.
22. Vilke G, Brennan J, Cronin A, Castillo E. Clinical features of covid-19 patients: is temperature screening useful? J Emerg Med. 2020.
23. Singh NS, Abrahim O, Altare C, Blanchet K, Favas C, Odlum A, Spiegel PB. COVID-19 in humanitarian settings: documenting and sharing context-specific programmatic experiences. Confl Health. 2020 Nov 19;14(1):79. doi: 10.1186/s13031-020-00321-w. PMID: 33292392; PMCID: PMC7676860.

24. Organization WH. Clinical Management of COVID-19 Interim Guidance. 2020:1-58.
25. Kompaniyets L, Goodman AB, Belay B, et al. Body Mass Index and Risk for COVID-19–Related Hospitalization, Intensive Care Unit Admission, Invasive Mechanical Ventilation, and Death — United States, March–December 2020. MMWR Morb Mortal Wkly Rep 2021;70:355–361.
26. Fang X, Li S, Yu H, Wang P, Zhang Y, Chen Z, et al. Epidemiological, comorbidity factors with severity and prognosis of COVID-19: a systematic review and meta-analysis. Aging (Albany NY). 2020;12(13):12493-503.
27. Pigoga J, Friedman A, Broccoli M, Hirner S, Naidoo A, Singh S, et al. Clinical and historical features associated with severe COVID-19 infection: a systematic review and meta-analysis. Paired paper submission. 2020.
28. Howitt R, de Jesus GA, Araujo F, Francis J, Marr I, McVean M, et al. Screening and triage at health-care facilities in Timor-Leste during the COVID-19 pandemic. Lancet Respir Med. 2020;8(6):e43.
29. Ayebare RR, Flick R, Okware S, Bodo B, Lamorde M. Adoption of COVID-19 triage strategies for low-income settings. Lancet Respir Med. 2020;8(4):e22.
30. Pigoga JL, Omer YO, Wallis LA. Derivation of a Contextually-Appropriate COVID-19 Mortality Scale for Low-Resource Settings. Ann Glob Health. 2021 Mar 26;87(1):31. doi: 10.5334/aogh.3278. PMID: 33816136; PMCID: PMC7996452.

Figure 1. Prisma Flow Chart for Selected Studies



Appendix 1: Search strategy

Search limits: 01 December 2019 to 01 April 2021, English only, publications only

Search terms:
The initial search terms included the following, formatted to the following databases:

- (COVID-19 OR SARS-CoV-2) AND (Triage OR Screening OR Risk OR Severity) AND (Stratification OR Prediction OR Tool OR Index or Score)

Given the rapid and logarithmic number of articles on Covid, an updated search led to the inclusion of the following terms specific to emergency care in order to refine the initial articles screened for review.

- ("emergency responders" OR "emergency medical services" OR "emergency treatment" OR "emergency medicine" OR "ambulances" OR "critical care" OR "shock" OR "sepsis" OR "wounds and injuries" OR "pregnancy complications" OR "emergency responder" OR "emergency responders" OR "emergency doctor" OR "emergency doctors" OR "emergency clinician" OR "emergency clinicians" OR "emergency physician" OR "emergency physicians" OR "emergency personnel" OR "emergency medical personnel" OR "emergency service" OR "emergency services" OR "emergency medical service" OR "emergency medical services" OR "emergency medicine" OR "emergency health service" OR "emergency health services" OR "emergency care" OR "emergency healthcare" OR "emergency treatment" OR "emergency treatments" OR "emergency department" OR "emergency departments" OR "emergency room" OR "emergency rooms" OR "emergency ward" OR "emergency wards" OR "emergency unit" OR "emergency units" OR "emergency hospital" OR "emergency hospitals" OR "emergency clinic" OR "emergency clinics" OR "emergency setting" OR "emergency staff" OR "emergency response" OR "emergency medical technician" OR "emergency medical technicians" OR "paramedic" OR "paramedics" OR "ambulance" OR "ambulances" OR "ER" OR "first responder" OR "first responders" OR "rescue work" OR "rescue worker" OR "rescue workers" OR "relief work" OR "relief worker" OR "relief workers" OR "firefighter" OR "firefighters" OR "fire fighter" OR "fire fighters" OR "trauma center" OR "trauma centers" OR "trauma unit" OR "trauma units" OR "critical care" OR "critical illness" OR "critical illnesses" OR "resuscitation" OR "shock" OR "sepsis" OR "septicemia" OR "septicaemia" OR "acute care" OR "acute disease" OR "acute diseases" OR "prehospital" OR "pre hospital" OR "wound" OR "wounds" OR "triage" OR "pregnancy complication" OR "pregnancy complications" OR "obstetric complication" OR "obstetric complications" OR "obstetric emergency" OR "obstetric emergencies")

Table 1. Total number of unique articles for initial screening

Database	Number of articles
Embase	7591
Ovid/Medline	587
PubMed	4206
Web of Science	2848

Appendix 2: Supplementary Tables

Supplementary Table 1: Screening tool study characteristics (n=57).

Title	First author	Year	Study location	Study setting income level	Study setting	Age group	No. tool inputs	Has the tool been proposed or implemented?
Preparing for emerging respiratory pathogens such as SARS-CoV, MERS-CoV, and SARS-CoV-2(1)	Al-Tawfiq	2020	Dhahran, Saudi Arabia	High-income	Not specified	All ages	7	Proposed
Correlation Between the COVID-19 Respiratory Triage Score and SARS-COV-2 PCR Test(2)	Aldobyany	2020	Makkah, Saudi Arabia	High-income	Not specified	Not specified	14	Implemented
Guidance for building a dedicated health facility to contain the spread of the 2019 novel coronavirus outbreak(3)	Argawal	2020	Pune, India	Lower-middle-income	Not specified	Not specified	4	Proposed
Rapid response infrastructure for pandemic preparedness in a tertiary care hospital: lessons learned from the COVID-19 outbreak in Cologne, Germany, February to March 2020(4)	Augustin	2020	Cologne, Germany	High-income	Not specified	Not specified	3	Implemented
Adoption of COVID-19 triage strategies for low-income settings(5)	Ayebare	2020	Uganda	Low-income	Outpatient / general practitioner	Not specified	6	Proposed
Development, evaluation, and validation of machine learning models for COVID-19 detection based on routine blood tests(6)	Cabitza	2021	Italy	High-income	Hospital	Not specified	23	Proposed
Hospital Emergency Management Plan During the COVID-19 Epidemic(7)	Cao	2020	Chengdu, China	Upper-middle-income	Hospital	Not specified	3	Implemented
Hospital surge capacity in a tertiary emergency referral centre during the COVID-19 outbreak in Italy(8)	Carenzo	2020	Milan, Italy	High-income	Hospital	Not specified	4	Implemented
Standard Operating Procedure for Triage of suspected COVID-19 patients in non-US Healthcare settings(9)	Centers for Disease Control and Prevention	2020	United States	High-income	Not specified	Not specified	4	Proposed

Enhancing the triage and cohort of patients in public primary care clinics in response to the coronavirus disease 2019 (COVID-19) in Hong Kong: an experience from a hospital cluster(10)	Chan	2020	Hong Kong, China	Upper-middle-income	Outpatient / general practitioner	Not specified	3	Implemented
Infection control measures of a Taiwanese hospital to confront the COVID-19 pandemic(11)	Chang	2020	Kaohsiun, Taiwan	High-income	Hospital	Not specified	3	Implemented
Fangcang shelter hospitals: a novel concept for responding to public health emergencies(12)	Chen	2020	Wuhan, China	Upper-middle-income	Hospital	Not specified		Implemented
Escalating infection control response to the rapidly evolving epidemiology of the coronavirus disease 2019 (COVID-19) due to SARS-CoV-2 in Hong Kong(13)	Cheng	2020	Hong Kong, China	Upper-middle-income	Not specified	Not specified	4	Implemented
Onsite telemedicine strategy for coronavirus (COVID-19) screening to limit exposure in ED(14)	Chou	2020	Texas, United States	High-income	Hospital-based emergency care	Not specified	3	Implemented
Mobilization and Preparation of a Large Urban Academic Center During the COVID-19 Pandemic(15)	Chowdhury	2020	Pennsylvania, United States	High-income	Hospital	Not specified	13	Implemented
Revised Triage and Surveillance Protocols for Temporary Emergency Department Closures in Tertiary Hospitals as a Response to COVID-19 Crisis in Daegu Metropolitan City(16)	Chung	2020	Daegu, Korea	High-income	Hospital-based emergency care	Not specified	7	Proposed
Infection control practices in children during COVID-19 pandemic: differences from adults(17)	Devrim	2020	Izmir, Turkey	Upper-middle-income	Not specified	Pediatric	4	Implemented
Calculated Decisions: Brescia-COVID Respiratory Severity Scale (BCRSS)/Algorithm(18)	Duca	2020	United States	High-income	Hospital-based emergency care	Not specified	1	Implemented
Triage decision-making at the time of COVID-19 infection: the Piacenza strategy(19)	Erika	2020	Piacenza, Italy	High-income	Hospital-based emergency care	Not specified	4	Implemented
Lung Ultrasound vs. Chest X-Ray Study for the Radiographic Diagnosis of COVID-19 Pneumonia in a High-Prevalence Population.(20)	Gibbons	2021	United States	High-income	Not specified	Not specified	7	Proposed
Immersion in an emergency department triage center during the Covid-19 outbreak: first report of the Liège University hospital experience(21)	Gilbert	2020	Liège, Belgium	High-income	Hospital-based emergency care	Not specified	5	Implemented

An effective screening and management process in the outpatient clinic for patients requiring hospitalization during the COVID-19 pandemic(22)	Guo	2020	Beijing, China	Upper-middle-income	Outpatient / general practitioner	Not specified	4	Proposed
How to transform a general hospital into an "infectious disease hospital" during the epidemic of COVID-19(23)	He	2020	China	Upper-middle-income	Hospital	Not specified	2	Implemented
Screening and triage at health-care facilities in Timor-Leste during the COVID-19 pandemic(24)	Howitt	2020	Timor-Leste	Lower-middle income	Not specified	Not specified	2	Implemented
Application and effects of fever screening system in the prevention of nosocomial infection in the only designated hospital of coronavirus disease 2019 (COVID-19) in Shenzhen, China(25)	Huang	2020	Shenzhen, China	Upper-middle-income	Hospital	Not specified	5	Implemented
The role of emergency medical services in containing COVID-19(26)	Jaffe	2020	Israel	High-income	Prehospital emergency care	Not specified	2	Implemented
An algorithmic approach to diagnosis and treatment of coronavirus disease 2019 (COVID-19) in children: Iranian expert's consensus statement(27)	Karimi	2020	Tehran, Iran	Upper-middle-income	Not specified	Paediatric	9	Proposed
2019-nCoV: The Identify-Isolate-Inform (3I) Tool Applied to a Novel Emerging Coronavirus(28)	Koenig	2020	United states	High-income	Not specified	Not specified	3	Proposed
Diagnosis and clinical management of severe acute respiratory syndrome Coronavirus 2 (SARS-CoV-2) infection: an operational recommendation of Peking Union Medical College Hospital (V2.0): Working Group of 2019 Novel Coronavirus, Peking Union Medical College Hospital(29)	Li	2020	Beijing, China	Upper-middle-income	Not specified	Not specified	1	Proposed
A Double Triage and Telemedicine Protocol to Optimize Infection Control in an Emergency Department in Taiwan During the COVID-19 Pandemic: Retrospective Feasibility Study(30)	Lin	2020	Taipei, Taiwan	High-income	Hospital	Adult	3	Implemented
Optimizing screening strategies for coronavirus disease 2019: A study from Middle China(31)	Liu	2020	Changsa, China	Upper-middle-income	Not specified	Not specified	3	Proposed

A COVID-19 Risk Assessment Decision Support System for General Practitioners: Design and Development Study(32)	Liu	2020	Hangzhou, China	Upper-middle-income	Outpatient / general practitioner	Not specified	36	Proposed
Reorganization of a large academic hospital to face COVID-19 outbreak: The model of Parma, Emilia-Romagna region, Italy(30)	Meschi	2020	Parma, Italy	High-income	Hospital-based emergency care	Not specified	3	Implemented
How emergency departments prepare for virus disease outbreaks like COVID-19(31)	Möckel	2020	Germany	High-income	Hospital-based emergency care	Not specified	3	Implemented
Clinical Triaging in Cough Clinic Alleviates COVID-19 Overload in Emergency Department in India.(32)	Nayan	2020	West Bengal, India	Lower-middle-income	Hospital	Not specified	8	Implemented
A Pediatric Emergency Department Protocol to Avoid Interhospital Spread of SARS-CoV-2 during the Outbreak in Bergamo, Italy(33)	Nicastro	2020	Bergamo, Italy	High-income	Hospital	Pediatric	3	Implemented
The ultrasound guided triage: a new tool for prehospital management of COVID-19 pandemic(34)	Piliego	2020	Italy	High-income	Not specified	Not specified	7	Proposed
Screening and managing of suspected or confirmed novel coronavirus (COVID-19) patients: experiences from a tertiary hospital outside Hubei province(35)	Pu	2020	Chengdu, China	Upper-middle-income	Hospital	Not specified	2	Implemented
Reorganising the emergency department to manage the COVID-19 outbreak(36)	Quah	2020	Singapore	High-income	Hospital-based emergency care	Not specified	7	Implemented
Diagnostic accuracy of symptoms as a diagnostic tool for SARS-CoV 2 infection: a cross-sectional study in a cohort of 2,173 patients.(37)	Romero-Gameros	2021	Mexico City, Mexico	Upper-middle-income	Hospital-based emergency care	Not specified	11	Proposed
Can You Catch It? Lessons Learned and Modification of ED Triage Symptom- and Travel-Screening Strategy(38)	Schwedhelm	2020	Nebraska, United States	High-income	Hospital-based emergency care	Not specified	4	Implemented
Emergency Responses to Covid-19 Outbreak: Experiences and Lessons from a General Hospital in Nanjing, China(39)	Shen	2020	Nanjing, China	Upper-middle-income	Hospital	Not specified	5	Implemented
A quickly, effectively screening process of novel corona virus disease 2019 (COVID-19) in children in Shanghai, China(40)	Shi	2020	Shanghai, China	Upper-middle-income	Hospital	Pediatric	3	Implemented
The response of Milan's Emergency Medical System to the COVID-19 outbreak in Italy(41)	Spina	2020	Milan, Italy	High-income	Prehospital emergency care	Not specified	2	Implemented
Reducing hospital admissions for COVID-19 at a dedicated screening centre in Singapore(42)	Tan	2020	Singapore	High-income	Hospital	Not specified	3	Implemented

The role of triage in the prevention and control of COVID-19(43)	Wang	2020	Xi'an, China	Upper-middle-income	Hospital	Not specified	7	Implemented
Providing uninterrupted care during COVID-19 pandemic: experience from Beijing Tiantan Hospital(44)	Wang	2020	Beijing, China	Upper-middle-income	Hospital	Not specified	4	Implemented
Containing COVID-19 in the Emergency Department: The Role of Improved Case Detection and Segregation of Suspect Cases(45)	Wee	2020	Singapore	High-income	Hospital-based emergency care	All ages	2	Implemented
Redesigning emergency department operations amidst a viral pandemic(46)	Whiteside	2020	United States	High-income	Hospital-based emergency care	Not specified	3	Proposed
Clinical Management of COVID-19 Interim Guidance(47)	World Health Organization	2020	Not applicable	Not applicable	Not specified	All ages	4	Proposed
Strategies for qualified triage stations and fever clinics during the outbreak of COVID-2019 in the county hospitals of Western Chongqing(48)	Wu	2020	Western Chongqing, China	Upper-middle-income	Outpatient / general practitioner	Not specified	17	Implemented
Therapeutic and triage strategies for 2019 novel coronavirus disease in fever clinics(49)	Zhang	2020	Wuhan, China	Upper-middle-income	Outpatient / general practitioner	Not specified	10	Implemented
Analysis and suggestions for the preview and triage screening of children with suspected COVID-19 outside the epidemic area of Hubei Province(50)	Zhang	2020	Chongqing, China	Upper-middle-income	Outpatient / general practitioner	Paediatric	5	Implemented
COVID19: A Systematic Approach to Early Identification and Healthcare Worker Protection(51)	Zhao	2020	Shanghai, China	Upper-middle-income	Not specified	Not specified	4	Proposed
Primary stratification and identification of suspected Corona virus disease 2019 (COVID-19) from clinical perspective by a simple scoring proposal(52)	Zhou	2020	Gansu, China	Upper-middle-income	Not specified	Not specified	10	Proposed
Proposed Clinical Indicators for Efficient Screening and Testing for COVID-19 Infection from Classification and Regression Trees (CART) Analysis(53)	Zimmerman	2020	Pennsylvania, United States	High-income	Outpatient / general practitioner	Not specified	5	Proposed
Application of Critical Care Ultrasound in Patients With COVID-19: Our Experience and Perspective.(54)	Zou	2020	Chengdu, China	Upper-middle-income	Not specified	Not specified	7	Proposed

Supplementary Table 2: Triage tool study characteristics (n=23).

Title	First author	Year	Study location	Study setting income level	Study setting	Age group	No. tool inputs	Has the tool been proposed or implemented?
Point-of-Care Ultrasound in the Evaluation of COVID-19.(55)	Abrams	2020	United States	High-income	Hospital	Not specified	1	Proposed
Emergency Department COVID-19 Severity Classification(56)	American College of Emergency Physicians	2020	United States	High-income	Not specified	Adults	41	Proposed
Fangcang shelter hospitals: a novel concept for responding to public health emergencies(12)	Chen	2020	Wuhan, China	Upper-middle-income	Hospital	Not specified	12	Implemented
Mobilization and Preparation of a Large Urban Academic Center During the COVID-19 Pandemic(15)	Chowdhury	2020	Pennsylvania, United States	High-income	Hospital	Not specified	16	Implemented
Revised Triage and Surveillance Protocols for Temporary Emergency Department Closures in Tertiary Hospitals as a Response to COVID-19 Crisis in Daegu Metropolitan City(16)	Chung	2020	Daegu, Korea	High-income	Hospital-based emergency care	Not specified	8	Proposed
Early prediction of the risk of severe coronavirus disease 2019: A key step in therapeutic decision making(57)	Côté	2020	Quebec, Canada	High-income	Not specified	Not specified	21	Proposed
Infection control practices in children during COVID-19 pandemic: differences from adults(17)	Devrim	2020	Izmir, Turkey	Upper-middle-income	Not specified	Paediatric	5	Implemented
Using Lung Point-of-care Ultrasound in Suspected COVID-19: Case Series and Proposed Triage Algorithm.(58)	Duggan	2020	United States	High-income	Not specified	Not specified	1	Proposed
Simple, fast and affordable triaging pathway for COVID-19.(59)	Eggleton	2020	United Kingdom	High-income	Not specified	Not specified	1	Proposed
How is COVID-19 affecting South Korea? What is our current strategy?(60)	Her	2020	South Korea	High-income	Not specified	Not specified	2	Implemented
Screening and triage at health-care facilities in Timor-Leste during the COVID-19 pandemic(24)	Howitt	2020	Timor-Leste	Lower-middle income	Not specified	Not specified	4	Implemented

An algorithmic approach to diagnosis and treatment of coronavirus disease 2019 (COVID-19) in children: Iranian expert's consensus statement(27)	Karimi	2020	Tehran, Iran	Upper-middle-income	Not specified	Paediatric	15	Proposed
Diagnosis and clinical management of severe acute respiratory syndrome Coronavirus 2 (SARS-CoV-2) infection: an operational recommendation of Peking Union Medical College Hospital (V2.0): Working Group of 2019 Novel Coronavirus, Peking Union Medical College Hospital(29)	Li	2020	Beijing, China	Upper-middle-income	Hospital	Not specified	11	Proposed
A Double Triage and Telemedicine Protocol to Optimize Infection Control in an Emergency Department in Taiwan During the COVID-19 Pandemic: Retrospective Feasibility Study(30)	Lin	2020	Taipei, Taiwan	High-income	Hospital	Adult	8	Implemented
CLUE: COVID-19 lung ultrasound in emergency department(61)	Manivel	2020	Sydney, Australia	High-income	Hospital-based emergency care	Not specified	1	Proposed
Proposed Modifications in the 6-minutue Walk Test for Potential Application in Patients with mild Coronavirus Disease 2019 (COVID-19): A Step to Optimize Triage Guidelines(62)	Mantha	2020	India	Lower-middle income	Not specified	Not specified	6	Proposed
Reorganization of a large academic hospital to face COVID-19 outbreak: The model of Parma, Emilia-Romagna region, Italy(30)	Meschi	2020	Parma, ltaly	High-income	Hospital-based emergency care	Not specified	8	Implemented
A Dynamic Bayesian Model for Identifying High-Mortality Risk in Hospitalized COVID-19 Patients.(63)	Momeni-Boroujeni	2021	New York, United States	High-income	Hospital	Not specified	11	Proposed
The ultrasound guided triage: a new tool for prehospital management of COVID-19 pandemic(34)	Piliego	2020	Italy	High-income	Not specified	Not specified	9	Proposed
Pattern recognition of high-resolution computer tomography (HRCT) chest to guide clinical management in patients with mild to moderate COVID-19.(64)	Rajalingam	2021	South Tamilnadu, India	Lower-middle-income	Outpatient/ general practitioner	Not specified	1	Proposed
COVID-19 Outpatient Screening: A Prediction Score for Adverse Events(65)	Sun	2020	Massachusetts, United States	High-income	Outpatient / general practitioner	Adult	20	Proposed

Lower mortality of COVID-19 by early recognition and intervention: experience from Jiangsu Province(66)	Sun	2020	Nanjing, China	Upper-middle-income	Not specified	Not specified	6	Implemented
Clinical Management of COVID-19 Interim Guidance(45)	World Health Organization	2020	Not applicable	Not applicable	Not specified	All ages	18	Proposed

Supplementary Table 3: Severity scoring / prognostication tool study characteristics (n=54).

Title	First author	Year	Study location	Study setting income level	Study setting	Age group	No. tool inputs	Has the tool been proposed or implemented?
Isaric 4c Mortality Score As A Predictor Of In-Hospital Mortality In Covid-19 Patients Admitted In Ayub Teaching Hospital During First Wave Of The Pandemic.(67)	Ali	2021	Abbottabad, Pakistan	Lower-middle-income	Hospital	Not specified	8	Proposed
Development and validation of a prediction model for severe respiratory failure in hospitalized patients with SARS-Cov-2 infection: a multicenter cohort study (PREDI-CO study) (68)	Bartoletti	2020	Bologna, Italy	High-income	Hospital	Not specified	8	Proposed
Lung ultrasonography for risk stratification in patients with COVID-19: a prospective observational cohort study(69)	Brahier	2020	Switzerland	High-income	Hospital	Not specified	1	Proposed
Prediction of severe illness due to COVID-19 based on an analysis of initial fibrinogen to albumin ratio and platelet count(70)	Bi	2020	Taizhou, China	Upper-middle-income	Hospital	Not specified	2	Proposed
Chest X-ray in new Coronavirus Disease 2019 (COVID-19) infection: findings and correlation with clinical outcome(71)	Cozzi	2020	Florence, Italy	High-income	Hospital	Not specified	1	Proposed
Predicting CoVID-19 community mortality risk using machine learning and development of an online prognostic tool.(72)	Das	2020	South Korea	High-income	Not specified	Not specified	3	Proposed
A novel simple scoring model for predicting severity of patients with SARS-CoV-2 infection(73)	Dong	2020	Wuhan, China	Upper-middle-income	Hospital	Not specified	3	Proposed
Correlation between the variables collected at admission and progression to severe cases during hospitalization among patients with COVID-19 in Chongqing(74)	Duan	2020	Chongqing, China	Upper-middle-income	Not specified	Not specified	3	Proposed
A multipurpose machine learning approach to predict COVID-19 negative prognosis in São Paulo, Brazil(75)	Fernandes	2021	São Paulo, Brazil	High-income	Upper-middle-income	Not specified	5	Proposed

The utility of established prognostic scores in COVID-19 hospital admissions: a multicentre prospective evaluation of CURB-65, NEWS2, and qSOFA(76)	Frost	2020	Liverpool, England	High-income	Hospital	Not specified	2	Proposed
A clinical risk score to identify patients with COVID-19 at high risk of critical care admission or death: An observational cohort study(77)	Galloway	2020	London, United Kingdom	High-income	Hospital	Not specified	10	Proposed
Prognostic Accuracy of the SIRS, qSOFA, and NEWS for Early Detection of Clinical Deterioration in SARS-CoV-2 Infected Patients(78)	Geol Jang	2020	Daegu, Korea	High-income	Not specified	Not specified	3	Proposed
Predictive value of National Early Warning Score 2 (NEWS2) for intensive care unit admission in patients with SARS-CoV-2 infection(79)	Gidari	2020	Perugia, Italy	High-income	Hospital	Not specified	1	Proposed
A Tool for Early Prediction of Severe Coronavirus Disease 2019 (COVID-19): A Multicenter Study Using the Risk Nomogram in Wuhan and Guangdong, China(80)	Gong	2020	Guangzhou, China	Upper-middle-income	Hospital	Not specified	7	Proposed
Development and validation of a prognostic model based on comorbidities to predict COVID-19 severity: a population-based study(81)	Gude-Sampedro	2021	Galicia, Spain	High-income	Not specified	Not specified	10	Proposed
Evaluation of the clinical profile, laboratory parameters and outcome of two hundred COVID-19 patients from a tertiary centre in India(82)	Gupta	2020	India	Lower-middle-income	Not specified	Not specified	12	Proposed
Development and validation of the quick COVID-19 severity index (qCSI): a prognostic tool for early clinical decompensation(83)	Haimovich	2020	Connecticut, United States	High-income	Not specified	Not specified	3	Proposed
Predictive Value of 5 Early Warning Scores for Critical COVID-19 Patients(84)	Hu	2020	Wuhan, China	Upper-middle-income	Hospital-based emergency care	Not specified	5	Proposed
COVID-19 Severity Index: predictive score for hospitalized patients(85)	Huespe	2020	Buenos Aires, Argentina	Upper-middle-income	Hospital	Not specified	16	Proposed

COVID-19: Symptoms, course of illness and use of clinical scoring systems for the first 42 patients admitted to a Norwegian local hospital(86)	Ihle-Hansen	2020	Viken county, Norway	High-income	Hospital	Not specified	1	Proposed
Clinical Characteristics and Prognostic Factors for Intensive Care Unit Admission of Patients With COVID-19: Retrospective Study Using Machine Learning and Natural Language Processing(87)	Izquierdo	2020	Castilla-La Mancha, Spain	High-income	Not specified	Not specified	3	Proposed
Development and validation of a model for individualized prediction of hospitalization risk in 4,536 patients with COVID-19(88)	Jehi	2020	Guangzhou, China	Upper-middle-income	Not specified	Not specified	8	Proposed
The association of chest radiographic findings and severity scoring with clinical outcomes in patients with COVID-19 presenting to the emergency department of a tertiary care hospital in Pakistan(89)	Kaleemi	2021	Pakistan	Lower-middle-income	Adult	Hospital-based emergency care	1	Proposed
The performance of the National Early Warning Score and National Early Warning Score 2 in hospitalised patients infected by the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2).(90)	Kostakis	2020	United Kingdome	High-income	Hospital	Not specified	1	Proposed
Clinical Frailty Scale for risk stratification in patients with SARS-CoV-2 infection(91)	Labenz	2020	Mainz, Germany	High-income	Hospital	Not specified	1	Proposed
Triage tool for suspected COVID-19 patients in the emergency room: AIFELL score(92)	Levenfus	2020	Zurich, Switzerland	High-income	Hospital	Not specified	6	Proposed
A simple algorithm helps early identification of SARS-CoV-2 infection patients with severe progression tendency(93)	Li	2020	Shanghai, China	Upper-middle-income	Not specified	Not specified	3	Proposed
Development and Validation of a Clinical Risk Score to Predict the Occurrence of Critical Illness in Hospitalized Patients With COVID-19(94)	Liang	2020	Guangzhou, China	Upper-middle-income	Not specified	Not specified	10	Proposed
Early triage of critically ill COVID-19 patients using deep learning(95)	Liang	2020	Guangzhou, China	Upper-middle-income	Not specified	Not specified	10	Proposed

Development and validation of a risk stratification model for screening suspected cases of COVID-19 in China(96)	Ma	2020	Wuhan, China	Upper-middle-income	Not specified	Not specified	23	Proposed
National Early Warning Score 2 (NEWS2) on admission predicts severe disease and in-hospital mortality from Covid-19 - a prospective cohort study(97)	Myrstad	2020	Oslo, Norway	High-income	Hospital	Not specified	1	Proposed
A score combining early detection of cytokines accurately predicts COVID-19 severity and intensive care unit transfer(98)	Nagant	2020	Brussels, Belgium	High-income	Hospital	Not specified	3	Proposed
A nomogram to predict the risk of unfavourable outcome in COVID-19: a retrospective cohort of 279 hospitalized patients in Paris area(99)	Nguyen	2020	Paris, France	High-income	Hospital	Not specified	7	Proposed
Automated EHR score to predict COVID-19 outcomes at US Department of Veterans Affairs(100)	Osborne	2020	California, United States	High-income	Not specified	Adult	25	Proposed
NEWS can predict deterioration of patients with COVID-19(101)	Peng	2020	Huazhong, China	Upper-middle-income	Not specified	Not specified	2	Proposed
Examining the utility of extended laboratory panel testing in the emergency department for risk stratification of patients with COVID-19: a single-centre retrospective service evaluation(102)	Ponsford	2021	Cardiff, United Kingdom	High-income	Hospital	Adult	8	Proposed
Association between Clinical Frailty Scale score and hospital mortality in adult patients with COVID-19 (COMET): an international, multicentre, retrospective, observational cohort study(103)	Sablerolles	2021	Europe	High-income	Hospital	Adult	1	Proposed
Performance of pneumonia severity index and CURB-65 in predicting 30-day mortality in patients with COVID-19(104)	Satici	2020	Istanbul, Turkey	Upper-middle-income	Hospital	Not specified	2	Proposed
Model-based Prediction of Critical Illness in Hospitalized Patients with COVID-19(105)	Schalekamp	2020	Amersfoort, The Netherlands	High-income	Not specified	Not specified	7	Proposed

Scoring systems for predicting mortality for severe patients with COVID-19(106)	Shang	2020	Wuhan, China	Upper-middle-income	Hospital	Not specified	5	Proposed
Evaluating a Widely Implemented Proprietary Deterioration Index Model Among Hospitalized COVID-19 Patients(107)	Singh	2020	Michigan, United States	High-income	Not specified	Not specified	1	Proposed
Development and validation of a simple risk score for diagnosing COVID-19 in the emergency room(108)	Sung	2020	Maryland, United States	High-income	Hospital	Not specified	10	Proposed
Prediction of Sepsis in COVID-19 Using Laboratory Indicators(109)	Tang	2021	Tongji, China	Upper-middle-income	Not specified	Not specified	7	Proposed
Development of a data-driven COVID-19 prognostication tool to inform triage and step-down care for hospitalised patients in Hong Kong: A population based cohort study(110)	Tsui	2020	Hong Kong, China	Upper-middle-income	Hospital	Not specified	7	Proposed
Personalized predictive models for symptomatic COVID-19 patients using basic preconditions: Hospitalizations, mortality, and the need for an ICU or ventilator(111)	Wollenstein-Betech	2020	Mexico	Upper-middle-income	Not specified	Not specified	9	Proposed
Development of a Clinical Decision Support System for Severity Risk Prediction and Triage of COVID-19 Patients at Hospital Admission: An International Multicenter Study(112)	Wu	2020	Maastricht, the Netherlands	High-income	Hospital	Not specified	7	Proposed
Development and validation of the HNC-LL score for predicting the severity of coronavirus disease 2019(113)	Xiao	2020	Guangzhou, China	Upper-middle-income	Not specified	Not specified	5	Proposed
Point-of-Care Lung Ultrasound for COVID-19: Findings and Prognostic Implications From 105 Consecutive Patients(114)	Yasukawa	2021	Washington D.C., United States	High-income	Hospital	Not specified	1	Proposed
A Novel Scoring System for Prediction of Disease Severity in COVID-19(115)	Zhang	2020	Beijing, China	Upper-middle-income	Hospital	Not specified	5	Proposed
Development and validation of a risk factor-based system to predict short-term survival in adult hospitalized patients with COVID-19: a multicenter, retrospective, cohort study(116)	Zhang	2020	Honghu, China	Upper-middle-income	Hospital	Not specified	1	Proposed

Lung Ultrasound Score in Evaluating the Severity of Coronavirus Disease 2019 (COVID-19) Pneumonia(117)	Zhao	2020	Shanghai, China	Upper-middle-income	Hospital	Not specified	1	Proposed
Development and validation a nomogram for predicting the risk of severe COVID-19: A multi-center study in Sichuan, China(118)	Zhou	2020	Sichuan, China	Upper-middle-income	Not specified	Not specified	6	Proposed
Deep-learning artificial intelligence analysis of clinical variables predicts mortality in COVID-19 patients(119)	Zhu	2020	New York, United States	High-income	Not specified	Not specified	5	Proposed
Acute Physiology and Chronic Health Evaluation II Score as a Predictor of Hospital Mortality in Patients of Coronavirus Disease 2019(120)	Zou	2020	Wuhan, China	Upper-middle-income	Hospital	Not specified	1	Proposed

Supplementary Table 4: Summary of validation data for tools being used to screen, triage, and prognosticate COVID-19 patients.

	Tool training/development validation data						Other validation data					
Title	Validation endpoint	AUC	Sensitivity	Specificity	PPV	NPV	Validation type	AUC	Sensitivity	Specificity	PPV	NPV
A Novel Scoring System for Prediction of Disease Severity in COVID-19(94)	ICU admission						Retro-spective	0·91	0·71	0·89		
A novel simple scoring model for predicting severity of patients with SARS-CoV-2 infection(62)	COVID-19 confirmed by RT-PCR						Retro-spective		0·8	0·79		
A quickly, effectively screening process of novel corona virus disease 2019 (COVID-19) in children in Shanghai, China(38)	COVID-19 diagnosis		1	0·71	0·18	1						
A simple algorithm helps early identification of SARS-CoV-2 infection patients with severe progression tendency(74)	Severe COVID-19 disease						Retro-spective		0·18	0·93	0·49	0·98
A Tool for Early Prediction of Severe Coronavirus Disease 2019 (COVID-19): A Multicenter Study Using the Risk Nomogram in Wuhan and Guangdong, China(67)	Severe COVID-19 disease	0·91	0·86	0·88								
Acute Physiology and Chronic Health Evaluation II Score as a Predictor of Hospital Mortality in Patients of Coronavirus Disease 2019(93)	In-hospital mortality	0·97	0·96	0·86								
Clinical Characteristics and Prognostic Factors for Intensive Care Unit Admission of Patients With COVID-19: Retrospective Study Using Machine Learning and Natural Language Processing.	ICU admission	0.76										
Containing COVID-19 in the Emergency Department: The Role of Improved Case Detection and Segregation of Suspect Cases(43)	COVID-19 confirmed by RT-PCR		0·842 (95% CI [0·736-0·919])	0·648 (95% CI [0·625-0·670])								
COVID-19 Outpatient Screening: A Prediction Score for Adverse Events(57)	Hospitalisation, ICU care, need for mechanical ventilation, or death within 7 days of an	0·80 (hospitalisation); 0·82 (critical illness);					Pro-spective	0·76 (hospitalisation); 0·79 (critical illness); 0·93 (death)				

	outpatient medical encounter	0·87 (death)										
Development and Validation of a Clinical Risk Score to Predict the Occurrence of Critical Illness in Hospitalized Patients With COVID-19(75)	Critical COVID-19 disease		72% (95% CI [65%-79%]) (at risk score >3)	86% (95% CI [89%-92%]) (at risk score >3)	74% (95% CI [67%-80%]) (at risk score >3)	89% (95% CI [85%-91%]) (at risk score >3)	Retro-spective		80% (95% CI [73%-85%]) (at risk score >3)	76% (95% CI [70%-81%]) (at risk score >3)	69% (95% CI [60%-74%]) (at risk score >3)	85% (95% CI [80%-89%]) (at risk score >3)
Development and validation of a prediction model for severe respiratory failure in hospitalized patients with SARS-Cov-2 infection: a multicenter cohort study (PREDI-CO study)(59)	Severe respiratory failure	0·89 (95% CI [0·86-0·92])										
Development and validation of a prognostic model based on comorbidities to predict COVID-19 severity: a population-based study.	Mortality	0.89										
Development and validation of a risk factor-based system to predict short-term survival in adult hospitalized patients with COVID-19: a multicenter, retrospective, cohort study(89)	28-day mortality						Retro-spective	0.879 (95% CI [0.856-0.900)				
Development and validation of a risk stratification model for screening suspected cases of COVID-19 in China(77)	COVID-19 confirmed by RT-PCR	0·86	0·83	0·78	0·32	0·97	Retro-spective	0·87	0·82	0·77	0·26	0·98
Development and validation of a simple risk score for diagnosing COVID-19 in the emergency room.	COVID-19 confirmed by RT-PCR		0.796	0.709								
Development and validation of the HNC-LL score for predicting the severity of coronavirus disease 2019(88)	Severe COVID-19 disease						Retro-spective	0·86	0·85	0·76		
Development and validation of the quick COVID-19 severity index (qCSI): a prognostic tool for early clinical decompensation(68)	Respiratory failure within 24 hours of admission						Retro-spective	0·91	0·94	0·82		
Development of a Clinical Decision Support System for Severity Risk Prediction and Triage of COVID-19 Patients at Hospital Admission: An International Multicenter Study(87)	Severe or critical COVID-19 disease	0·88	0·85	0·74	0·75	0·85						
Development of a data-driven COVID-19 prognostication tool to inform triage and step-down care	Severe COVID-19 disease			0·913 (Day-1 model) and								

for hospitalised patients in Hong Kong: A population based cohort study(86)				0·942 (Day-5 model)					
Evaluating a Widely Implemented Proprietary Deterioration Index Model Among Hospitalized COVID-19 Patients(85)	ICU-level care, mechanical ventilation, or in-hospital death				Retro-spective	0·79	0·39	0·91	0·74	0·9
Examining the utility of extended laboratory panel testing in the emergency department for risk stratification of patients with COVID-19: a single-centre retrospective service evaluation.	28-day mortality	0.77								
Lower mortality of COVID-19 by early recognition and intervention: experience from Jiangsu Province(58)	Severe COVID-19 disease	0·96	0·955 (95% CI [0·772-0·999])	0·899 (95% CI [0·863-0·928])						
Lung Ultrasound Score in Evaluating the Severity of Coronavirus Disease 2019 (COVID-19) Pneumonia(90)	Refractory COVID-19 disease				Retro-spective	0·52	1	0·74		
Model-based Prediction of Critical Illness in Hospitalized Patients with COVID-19(83)	Critical COVID-19 disease				Retro-spective	0·77	0·5	0·88	0·79	0·66
National Early Warning Score 2 (NEWS2) on admission predicts severe disease and in-hospital mortality from Covid-19 - a prospective cohort study(78)	Severe COVID-19 disease	0·82	0·8	0·84						
NEWS can predict deterioration of patients with COVID-19(81)	Severe and critical COVID-19 disease				Pro-spective	0·84	1	0·51		
Performance of pneumonia severity index and CURB-65 in predicting 30-day mortality in patients with COVID-19(82)	30-day mortality				Retro-spective	0·79 (CURB-65); 0·85 (PSI)	0·73 (CURB-65); 0·80 (PSI)	0·85 (CURB-65); 0·89 (PSI)	0·31 (CURB-65), 0·39 (PSI)	0·97 (CURB-65), 0·98 (PSI)
Personalized predictive models for symptomatic COVID-19 patients using basic preconditions: Hospitalizations, mortality, and the need for an ICU or ventilator.	Mortality	0.63								
Predicting CoVID-19 community mortality risk using machine learning and development of an online prognostic tool.	Mortality	0·83	0·692	0·968						

Prediction of severe illness due to COVID-19 based on an analysis of initial Fibrinogen to Albumin Ratio and Platelet count(60)	Severe COVID-19 disease		0·863 (95% CI [0·640–0·964])	0·593 (95% CI [0·485–0·694])	0·339 (95% CI [0·222–0·0·479])	0·9474 (95% CI [0·845–0·986])	Pro-spective		0·857 (95% CI [0·420–0·992])	0·429 (95% CI [0·226–0·556])	0·333 (95% CI [0·143–0·588])	0·9 (95% CI [0·541–0·994])
Predictive value of National Early Warning Score 2 (NEWS2) for intensive care unit admission in patients with SARS-CoV-2 infection(66)	Severe COVID-19 disease						Retro-spective		0·89	0·66	0·63	0·9
Prognostic Accuracy of the SIRS, qSOFA, and NEWS for Early Detection of Clinical Deterioration in SARS-CoV-2 Infected Patients(84)	28-day mortality						Retro-spective	0·918 (NEWS); 0·760 (qSOFA); 0·744 (SIRS)	0·867 (NEWS≥ 5)	0·905 (NEWS≥ 5)	0·591 (NEWS≥ 5)	0·977 (NEWS≥ 5)
Proposed Clinical Indicators for Efficient Screening and Testing for COVID-19 Infection from Classification and Regression Trees (CART) Analysis(51)	COVID-19 confirmed by RT-PCR	0·78	0·96	0·53	0·14	0·99						
The utility of established prognostic scores in COVID-19 hospital admissions: a multicentre prospective evaluation of CURB-65, NEWS2, and qSOFA(63)	30-day mortality						Pro-spective	0·75 (CURB-65 2); 0·61 (CURB-65 ≥3); 0·78 (NEWS2 ≥5); 0·66 (qSOFA ≥2)	0·85 (CURB-65 ≥2); 0·69 (CURB-65 ≥3); 0·93 (NEWS2 ≥5); 0·45 (qSOFA ≥2)	0·47 (CURB-65 ≥2); 0·73 (CURB-65 ≥3); 0·31 (NEWS2 ≥5); 0·484(qSOFA ≥2)	0·12 (CURB-65 ≥2); 0·17 (CURB-65 ≥3); 0·10 (NEWS2 ≥5); 0·19 (qSOFA ≥2)	0·97 (CURB-65 ≥2); 0·96 (CURB-65 ≥3); 0·98 (NEWS2 ≥5); 0·94 (qSOFA ≥2)

Note: Only common, standardised measures of validation were extracted.
AUC = area under curve score; PPV = positive predictive value; NPV = negative predictive value

Supplementary Table 5: Breakdown of inputs used tools used to screen, triage, and prognosticate COVID-19 patients.

Input	Feasible to evaluate or perform in low-resource setting emergency units?	Screening tools (n=57)		Triage tools (n=23)		Severity scoring tools (n=54)	
		No. tools using input	%	No. tools using input	%	No. tools using input	%
CONCURRENT ACUTE CONDITIONS (n=20)							
Acute renal failure	No	0	0·0%	0	0·0%	2	3·7%
Acute respiratory distress syndrome	No	0	0·0%	3	13·0%	0	0·0%
Animal/insect bites	Yes	0	0·0%	1	4·3%	0	0·0%
Bacterial coinfection	No	0	0·0%	2	8·7%	0	0·0%
Cardiac arrest	Yes	0	0·0%	2	8·7%	0	0·0%
Current level of physical fitness	Yes	0	0·0%	0	0·0%	2	3·7%
Encephalopathy	Yes	0	0·0%	1	4·3%	0	0·0%
Major trauma	Yes	0	0·0%	0	0·0%	0	0·0%
Metabolic acidosis	No	0	0·0%	1	4·3%	0	0·0%
Multilobe infiltrate	Yes	0	0·0%	0	0·0%	0	0·0%
Organ failure	No	0	0·0%	1	4·3%	2	3·7%
Pericarditis	No	0	0·0%	1	4·3%	0	0·0%
Pleural effusion	Yes	0	0·0%	0	0·0%	1	1·9%
Pneumonia	Yes	2	3·5%	3	13·0%	2	3·7%
Respiratory distress	Yes	1	1·8%	3	13·0%	2	3·7%
Pneumothorax	No	0	0·0%	3	13·0%	0	0·0%
Respiratory failure	Yes	0	0·0%	3	13·0%	4	7·4%
Septic shock	Yes	0	0·0%	3	13·0%	1	1·9%
Systemic inflammatory response syndrome (SIRS)	Yes	0	0·0%	1	4·3%	0	0·0%
Unknown clinical inputs (proprietary algorithm)	No	0	0·0%	0	0·0%	1	1·9%
CLINICAL INTERVENTIONS RECEIVED (n=5)							
Nasal intermittent positive pressure ventilation	No	0	0·0%	1	4·3%	0	0·0%
Need for supplemental oxygen	Yes	0	0·0%	1	4·3%	7	13·0%
High-flow nasal canula	No	0	0·0%	1	4·3%	0	0·0%
Mechanical ventilation	No	0	0·0%	1	4·3%	0	0·0%
Vasopressors	No	0	0·0%	1	4·3%	0	0·0%
DEMOGRAPHICS (n=7)							

Age	Yes	4	7·0%	9	**39·1%**	28	**51·9%**
Sex	Yes	2	3·5%	3	**13·0%**	12	**22·2%**
Ethnicity	Yes	0	0·0%	0	**0·0%**	2	**3·7%**
Marital status	Yes	0	0·0%	0	**0·0%**	1	**1·9%**
Pregnancy	Yes	0	0·0%	0	0·0%	1	**1·9%**
Race	Yes	0	0·0%	1	**4·3%**	1	**1·9%**
Welsh Index of Multiple Deprivation	Yes	0	0·0%	0	0·0%	1	**1·9%**
COMORBIDITIES (n=29)							
Amyotrophic lateral sclerosis	Yes	0	0·0%	1	4·3%	0	0·0%
Any comorbidity	Yes	2	3·5%	**3**	13·0%	2	3·7%
Asthma	Yes	0	0·0%	0	0·0%	1	1·9%
Atrial fibrillation	Yes	0	0·0%	0	0·0%	1	1·9%
Body mass index	Yes	1	1·8%	2	8·7%	6	11·1%
Chronic kidney disease	Yes	2	3·5%	1	4·3%	5	9·3%
Chronic obstructive lung disease	Yes	0	0·0%	2	8·7%	7	11·1%
Connective tissue disease	Yes	0	0·0%	0	0·0%	1	1·9%
Coronary artery disease / congestive heart failure	Yes	2	3·5%	1	4·3%	7	13·0%
Cystic fibrosis	Yes	0	0·0%	1	4·3%	0	0·0%
Dementia	Yes	0	0·0%	0	0·0%	1	1·9%
Depression	Yes	0	0·0%	0	0·0%	1	1·9%
Diabetes	Yes	0	0·0%	1	4·3%	6	11·1%
Functional disorder	Yes	0	0·0%	0	0·0%	1	1·9%
Hypertension	Yes	0	0·0%	3	13·0%	6	11·1%
Immunocompromise	Yes	3	5·3%	0	0·0%	4	7·4%
Liver disease	Yes	0	0·0%	0	0·0%	3	5·6%
Malignancy	Yes	0	0·0%	2	8·7%	6	11·1%
Malnutrition	Yes	0	0·0%	0	0·0%	1	1·9%
Myasthenia gravis	Yes	0	0·0%	1	4·3%	0	0·0%
Pancreatitis	Yes	0	0·0%	1	4·3%	0	0·0%
Peripheral vascular disease	Yes	0	0·0%	0	0·0%	1	1·9%
Psychiatric disorder	Yes	1	1·8%	0	0·0%	1	1·9%
Seizure disorder	Yes	0	0·0%	1	4·3%	0	0·0%
Smoking history	Yes	0	0·0%	2	8·7%	1	1·9%
Spinal muscular atrophy	Yes	0	0·0%	0	0·0%	1	1·9%
Stroke	Yes	0	0·0%	1	4·3%	1	1·9%
Transplant history	Yes	0	0·0%	0	0·0%	1	1·9%

Valvular heart disease	Yes	0	0·0%	0	0·0%	1	1·9%
LABORATORY INVESTIGATIONS (n=64)							
Albumin	No	0	0·0%	1	4·3%	3	5·6%
Alanine aminotransferase	No	0	0·0%	2	8·7%	0	0·0%
Albumin/globulin ratio	No	0	0·0%	0	0·0%	1	1·9%
Alkaline phosphatase	No	0	0·0%	1	4·3%	0	0·0%
Arterial blood gas	No	0	0·0%	2	8·7%	1	1·9%
Aspartate aminotransferase	No	0	0·0%	1	4·3%	1	1·9%
Basophil count	No	3	5·3%	1	4·3%	0	0·0%
Blood urea nitrogen	No	0	0·0%	2	8·7%	5	9·3%
C-reactive protein	No	2	3·5%	7	30·4%	14	25·9%
Calcium	No	0	0·0%	0	0·0%	1	1·9%
Cardiovascular abnormalities	No	0	0·0%	2	8·7%	0	0·0%
CD3	No	0	0·0%	0	0·0%	1	1·9%
CD4	No	0	0·0%	0	0·0%	2	3·7%
Chloride	No	0	0·0%	0	0·0%	1	1·9%
Complete blood count	No	0	0·0%	1	4·3%	0	0·0%
Creatine kinase	No	0	0·0%	0	0·0%	1	1·9%
Creatinine	No	0	0·0%	4	17·4%	5	9·3%
D-dimer	No	0	0·0%	3	13·0%	5	9·3%
Direct bilirubin	No	0	0·0%	1	4·3%	4	7·4%
Eosinophil count	No	2	3·5%	2	8·7%	0	0·0%
Erythrocyte sedimentation rate	No	0	0·0%	0	0·0%	1	1·9%
Ferritin	No	0	0·0%	1	4·3%	0	0·0%
Fibrinogen to albumin ratio	No	0	0·0%	0	0·0%	1	1·9%
Globulin	No	0	0·0%	0	0·0%	1	1·9%
Glomerular filtration rate	No	0	0·0%	0	0·0%	1	1·9%
Glucose	Yes	0	0·0%	0	0·0%	1	1·9%
Haematocrit	No	2	3·5%	0	0·0%	3	5·6%
Haemoglobin	No	2	3·5%	0	0·0%	0	0·0%
IL-2R	No	0	0·0%	0	0·0%	1	1·9%
IL-6	No	0	0·0%	0	0·0%	2	3·7%
IL-8	No	0	0·0%	0	0·0%	1	1·9%
IL-10	No	0	0·0%	0	0·0%	1	1·9%
Immature granulocyte percentage	No	1	1·8%	0	0·0%	0	0·0%
Influenza test	No	1	1·8%	0	0·0%	0	0·0%

INR	No	0	0·0%	1	4·3%	0	0·0%
Lactate	No	0	0·0%	1	4·3%	0	0·0%
Lactate dehydrogenase	No	0	0·0%	3	13·0%	11	20·4%
Leukocyte count	No	2	3·5%	1	4·3%	1	1·9%
Lymphocyte count	No	6	10·5%	4	17·4%	1	1·9%
Lymphocyte percentage	No	0	0·0%	1	4·3%	1	1·9%
Mean corpuscular haemoglobin	No	2	3·5%	0	0·0%	0	0·0%
Mean corpuscular haemoglobin concentration	No	1	1·8%	0	0·0%	0	0·0%
Mean corpuscular volume	No	3	5·3%	0	0·0%	0	0·0%
Mean platelet volume	No	1	1·8%	0	0·0%	0	0·0%
Comprehensive metabolic panel	No	0	0·0%	3	13·0%	0	0·0%
Mononuclear cell count	No	2	3·5%	0	0·0%	1	1·9%
Neutrophil count	No	1	1·8%	2	8·7%	5	9·3%
Neutrophil to lymphocyte ratio	No	1	0·0%	2	8·7%	5	9·3%
Nucleated red blood cells	No	1	1·8%	0	0·0%	0	0·0%
pH	No	0	0·0%	0	0·0%	3	5·6%
Platelet count	No	3	5·3%	3	13·0%	5	9·3%
Platelet distribution width	No	2	3·5%	0	0·0%	0	0·0%
Platelet haematocrit	No	2	3·5%	0	0·0%	0	0·0%
Potassium	No	0	0·0%	0	0·0%	4	7·4%
Prealbumin	No	0	0·0%	0	0·0%	1	1·9%
Procalcitonin	No	0	0·0%	1	4·3%	1	1·9%
Red cell count	No	0	0·0%	1	4·3%	0	0·0%
Red cell distribution width	No	2	3·5%	1	4·3%	1	1·9%
SARS-CoV-2 RT-PCR	No	9	15·8%	1	4·3%	0	0·0%
Sodium	No	0	0·0%	0	0·0%	3	5·6%
Total protein	No	0	0·0%	0	0·0%	1	1·9%
Troponin	No	0	0·0%	3	13·0%	1	1·9%
Urea	No	0	0·0%	1	4·3%	3	5·6%
White blood cell count	No	0	0·0%	2	8·7%	2	3·7%
IMAGING INVESTIGATIONS (n=3)							
Chest X-ray	No	4	7·0%	8	**34·8%**	7	13·0%
Chest CT	No	9	15·8%	10	**43·5%**	3	5·6%
Lung ultrasound	No	5	8·8%	8	**34·8%**	2	3·7%
SIGNS AND SYMPTOMS (n=37)							
Abdominal pain	Yes	0	0·0%	1	4·3%	0	0·0%

Anosmia / agueisa	Yes	4	7·0%	0	0·0%	1	1·9%
Any COVID-related symptoms	Yes	10	17·5%	1	4·3%	0	0·0%
Any respiratory symptoms	Yes	26	45·6%	0	0·0%	0	0·0%
Arthralgia	Yes	1	1·8%	0	0·0%	0	0·0%
Chest distress	Yes	2	3·5%	0	0·0%	0	0·0%
Chest pain	Yes	3	5·3%	0	0·0%	0	0·0%
Chest tightness	Yes	1	1·8%	0	0·0%	0	0·0%
Chills	Yes	6	10·5%	0	0·0%	0	0·0%
Conjunctival congestion	Yes	1	1·8%	0	0·0%	0	0·0%
Constipation	Yes	0	0·0%	1	4·3%	0	0·0%
Convulsions	Yes	0	0·0%	1	4·3%	0	0·0%
Cough	Yes	23	40·4%	0	0·0%	2	3·7%
Cyanosis	Yes	0	0·0%	1	4·3%	0	0·0%
Diarrhoea	Yes	3	5·3%	1	4·3%	0	0·0%
Dizziness	Yes	1	1·8%	0	0·0%	0	0·0%
Duration of fever	Yes	2	3·5%	0	0·0%	0	0·0%
Duration of symptoms	Yes	0	0·0%	2	8·7%	1	1·9%
Fatigue	Yes	1	1·8%	0	0·0%	1	1·9%
Fever	Yes	31	54·4%	2	8·7%	3	5·6%
Frequency of cough	Yes	1	1·8%	0	0·0%	0	0·0%
Gastrointestinal symptoms	Yes	1	1·8%	0	0·0%	0	0·0%
Haematemesis	Yes	0	0·0%	2	8·7%	0	0·0%
Haemoptysis	Yes	0	0·0%	0	0·0%	2	3·7%
Headache	Yes	1	1·8%	1	4·3%	1	1·9%
Inability to breastfeed or drink	Yes	0	0·0%	1	4·3%	0	0·0%
Myalgia	Yes	5	8·8%	0	0·0%	0	0·0%
Nasal congestion	Yes	3	5·3%	0	0·0%	1	1·9%
Nausea	Yes	1	1·8%	1	4·3%	0	0·0%
Rash	Yes	1	1·8%	0	0·0%	0	0·0%
Rhinorrhoea	Yes	2	3·5%	1	4·3%	0	0·0%
Shortness of breath	Yes	16	28·1%	0	0·0%	5	9·3%
Sore throat	Yes	5	8·8%	0	0·0%	1	1·9%
Sputum production	Yes	2	3·5%	0	0·0%	0	0·0%
Unconsciousness	Yes	0	0·0%	1	4·3%	1	1·9%
Unspecified signs and symptoms	Yes	1	1·8%	1	4·3%	0	0·0%
Vomiting	Yes	1	1·8%	1	4·3%	0	0·0%

VITAL SIGNS (n=17)							
Altered mental status	Yes	1	1·8%	3	13·0%	5	9·3%
AVPU scale	Yes	0	0·0%	1	4·3%	0	0·0%
Clinical gestalt	Yes	1	1·8%	1	4·3%	1	1·9%
Diastolic blood pressure	Yes	0	0·0%	3	13·0%	1	1·9%
Exertional oxygen saturation	Yes	0	0·0%	1	4·3%	0	0·0%
FiO2	Yes	0	0·0%	0	0·0%	1	1·9%
Glasgow Coma Scale	Yes	0	0·0%	4	17·4%	4	7·4%
Haemodynamic instability	Yes	1	1·8%	1	4·3%	0	0·0%
Heart rate	Yes	1	1·8%	4	17·4%	8	14·8%
Hypercapnia	No	1	1·8%	0	0·0%	0	0·0%
Oxygen saturation	Yes	9	15·8%	14	60·9%	8	14·8%
Pain severity	Yes	0	0·0%	1	4·3%	0	0·0%
PaO2/FIO2 < 300	No	0	0·0%	4	17·4%	0	0·0%
Respiratory rate	Yes	2	3·5%	13	56·5%	16	29·6%
Systolic blood pressure	Yes	1	1·8%	9	39·1%	9	16·7%
Temperature	Yes	17	29·8%	5	21·7%	13	24·1%
Altered mental status	Yes	1	1·8%	2	8·7%	5	9·3%
OTHER CHARACTERISTICS (n=7)							
Ability to live and walk independently	Yes	1	1·8%	0	0·0%	0	0·0%
Abnormal ECG findings	No	0	0·0%	1	4·3%	0	0·0%
Score on the Braden scale	Yes	0	0·0%	0	0·0%	0	0·0%
Epidemiological history	Yes	36	63·2%	2	8·7%	2	3·7%
Nursing home resident	Yes	0	0·0%	1	4·3%	1	1·9%
Status as a healthcare worker	Yes	2	3·5%	0	0·0%	0	0·0%
Use of prescription medications	Yes	0	0·0%	1	4·3%	0	0·0%

Supplementary Table 6: Overview of use of established prognostication tools for COVID-19.

Tool	No. inputs	Inputs	Feasible in low-resource settings?	No. studies using tool
APACHE II Score(95)	15	• Acute renal failure • Age • Creatinine • FiO2 • Glasgow Coma Scale • Haematocrit • Heart rate • History of severe organ failure or immunocompromise • Mean arterial pressure • pH • Potassium • Respiratory rate • Sodium • Temperature • White blood cell count	No	1
Clinical Frailty Score	1	• Level of physical fitness	Yes	3
CURB-65 Score for Pneumonia Severity	5	• Age • Blood urea nitrogen • Confusion • Respiratory rate • Systolic or diastolic blood pressure	No	4
Deyo-Charlson Score(96)	17	• AIDS • Any malignancy • Cerebrovascular disease • Chronic pulmonary disease • Congestive heart failure • Dementia • Diabetes with complications • Diabetes without chronic complications • Hemiplegia or paraplegia • Metastatic solid tumour • Mild liver disease • Moderate/severe liver disease • Myocardial infarction • Peptic ulcer disease • Peripheral vascular disease • Renal disease • Rheumatoid disease	Yes	1
HEWS Korean Triage and Acuity Scale(97)	17	• • Abdominal pain • Bites • Cardiac arrest • Chest pain • Constipation • Diarrhoea • Glasgow Coma Scale • Haematemesis • Headache • Major trauma	Yes	1

		• Nausea and/or vomiting • Prescription medications • Respiratory failure • Systolic blood pressure • Systemic inflammatory response syndrome (SIRS) • Temperature • Urinary tract infection		
Modified 6-Minute Walk Test(98)	1	• Distance walked in 6 minutes	Yes	1
Modified Early Warning Score (MEWS) for Clinical Deterioration(99)	5	• AVPU score • Heart rate • Respiratory rate • Systolic blood pressure • Temperature	Yes	1
MuLBSTA Score for Viral Pneumonia Mortality(100)	6	• Absolute lymphocyte count • Age • Bacterial coinfection • History of hypertension • Multilobe infiltrate • Smoking history	No	1
National Early Warning Score (NEWS)(101)	5	• Need for supplemental oxygen • Oxygen saturation • Respiratory rate • Systolic blood pressure • Temperature	Yes	4
National Early Warning Score 2 (NEWS2)(102)	7	• Consciousness • Heart rate • Hypercapnic respiratory failure • Need for supplemental oxygen • Respiratory rate • Systolic blood pressure • Temperature	Yes	5
Pneumonia Severity Index for Community Acquired Pneumonia(103)	19	• Age • Altered mental status • Blood urea nitrogen • Glucose • Haematocrit • Heart rate • History of congestive heart failure • History of liver disease history • History of renal disease • Neoplastic disease • Nursing home resident • Partial pressure of oxygen • pH • Pleural effusion on X-ray • Respiratory rate • Sex • Sodium • Systolic blood pressure • Temperature	No	1
qSOFA (Quick SOFA) Score for Sepsis(104)	3	• Glasgow Coma Scale • Respiratory rate • Systolic blood pressure	Yes	5
SEWS		•		

REFERENCES

1. Al-Tawfiq JA, Garout MA, Gautret P. Preparing for emerging respiratory pathogens such as SARS-CoV, MERS-CoV, and SARS-CoV-2. Infez Med. 2020;28(suppl 1):64-70.
2. Aldobyany A, Touman A, Ghaleb N, et al. Correlation Between the COVID-19 Respiratory Triage Score and SARS-COV-2 PCR Test. Front Med (Lausanne) 2020;7:605689. doi: 10.3389/fmed.2020.605689
3. Agarwal A, Nagi N, Chatterjee P, Sarkar S, Mourya D, Sahay RR, et al. Guidance for building a dedicated health facility to contain the spread of the 2019 novel coronavirus outbreak. Indian J Med Res. 2020;151(2 & 3):177-83.
4. Augustin M, Schommers P, Suarez I, Koehler P, Gruell H, Klein F, et al. Rapid response infrastructure for pandemic preparedness in a tertiary care hospital: lessons learned from the COVID-19 outbreak in Cologne, Germany, February to March 2020. Euro Surveill. 2020;25(21).
5. Ayebare RR, Flick R, Okware S, Bodo B, Lamorde M. Adoption of COVID-19 triage strategies for low-income settings. Lancet Respir Med. 2020;8(4):e22.
6. Cabitza F, Campagner A, Ferrari D, et al. Development, evaluation, and validation of machine learning models for COVID-19 detection based on routine blood tests. Clinical Chemistry and Laboratory Medicine 2021;59(2):421-31. doi: 10.1515/cclm-2020-1294
7. Cao Y, Li Q, Chen J, Guo X, Miao C, Yang H, et al. Hospital Emergency Management Plan During the COVID-19 Epidemic. Acad Emerg Med. 2020;27(4):309-11.
8. Carenzo L, Costantini E, Greco M, Barra FL, Rendiniello V, Mainetti M, et al. Hospital surge capacity in a tertiary emergency referral centre during the COVID-19 outbreak in Italy. Anaesthesia. 2020;75(7):928-34.
9. Standard Operating Procedure for Triage of suspected COVID-19 patients in non-US Healthcare settings. Atlanta: Centers for Disease Control and Prevention.
10. Chan PF, Lai KPL, Chao DVK, Fung SCK. Enhancing the triage and cohort of patients in public primary care clinics in response to the coronavirus disease 2019 (COVID-19) in Hong Kong: an experience from a hospital cluster. BJGP Open. 2020;4(2).
11. Chang YT, Lin CY, Tsai MJ, Hung CT, Hsu CW, Lu PL, et al. Infection control measures of a Taiwanese hospital to confront the COVID-19 pandemic. Kaohsiung J Med Sci. 2020;36(5):296-304.
12. Chen S, Zhang Z, Yang J, Wang J, Zhai X, Barnighausen T, et al. Fangcang shelter hospitals: a novel concept for responding to public health emergencies. Lancet. 2020;395(10232):1305-14.
13. Cheng VCC, Wong SC, Chen JHK, Yip CCY, Chuang VWM, Tsang OTY, et al. Escalating infection control response to the rapidly evolving epidemiology of the coronavirus disease 2019 (COVID-19) due to SARS-CoV-2 in Hong Kong. Infect Control Hosp Epidemiol. 2020;41(5):493-8.
14. Chou E, Hsieh YL, Wolfshohl J, Green F, Bhakta T. Onsite telemedicine strategy for coronavirus (COVID-19) screening to limit exposure in ED. Emerg Med J. 2020;37(6):335-7.
15. Chowdhury JM, Patel M, Zheng M, Abramian O, Criner GJ. Mobilization and Preparation of a Large Urban Academic Center during the COVID-19 Pandemic. Ann Am Thorac Soc. 2020;17(8):922-5.
16. Chung HS, Lee DE, Kim JK, Yeo IH, Kim C, Park J, et al. Revised Triage and Surveillance Protocols for Temporary Emergency Department Closures in Tertiary Hospitals as a Response to COVID-19 Crisis in Daegu Metropolitan City. J Korean Med Sci. 2020;35(19):e189.
17. Devrim I, Bayram N. Infection control practices in children during COVID-19 pandemic: Differences from adults. Am J Infect Control. 2020;48(8):933-9.7.

18. Duca A, Piva S, Foca E, Latronico N, Rizzi M. Calculated Decisions: Brescia-COVID Respiratory Severity Scale (BCRSS)/Algorithm. Emerg Med Pract. 2020;22(5 Suppl):CD1-CD2.
19. Erika P, Andrea V, Cillis MG, Ioannilli E, Iannicelli T, Andrea M. Triage decision-making at the time of COVID-19 infection: the Piacenza strategy. Intern Emerg Med. 2020;15(5):879-82.
20. Gibbons RC, Magee M, Goett H, et al. Lung Ultrasound vs. Chest X-Ray Study for the Radiographic Diagnosis of COVID-19 Pneumonia in a High-Prevalence Population. J Emerg Med 2021 doi: 10.1016/j.jemermed.2021.01.041
21. Gilbert A, Brasseur E, Petit M, Donneau AF, Diep A, Hetzel Campbell S, et al. Immersion in an emergency department triage center during the Covid-19 outbreak: first report of the Liege University hospital experience. Acta Clin Belg. 2020:1-7.
22. Guo F, Du Z, Wang T. An effective screening and management process in the outpatient clinic for patients requiring hospitalization during the COVID-19 pandemic. J Med Virol. 2020.
23. He H, Hu C, Xiong N, Liu C, Huang X. How to transform a general hospital into an "infectious disease hospital" during the epidemic of COVID-19. Crit Care. 2020;24(1).
24. Howitt R, de Jesus GA, Araujo F, Francis J, Marr I, McVean M, et al. Screening and triage at health-care facilities in Timor-Leste during the COVID-19 pandemic. Lancet Respir Med. 2020;8(6):e43.
25. Huang T, Guo Y, Li S, Zheng Y, Lei L, Zeng X, et al. Application and effects of fever screening system in the prevention of nosocomial infection in the only designated hospital of coronavirus disease 2019 (COVID-19) in Shenzhen, China. Infect Control Hosp Epidemiol. 2020;41(8):978-81.
26. Jaffe E, Stugo R, Bin E, Blustein O, Rosenblat I, Alpert E, et al. The role of emergency medical services in containing COVID-19. J Emerg Med. 2020;38:1526-7.
27. Karimi A, Tabatabaei S, Rajabnejad, Pourmoghaddas Z, Rahimi H, Armin S, et al. An algorithmic approach to diagnosis and treatment of coronavirus disease 2019 (COVID-19) in children: Iranian expert's consensus statement. Arch Pediatr Infect Dis. 2020.
28. Koenig KL, Bey CK, McDonald EC. 2019-nCoV: The Identify-Isolate-Inform (3I) Tool Applied to a Novel Emerging Coronavirus. West J Emerg Med. 2020;21(2):184-90.
29. Li T. Diagnosis and clinical management of severe acute respiratory syndrome Coronavirus 2 (SARS-CoV-2) infection: an operational recommendation of Peking Union Medical College Hospital (V2.0). Emerg Microbes Infect. 2020;9(1):582-5.
30. Lin CH, Tseng WP, Wu JL, Tay J, Cheng MT, Ong HN, et al. A Double Triage and Telemedicine Protocol to Optimize Infection Control in an Emergency Department in Taiwan During the COVID-19 Pandemic: Retrospective Feasibility Study. J Med Internet Res. 2020;22(6):e20586.
31. Liu L, Hong X, Su X, Chen H, Zhang D, Tang S, et al. Optimizing screening strategies for coronavirus disease 2019: A study from Middle China. J Infect Public Health. 2020;13(6):868-72.
32. Liu Y, Wang Z, Ren J, Tian Y, Zhou M, Zhou T, et al. A COVID-19 Risk Assessment Decision Support System for General Practitioners: Design and Development Study. J Med Internet Res. 2020;22(6):e19786.
30. Meschi T, Rossi S, Volpi A, Ferrari C, Sverzellati N, Brianti E, et al. Reorganization of a large academic hospital to face COVID-19 outbreak: The model of Parma, Emilia-Romagna region, Italy. Eur J Clin Invest. 2020;50(6):e13250.
31. Möckel M, Bachmann U, Behringer W, Pfafflin F, Stegemann MS. How emergency departments prepare for virus disease outbreaks like COVID-19. Eur J Emerg Med. 2020;27(3):161-2.

32. Nayan N, Kumar MK, Nair RK, et al. Clinical Triaging in Cough Clinic Alleviates COVID-19 Overload in Emergency Department in India. SN Compr Clin Med 2021:1-6. doi: 10.1007/s42399-020-00705-2
33. Nicastro E, Mazza A, Gervasoni A, Di Giorgio A, D'Antiga L. A Pediatric Emergency Department Protocol to Avoid Intrahospital Spread of SARS-CoV-2 during the Outbreak in Bergamo, Italy. J Pediatr. 2020;222:231-5.
34. Piliego C, Strumia A, Stone MB, Pascarella G. The ultrasound guided triage: a new tool for prehospital management of COVID-19 pandemic. Anesth Analg. 2020.
35. Pu H, Xu Y, Doig G, Zhou Y. Screening and managing of suspected or confirmed novel coronavirus (COVID-19) patients: experiences from a tertiary hospital outside Hubei province. 2020.
36. Quah LJJ, Tan BKK, Fua TP, Wee CPJ, Lim CS, Nadarajan G, et al. Reorganising the emergency department to manage the COVID-19 outbreak. Int J Emerg Med. 2020;13(1):32.
37. Romero-Gameros CA, Colin-MartÌnez T, Waizel-Haiat S, et al. Diagnostic accuracy of symptoms as a diagnostic tool for SARS-CoV 2 infection: a cross-sectional study in a cohort of 2,173 patients. BMC Infect Dis 2021;21(1):255. doi: 10.1186/s12879-021-05930-1
38. Schwedhelm MM, Herstein JJ, Watson SM, Mead AL, Maddalena L, Liston DD, et al. Can You Catch It? Lessons Learned and Modification of ED Triage Symptom- and Travel-Screening Strategy. J Emerg Nurs. 2020.
39. Shen Y, Cui Y, Li N, Tian C, Chen M, Zhang YW, et al. Emergency Responses to Covid-19 Outbreak: Experiences and Lessons from a General Hospital in Nanjing, China. Cardiovasc Intervent Radiol. 2020;43(6):810-9.
40. Shi Y, Wang X, Liu G, Zhu Q, Wang J, Yu H, et al. A quickly, effectively screening process of novel corona virus disease 2019 (COVID-19) in children in Shanghai, China. Ann Transl Med. 2020;8(5):241.
41. Spina S, Marrazzo F, Migliari M, Stucchi R, Sforza A, Fumagalli R. The response of Milan's Emergency Medical System to the COVID-19 outbreak in Italy. Lancet. 2020;395(10227):e49-e50.
42. Tan GSE, Ang H, Manauis CM, Chua JM, Gao CQ, Ng FKK, et al. Reducing hospital admissions for COVID-19 at a dedicated screening centre in Singapore. Clin Microbiol Infect. 2020;26(9):1278-9.
43. Wang Q, Wang X, Lin H. The role of triage in the prevention and control of COVID-19 Infect Control Hosp Epidemiol. 2020:1-5.
44. Wang X, Chen Y, Li Z, Wang D, Wang Y. Providing uninterrupted care during COVID-19 pandemic: experience from Beijing Tiantan Hospital. Stroke Vasc Neurol. 2020;5(2):180-4.
45. Wee LE, Fua TP, Chua YY, Ho AFW, Sim XYJ, Conceicao EP, et al. Containing COVID-19 in the Emergency Department: The Role of Improved Case Detection and Segregation of Suspect Cases. Acad Emerg Med. 2020;27(5):379-87.
46. Whiteside T, Kane E, Aljohani B, Alsamman M, Pourmand A. Redesigning emergency department operations amidst a viral pandemic. Am J Emerg Med. 2020;38(7):1448-53.
47. Clinical management of severe acute respiratory infection (SARI) when COVID-19 disease is suspected. Interim guidance, 13 March 2020. Geneva: World Health Organization; 2020.
48. Wu X, Zhou H, Wu X, Huang W, Jia B. Strategies for qualified triage stations and fever clinics during the outbreak of COVID-2019 in the county hospitals of Western Chongqing. J Hosp Infect. 2020;105(2):128-9.

49. Zhang J, Zhou L, Yang Y, Peng W, Wang W, Chen X. Therapeutic and triage strategies for 2019 novel coronavirus disease in fever clinics. Lancet Respir Med. 2020;8(3):e11-e2.
50. Zhang N, Deng Y, Li W, Liu J, Li H, Liu E, et al. Analysis and suggestions for the preview and triage screening of children with suspected COVID-19 outside the epidemic area of Hubei Province. Transl Pediatr. 2020;9(2):126-32.
51. Zhao Y, Cui C, Zhang K, Liu J, Xu J, Nisenbaum E, et al. COVID19: A Systematic Approach to Early Identification and Healthcare Worker Protection. Front Public Health. 2020;8:205.
52. Zhou TT, Wei FX. Primary stratification and identification of suspected Corona virus disease 2019 (COVID-19) from clinical perspective by a simple scoring proposal. Mil Med Res. 2020;7(1):16.
53. Zimmerman RK, Nowalk MP, Bear T, Taber R, Sax TM, Eng H, et al. Proposed Clinical Indicators for Efficient Screening and Testing for COVID-19 Infection from Classification and Regression Trees (CART) Analysis. medRxiv. 2020.
54. Zou T, Yin W, Kang Y. Application of Critical Care Ultrasound in Patients With COVID-19: Our Experience and Perspective. IEEE Trans Ultrason Ferroelectr Freq Control 2020;67(11):2197-206. doi: 10.1109/TUFFC.2020.3020628
55. Abrams ER, Rose G, Fields JM, et al. Point-of-Care Ultrasound in the Evaluation of COVID-19. J Emerg Med 2020;59(3):403-08. doi: 10.1016/j.jemermed.2020.06.032
56. Emergency Department COVID-19 Severity Classi-cation: American College of Emergency Physicians; [Available from: https://www.acep.org/globalassets/sites/acep/media/covid-19-main/acep_evidencecare_covid19severitytool.pdf.
57. Côté A, Ternacle J, Pibarot P. Early prediction of the risk of severe coronavirus disease 2019: A key step in therapeutic decision making. EBioMedicine. 2020;59:102948.
58. Duggan NM, Liteplo AS, Shokoohi H, et al. Using Lung Point-of-care Ultrasound in Suspected COVID-19: Case Series and Proposed Triage Algorithm. Clinical practice and cases in emergency medicine 2020;4(3):289-94. doi: https://dx.doi.org/10.5811/cpcem.2020.7.47912
59. Eggleton EJ. Simple, fast and affordable triaging pathway for COVID-19. Postgrad Med J 2021;97(1145):192-95. doi: 10.1136/postgradmedj-2020-138029
60. Her M. How Is COVID-19 Affecting South Korea? What Is Our Current Strategy? Disaster Med Public Health Prep 2020;14(5):684-86. doi: 10.1017/dmp.2020.69
61. Manivel V, Lesnewski A, Shamim S, Carbonatto G, Govindan T. CLUE: COVID-19 lung ultrasound in emergency department. Emerg Med Australas. 2020;32(4):694-6.
62. Mantha S, Tripuraneni SL, Roizen MF, Fleisher LA. Proposed Modifications in the 6-Minute Walk Test for Potential Application in Patients With Mild COVID-19: A Step to Optimize Triage Guidelines. Anesth Analg. 2020;131(2):398-402.
63. Momeni-Boroujeni A, Mendoza R, Stopard IJ, et al. A Dynamic Bayesian Model for Identifying High-Mortality Risk in Hospitalized COVID-19 Patients. Infect Dis Rep 2021;13(1):239-50. doi: 10.3390/idr13010027
64. Rajalingam B, Narayanan E, Nirmalan P, et al. Pattern recognition of high-resolution computer tomography (HRCT) chest to guide clinical management in patients with mild to moderate COVID-19. Indian J Radiol Imaging 2021;31(Suppl 1):S110-S18. doi: 10.4103/ijri.IJRI_774_20
65. Sun H, Jain A, Leone MJ, Alabsi HS, Brenner LN, Ye E, et al. COVID-19 Outpatient Screening: a Prediction Score for Adverse Events. medRxiv. 2020.
66. Sun Q, Qiu H, Huang M, Yang Y. Lower mortality of COVID-19 by early recognition and intervention: experience from Jiangsu Province. Ann Intensive Care. 2020;10(1):33.

67. Ali R, Qayyum F, Ahmed N, et al. Isaric 4c Mortality Score As A Predictor Of In-Hospital Mortality In Covid-19 Patients Admitted In Ayub Teaching Hospital During First Wave Of The Pandemic. J Ayub Med Coll Abbottabad 2021;33(1):20-25.
68. Bartoletti M, Giannella M, Scudeller L, Tedeschi S, Rinaldi M, Bussini L, et al. Development and validation of a prediction model for severe respiratory failure in hospitalized patients with SARS-CoV-2 infection: a multicentre cohort study (PREDI-CO study). Clin Microbiol Infect. 2020.
69. Brahier T, Meuwly JY, Pantet O, et al. Lung ultrasonography for risk stratification in patients with COVID-19: a prospective observational cohort study. Clin Infect Dis 2020 doi: 10.1093/cid/ciaa1408
70. Bi X, Su Z, Yan H, Du J, Wang J, Chen L, et al. Prediction of severe illness due to COVID-19 based on an analysis of initial Fibrinogen to Albumin Ratio and Platelet count. Platelets. 2020;31(5):674-9.
71. Cozzi D, Albanesi M, Cavigli E, Moroni C, Bindi A, Luvara S, et al. Chest X-ray in new Coronavirus Disease 2019 (COVID-19) infection: findings and correlation with clinical outcome. Radiol Med. 2020;125(8):730-7.
72. Das AK, Mishra S, Saraswathy Gopalan S. Predicting CoVID-19 community mortality risk using machine learning and development of an online prognostic tool. PeerJ 2020;8:e10083. doi: 10.7717/peerj.10083
73. Dong Y, Zhou H, Li M, Zhang Z, Guo W, Yu T, et al. A novel simple scoring model for predicting severity of patients with SARS-CoV-2 infection. Transbound Emerg Dis. 2020.
74. Duan J, Wang X, Chi J, et al. Correlation between the variables collected at admission and progression to severe cases during hospitalization among patients with COVID-19 in Chongqing. J Med Virol 2020;92(11):2616-22. doi: 10.1002/jmv.26082
75. Fernandes FT, de Oliveira TA, Teixeira CE, et al. A multipurpose machine learning approach to predict COVID-19 negative prognosis in S,,o Paulo, Brazil. Sci Rep 2021;11(1):3343. doi: 10.1038/s41598-021-82885-y
76. Frost F, Bradley P, Tharmaratnam K, Wootton D. The utility of established prognostic scores in COVID-19 hospital admissions: a multicentre prospective evaluation of CURB-65, NEWS2, and qSOFA. 2020.
77. Galloway J, Norton S, Barker R, Brookes A, Carey I, Xlarke B, et al. A clinical risk score to identify patients with COVID-19 at high risk of critical care admission or death: An observational cohort study. J Infect. 2020;81(2):282-8.
78. Jang JG, Ahn JH. The Author's Response: Prognostic Accuracy of the SIRS, qSOFA, and NEWS for Early Detection of Clinical Deterioration in SARS-CoV-2 Infected Patients. J Korean Med Sci. 2020;35(30):e275.
79. Gidari A, De Socio GV, Sabbatini S, Francisci D. Predictive value of National Early Warning Score 2 (NEWS2) for intensive care unit admission in patients with SARS-CoV-2 infection. Infect Dis (Lond). 2020;52(10):698-704.
80. Gong J, Ou J, Qui X, Jie Y, Chen Y, Yuan L, et al. A Tool for Early Prediction of Severe Coronavirus Disease 2019 (COVID-19): A Multicenter Study Using the Risk Nomogram in Wuhan and Guangdong, China Clinical Infectious Diseases. 2020;71(15):833-
81. Gude-Sampedro F, Fern·ndez-Merino C, Ferreiro L, et al. Development and validation of a prognostic model based on comorbidities to predict COVID-19 severity: a population-based study. Int J Epidemiol 2021;50(1):64-74. doi: 10.1093/ije/dyaa209
82. Gupta N, Ish P, Kumar R, et al. Evaluation of the clinical profile, laboratory parameters and outcome of two hundred COVID-19 patients from a tertiary centre in India. Monaldi Arch Chest Dis 2020;90(4) doi: 10.4081/monaldi.2020.1507
83. Haimovich A, Ravindra N, Stoytchew S, Young H, Wilson F, van Dijk D, et al.

Development and validation of the quick COVID-19 severity index (qCSI): a prognostic tool for early clinical decompensation. Ann Emerg Med. 2020.
84. Hu H, Yao N, Qiu Y. Predictive Value of 5 Early Warning Scores for Critical COVID-19 Patients. Disaster Med Public Health Prep 2020:1-8. doi: 10.1017/dmp.2020.324
85. Huespe I, Bisso I, Gemeli N, Terrasa S, Di Stefano S, Biurgos V, et al. COVID-19 Severity Index: predictive score for hospitalized patients. 2020.
86. Ihle-Hansen H, Berge T, Tveita A, Ronning EJ, Erno PE, Andersen EL, et al. COVID-19: Symptoms, course of illness and use of clinical scoring systems for the first 42 patients admitted to a Norwegian local hospital. Tidsskr Nor Laegeforen. 2020;140(7).
87. Izquierdo JL, Ancochea J, Soriano JB. Clinical Characteristics and Prognostic Factors for Intensive Care Unit Admission of Patients With COVID-19: Retrospective Study Using Machine Learning and Natural Language Processing. J Med Internet Res 2020;22(10):e21801. doi: 10.2196/21801
88. Jehi L, Ji X, Milinovich A, Erzurum S, Merlino A, Gordon S, et al. Development and validation of a model for individualized prediction of hospitalization risk in 4,536 patients with COVID-19. PLoS One. 2020;15(8):e0237419.
89. Kaleemi R, Hilal K, Arshad A, et al. The association of chest radiographic findings and severity scoring with clinical outcomes in patients with COVID-19 presenting to the emergency department of a tertiary care hospital in Pakistan. PLoS One 2021;16(1):e0244886. doi: 10.1371/journal.pone.0244886
90. Kostakis I, Smith GB, Prytherch D, et al. The performance of the National Early Warning Score and National Early Warning Score 2 in hospitalised patients infected by the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2). Resuscitation 2021;159:150-57. doi: 10.1016/j.resuscitation.2020.10.039
91. Labenz C, Kremer WM, Schattenberg JM, Worns MA, Toenges G, Weinmann A, et al. Clinical Frailty Scale for risk stratification in patients with SARS-CoV-2 infection. J Investig Med. 2020;68(6):1199-202.
92. Levenfus I, Ullmann E, Battegay E, Schuurmans MM. Triage tool for suspected COVID-19 patients in the emergency room: AIFELL score. Braz J Infect Dis. 2020.
93. Li Q, Zhang J, Ling Y, Li W, Zhang X, Lu H, et al. A simple algorithm helps early identification of SARS-CoV-2 infection patients with severe progression tendency. Infection. 2020;48(4):577-84.
94. Liang W, Liang H, Ou L, Chen B, Chen A, Li C, et al. Development and Validation of a Clinical Risk Score to Predict the Occurrence of Critical Illness in Hospitalized Patients With COVID-19. JAMA Intern Med. 2020;180(8):1081-9.
95. Liang W, Yao J, Chen A, Lv Q, Zanin M, Liu J, et al. Early triage of critically ill COVID-19 patients using deep learning. Nat Commun. 2020;11(1):3543.
96. Ma J, Shi X, Xu W, Lv F, Wu J, Pan Q, et al. Development and validation of a risk stratification model for screening suspected cases of COVID-19 in China. Aging (Albany NY). 2020;12(14):13882-94.
97. Myrstad M, Ihle-Hansen H, Tveita AA, Andersen EL, Nygard S, Tveit A, et al. National Early Warning Score 2 (NEWS2) on admission predicts severe disease and in-hospital mortality from Covid-19 - a prospective cohort study. Scand J Trauma Resusc Emerg Med. 2020;28(1):66.
98. Nagant C, Ponthieux F, Smet J, et al. A score combining early detection of cytokines accurately predicts COVID-19 severity and intensive care unit transfer. International Journal of Infectious Diseases 2020;101:342-45. doi: 10.1016/j.ijid.2020.10.003
99. Nguyen Y, Corre F, Honsel V, Curac S, Zarrouk V, Burtz CP, et al. A nomogram to predict the risk of unfavourable outcome in COVID-19: a retrospective cohort of 279 hospitalized patients in Paris area. Ann Med. 2020;52(7):367-75.

100. Osborne TF, Veigulis ZP, Arreola DM, Roosli E, Curtin CM. Automated EHR score to predict COVID-19 outcomes at US Department of Veterans Affairs. PLoS One. 2020;15(7):e0236554.
101. Peng X, Subbe CP, Zhang L, Luo Z, Peng L. NEWS can predict deterioration of patients with COVID-19. Resuscitation. 2020;152:26-7.
102. Ponsford MJ, Burton RJ, Smith L, et al. Examining the utility of extended laboratory panel testing in the emergency department for risk stratification of patients with COVID-19: a single-centre retrospective service evaluation. J Clin Pathol 2021 doi: 10.1136/jclinpath-2020-207157
103. Sablerolles RSG, Lafeber M, van Kempen JAL, et al. Association between Clinical Frailty Scale score and hospital mortality in adult patients with COVID-19 (COMET): an international, multicentre, retrospective, observational cohort study. Lancet Healthy Longev 2021;2(3):e163-e70. doi: 10.1016/S2666-7568(21)00006-4
104. Satici C, Demirkol MA, Sargin Altunok E, Gursoy B, Alkan M, Kamat S, et al. Performance of pneumonia severity index and CURB-65 in predicting 30-day mortality in patients with COVID-19. Int J Infect Dis. 2020;98:84-9.
105. Schalekamp S, Huisman M, van Dijk RA, Boomsma MF, Freire Jorge PJ, de Boer WS, et al. Model-based Prediction of Critical Illness in Hospitalized Patients with COVID-19. Radiology. 2020:202723.
106. Shang JG, Hur J, Hong KS, Lee W, Ahn JH. Prognostic Accuracy of the SIRS, qSOFA, and NEWS for Early Detection of Clinical Deterioration in SARS-CoV-2 Infected Patients. J Korean Med Sci. 2020;35(25):e234.
107. Singh K, Valley T, Tang S, Li B, Kamran F, Sjoding M, et al. Evaluating a Widely Implemented Proprietary Deterioration Index Model Among Hospitalized COVID-19 Patients. 2020.
108. Sung J, Choudry N, Bachour R. Development and validation of a simple risk score for diagnosing COVID-19 in the emergency room. Epidemiol Infect 2020;148:e273. doi: 10.1017/S0950268820002769
109. Tang G, Luo Y, Lu F, et al. Prediction of Sepsis in COVID-19 Using Laboratory Indicators. Front Cell Infect Microbiol 2020;10:586054. doi: 10.3389/fcimb.2020.586054
110. Tsui E, Lui C, Woo P, Cheung A, Lam P, Tang T, et al. Development of a data-driven COVID-19 prognostication tool to inform triage and step-down care for hospitalised patients in Hong Kong: A population based cohort study. 2020.
111. Wollenstein-Betech S, Cassandras CG, Paschalidis IC. Personalized predictive models for symptomatic COVID-19 patients using basic preconditions: Hospitalizations, mortality, and the need for an ICU or ventilator. Int J Med Inform 2020;142:104258. doi: 10.1016/j.ijmedinf.2020.104258
112. Wu G, Yang P, Xie Y, Woodruff HC, Rao X, Guiot J, et al. Development of a clinical decision support system for severity risk prediction and triage of COVID-19 patients at hospital admission: an international multicentre study. Eur Respir J. 2020;56(2).
113. Xiao LS, Zhang WF, Gong MC, Zhang YP, Chen LY, Zhu HB, et al. Development and validation of the HNC-LL score for predicting the severity of coronavirus disease 2019. EBioMedicine. 2020;57:102880.
114. Yasukawa K, Minami T, Boulware DR, et al. Point-of-Care Lung Ultrasound for COVID-19: Findings and Prognostic Implications From 105 Consecutive Patients. J Intensive Care Med 2021;36(3):334-42. doi: 10.1177/0885066620988831
115. Zhang C, Qin L, Li K, Wang Q, Zhao Y, Xu B, et al. A Novel Scoring System for Prediction of Disease Severity in COVID-19. Front Cell Infect Microbiol. 2020;10:318.
116. Zhang S, Guo M, Duan L, Wu F, Hu G, Wang Z, et al. Development and validation of a risk factor-based system to predict short-term survival in adult hospitalized patients with COVID-19: a multicenter, retrospective, cohort study. Crit Care. 2020;24(1):438.

117. Zhao L, Yu K, Zhao Q, Tian R, Xie H, Xie L, et al. Lung Ultrasound Score in Evaluating the Severity of Coronavirus Disease 2019 (COVID-19) Pneumonia. Ultrasound Med Biol. 2020.
118. Zhou Y, He Y, Yang H, Yu H, Wang T, Chen Z, et al. Development and validation a nomogram for predicting the risk of severe COVID-19: A multi-center study in Sichuan, China. PLoS One. 2020;15(5):e0233328.
119. Zhu JS, Ge P, Jiang C, Zhang Y, Li X, Zhao Z, et al. Deep-learning artificial intelligence analysis of clinical variables predicts mortality in COVID-19 patients. J Am Coll Emerg Physicians Open. 2020.
120. Zou X, Li S, Fang M, Hu M, Bian Y, Ling J, et al. Acute Physiology and Chronic Health Evaluation II Score as a Predictor of Hospital Mortality in Patients of Coronavirus Disease 2019. Crit Care Med. 2020;48(8):e657-e65.
121. APACHE II Score: MDCalc; [Available from: https://www.mdcalc.com/apache-ii-score.
122. Ladha KS, Zhao K, Quraishi SA, Kurth T, Eikermann M, Kaafarani HM, et al. The Deyo-Charlson and Elixhauser-van Walraven Comorbidity Indices as predictors of mortality in critically ill patients. BMJ Open. 2015;5(9):e008990.
123. Ryu JH, Min MK, Lee DS, Yeom SR, Lee SH, Wang IJ, et al. Changes in Relative Importance of the 5-Level Triage System, Korean Triage and Acuity Scale, for the Disposition of Emergency Patients Induced by Forced Reduction in Its Level Number: a Multi-Center Registry-based Retrospective Cohort Study. J Korean Med Sci. 2019;34(14):e114.
124. Laboratories ATSCoPSfCPF. ATS statement: guidelines for the six-minute walk test. Am J Respir Crit Care Med. 2002;166(1):111-7.
126. Modified Early Warning Score (MEWS) for Clinical Deterioration: MDCalc; [Available from: https://www.mdcalc.com/modified-early-warning-score-mews-clinical-deterioration.
125. MuLBSTA Score for Viral Pneumonia Mortality: MDCalc; [Available from: https://www.mdcalc.com/mulbsta-score-viral-pneumonia-mortality.
126. National Early Warning Score (NEWS): MDCalc; [Available from: https://www.mdcalc.com/national-early-warning-score-news.
127. National Early Warning Score (NEWS) 2: MDCalc; [Available from: https://www.mdcalc.com/national-early-warning-score-news-2.
128. PSI/PORT Score: Pneumonia Severity Index for CAP: MDCalc; [Available from: https://www.mdcalc.com/psi-port-score-pneumonia-severity-index-cap.
129. qSOFA (Quick SOFA) Score for Sepsis: MDCalc; [Available from: https://www.mdcalc.com/qsofa-quick-sofa-score-sepsis.

1Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR) Checklist

SECTION	ITEM	PRISMA-ScR CHECKLIST ITEM	REPORTED ON PAGE #
TITLE			
Title	1	Identify the report as a scoping review.	1
ABSTRACT			
Structured summary	2	Provide a structured summary that includes (as applicable): background, objectives, eligibility criteria, sources of evidence, charting methods, results, and conclusions that relate to the review questions and objectives.	2
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of what is already known. Explain why the review questions/objectives lend themselves to a scoping review approach.	4
Objectives	4	Provide an explicit statement of the questions and objectives being addressed with reference to their key elements (e.g., population or participants, concepts, and context) or other relevant key elements used to conceptualize the review questions and/or objectives.	4
METHODS			
Protocol and registration	5	Indicate whether a review protocol exists; state if and where it can be accessed (e.g., a Web address); and if available, provide registration information, including the registration number.	4
Eligibility criteria	6	Specify characteristics of the sources of evidence used as eligibility criteria (e.g., years considered, language, and publication status), and provide a rationale.	5
Information sources*	7	Describe all information sources in the search (e.g., databases with dates of coverage and contact with authors to identify additional sources), as well as the date the most recent search was executed.	4
Search	8	Present the full electronic search strategy for at least 1 database, including any limits used, such that it could be repeated.	4
Selection of sources of evidence†	9	State the process for selecting sources of evidence (i.e., screening and eligibility) included in the scoping review.	5
Data charting process‡	10	Describe the methods of charting data from the included sources of evidence (e.g., calibrated forms or forms that have been tested by the team before their use, and whether data charting was done independently or in duplicate) and any processes for obtaining and confirming data from investigators.	5
Data items	11	List and define all variables for which data were sought and any assumptions and simplifications made.	4
Critical appraisal of individual sources of evidence§	12	If done, provide a rationale for conducting a critical appraisal of included sources of evidence; describe the methods used and how this information was used in any data synthesis (if appropriate).	N/A

SECTION	ITEM	PRISMA-ScR CHECKLIST ITEM	REPORTED ON PAGE #
Synthesis of results	13	Describe the methods of handling and summarizing the data that were charted.	5
RESULTS			
Selection of sources of evidence	14	Give numbers of sources of evidence screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally using a flow diagram.	5
Characteristics of sources of evidence	15	For each source of evidence, present characteristics for which data were charted and provide the citations.	5-6
Critical appraisal within sources of evidence	16	If done, present data on critical appraisal of included sources of evidence (see item 12).	N/A
Results of individual sources of evidence	17	For each included source of evidence, present the relevant data that were charted that relate to the review questions and objectives.	6
Synthesis of results	18	Summarize and/or present the charting results as they relate to the review questions and objectives.	6
DISCUSSION			
Summary of evidence	19	Summarize the main results (including an overview of concepts, themes, and types of evidence available), link to the review questions and objectives, and consider the relevance to key groups.	7
Limitations	20	Discuss the limitations of the scoping review process.	8-9
Conclusions	21	Provide a general interpretation of the results with respect to the review questions and objectives, as well as potential implications and/or next steps.	9
FUNDING			
Funding	22	Describe sources of funding for the included sources of evidence, as well as sources of funding for the scoping review. Describe the role of the funders of the scoping review.	9

JBI = Joanna Briggs Institute; PRISMA-ScR = Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews.
* Where *sources of evidence* (see second footnote) are compiled from, such as bibliographic databases, social media platforms, and Web sites.
† A more inclusive/heterogeneous term used to account for the different types of evidence or data sources (e.g., quantitative and/or qualitative research, expert opinion, and policy documents) that may be eligible in a scoping review as opposed to only studies. This is not to be confused with *information sources* (see first footnote).
‡ The frameworks by Arksey and O'Malley (6) and Levac and colleagues (7) and the JBI guidance (4, 5) refer to the process of data extraction in a scoping review as data charting.
§ The process of systematically examining research evidence to assess its validity, results, and relevance before using it to inform a decision. This term is used for items 12 and 19 instead of "risk of bias" (which is more applicable to systematic reviews of interventions) to include and acknowledge the various sources of evidence that may be used in a scoping review (e.g., quantitative and/or qualitative research, expert opinion, and policy document).

From: Tricco AC, Lillie E, Zarin W, O'Brien KK, Colquhoun H, Levac D, et al. PRISMA Extension for Scoping Reviews (PRISMAScR): Checklist and Explanation. Ann Intern Med. 2018;169:467–473. doi: 10.7326/M18-0850.