Received: 9 April 2020 | Revised: 10 July 2020 | Accepted: 14 July 2020

DOI: 10.1002/emp2.12210

JACEP OPEN WILEY

REVIEW ARTICLE

Infectious Disease

An adapted emergency department triage algorithm for the COVID-19 pandemic

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Funding and support: By *JACEP Open* policy, all authors are required to disclose any and all commercial, financial, and other relationships in any way related to the subject of this article as per ICMJE conflict of interest guidelines (see www.icmje.org). The authors have stated that no such relationships exist.

Abstract

The novel coronavirus disease 2019 (COVID-19) pandemic, with its public health implications, high case fatality rate, and strain on hospital resources, will continue to challenge clinicians and researchers alike for months to come. Accurate triage of patients during the pandemic will assign patients to the appropriate level of care, provide the best care for the maximum number of patients, rationally limit personal protective equipment (PPE) usage, and mitigate nosocomial exposures. The authors describe an adapted COVID-19 pandemic triage algorithm for emergency departments (EDs) guided by the best available evidence and responses to prior pandemics, with recommendations for clinician PPE use for each level of encounter in the setting of an ongoing PPE shortage. Our algorithm adheres to Centers for Disease Control and Prevention guidelines and supports discharge of patients with mild symptoms coupled with explicit and strict return precautions and infection control education.

KEYWORDS
coronavirus, COVID-19, pandemic, personal protective equipment, SARS-CoV-2, triage

1 | INTRODUCTION

With over 12.3 million cases and 550,000 deaths worldwide at the time of this writing, the global impact of COVID-19 is ever increasing.[1,2] Widespread community transmission is occurring in the United States (US) and health systems around the world continue to face challenges in the management of COVID-19 patients.[3] Hospitals across the United States have adapted to the COVID-19 pandemic by limiting nonessential patient interaction and transforming their emergency departments (EDs) to treat patients who are both critically ill and highly contagious.[4]

With the looming threat of recurrent patient surges ever on the horizon, emergency clinicians must thoughtfully consider how to best handle an influx of patients while limiting the exposure of themselves and others.[4] This article offers triage tools that the authors believe will help us provide better care for our patients, protect our colleagues and patients alike, and contribute to the greater public health response to the pandemic.

2 | IMPACT ON EMERGENCY CARE IN THE UNITED STATES

US healthcare systems are structured such that emergency clinicians stand on the frontline of any pandemic. Although other departments can regulate patient flow and volume with scheduled encounters or operating room allocation, EDs must respond efficiently and effectively to any patient surge. Worldwide data indicates that ∼25% of

Supervising Editor: Angela Lumba-Brown, MD.

COVID-19 patients require critical care resources.[5,6] Many US EDs operate with a baseline of demand exceeding capacity, with boarding an unfortunate reality of modern emergency medicine practice. Any influx of critical patients during a pandemic only exacerbates any existing system strain, heightening the potential for an increase in inpatient morbidity and mortality.[7] History has demonstrated similar outcomes: the 2009 H1N1 pandemic resulted in a notable increase in ED volumes and affected hospitals were demonstrated to have statistically significant higher numbers of deaths attributable to myocardial infarction and stroke.[8]

As ED and inpatient volumes increase, so too does the likelihood of nosocomial transmission. In 1 Chinese case series, nearly 4% of all cases of COVID-19 involved health care workers and similar rates of nosocomial transmission have been noted in the United States.[9,10] This underscores the need for clinician access to adequate PPE and shortages have been reported across the United States, reminding us that resource-rich countries are not immune to the effects of a pandemic.[11,12]

3 | PANDEMIC TRIAGE ALGORITHMS

Perhaps the most important tenet of disaster medicine is to have a planned approach to any patient surge. Mass casualty exercises should be conducted regularly even during times of standard operating procedure and adequate preparation is vital to facilitating any mass casualty response.[13] A pandemic triage system may serve in a similar fashion, allowing systems and clinicians to prepare in advance for a large influx of patients, while adapting to the particular circumstances of an individual outbreak. Accurate triage systems and appropriate allocation of limited resources will be essential components in our continued response to the ongoing pandemic.

Standardized triage systems and protocols have been in use by US healthcare systems for several decades and are common practice for EDs in accordance with the American College of Emergency Physicians (ACEP) recommendations.[14] Triage systems are intended to rapidly identify patients who require immediate attention and optimize efficient use of medical resources. Effective triage is paramount during any mass casualty situation, because rising numbers of patients can rapidly overwhelm the limited resources available, and recent surges during the COVID-19 pandemic have served to remind us of past lessons in surge response. Prior pandemics have demonstrated the need for a standardized approach to resource allocation and patient care, with a number of protocolized approaches borne out of this need.[13] The majority of prediction rules designed for allocation of critical care resources during a pandemic were developed in response to influenza outbreaks during the 20th century. These rules rely largely on laboratory and radiologic findings performed after the initial evaluation to categorize patients, and are therefore less helpful in the immediate triage setting.[15,16]

Of more acute relevance, the Centers for Disease Control and Prevention (CDC) created a "Pandemic Influenza Triage Algorithm" (PITA) in response to the 2009 H1N1 pandemic. PITA incorporates triage data to categorize patients into 5 levels ranging from those requiring immediate resuscitation (red, level 1), to those requiring only a cursory evaluation before discharge (green, level 5). The PITA algorithm was designed to triage patients rapidly and effectively upon initial evaluation, rationally minimize PPE usage, and limit nosocomial transmission. Its core tenets are readily translatable to the COVID-19 outbreak.[17]

4 | CHARACTERIZATION OF THE ALGORITHM

The authors adapted the PITA algorithm into a specialized COVID-19 triage algorithm (see Figure 1) with the same primary goals of assigning patients to the appropriate care level, providing the best care for the maximum number of patients, rationally limiting PPE usage, and mitigating nosocomial exposures. It should be noted that our algorithm was designed to be used in the context of a PPE shortage, and the authors do recommend use of airborne and contact precautions when experiencing close clinical contact with all pandemic patients as resource allocation allows. Patients under investigation (PUIs) enter the algorithm at 2 points: "Undifferentiated patients that require resuscitation" or patients with "1 or more symptoms consistent with COVID-19." This allows patients able to communicate concerning symptoms as well as patients in extremis to be considered PUIs, an essential consideration given the high proportion of COVID-19 patients presenting with undifferentiated critical illness in the context of widespread community transmission.[1,5,18–24] This is in contrast to PITA, which called for PUI identification by symptom screening prior to entry into the algorithm.[17] Automatic entry of undifferentiated critically ill patients into the algorithm is felt to be important, because it reminds clinicians to protect themselves during the resuscitation of patients who cannot communicate any PUI symptoms with adequate PPE and appropriate precautions.

Similar to PITA, the algorithm is delineated into 5 levels of patient acuity and harbors the same assumptions (pandemic conditions, in-person visits, vital sign assessment, clinical evaluation prior to disposition, and use by healthcare professionals).[17] PITA and the authors' algorithm were designed to be used once pandemic conditions have already been declared by an appropriate agency such as the local Centers for Disease Control or the World Health Organization (WHO). Its use also implies that other healthcare setting operations are not sufficient for triage of PUIs while adequately protecting staff and other patients. Implementation of the algorithm should be initiated when PUI patients are presenting to the requisite ED and demand for care delivery is expected to exceed capacity and PPE shortages are expected to arise.

In our system, the algorithm was designed and implemented at the outset of pandemic in mid-March 2020. Our ED was modified to fit the needs of the pandemic, with the initiation of a modified split-flow triage system with cohorting of our waiting room and treatment areas into non-PUI and PUI patients. Educational sessions were held for all levels of staff and the algorithm was posted in our treatment areas and widely distributed. PUIs were designated on arrival based on triage screening by an experienced nursing provider and the necessary level

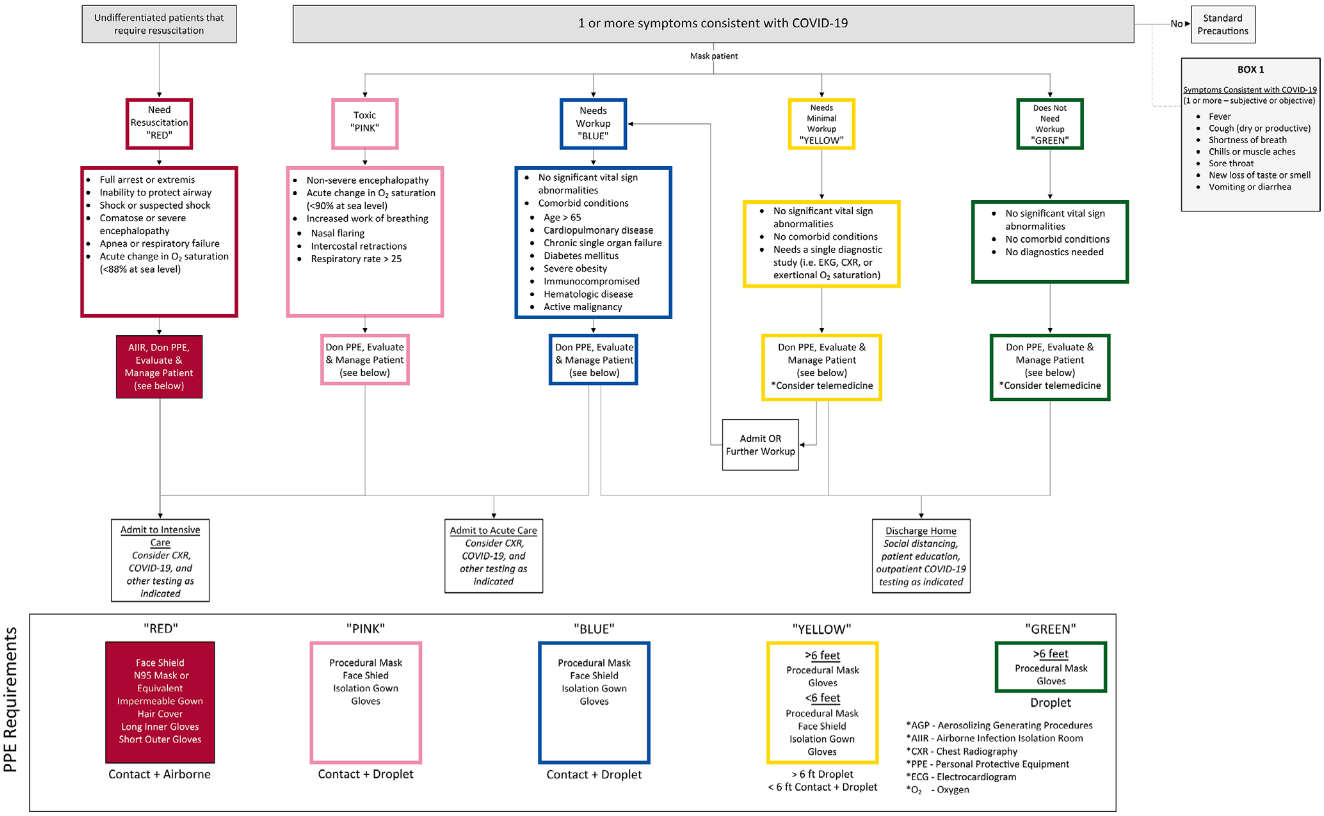

FIGURE 1 COVID-19 emergency department triage algorithm

of care (color designation) was determined by a physician in triage (PIT) or less commonly an advanced practiced provider (APP). In a more limited resource setting, an experienced nursing provider may be an appropriate alternative choice to assign the level of care. In our ED, triage providers wore at minimum a surgical mask, eye protection, and gloves when triaging patients. A Plexiglas shield was also placed in front of the triage station.

A lack of required testing prior to level of care designation is felt to be a major strength of the algorithm as it expedites the triage process. The algorithm was designed prior to the widespread availability of rapid COVID-19 testing, and as such, it was intentionally not mandated in the algorithm. Additionally, on initial presentation and subsequent triage, COVID-19 testing results are not routinely available for rapid decisionmaking in the ED setting. All testing should be adapted to local and institutional guidelines.

"Need Resuscitation-Red" patients are defined in our algorithm as patients in full arrest or extremis, patients with an inability to protect their airway, patients with frank respiratory failure or apnea, patients with significant hypoxemia (<88% at sea level), patients in shock, or patients with significant alteration in mental status. These patients are universally assumed to be PUIs. We recommend use of the highest level of PPE for these patients (as indicated in Figure 1), because they may need to undergo high risk aerosolizing-generating procedures (ie, endotracheal intubation, non-invasive ventilation).[25–28] The authors additionally recommend use of an airborne infection isolation room (AIIR, or "negative pressure room") for patients undergoing aerosolizing-generating procedures given the significant risk for airborne disease transmission during such procedures.[25–28] The patient can be transferred or dispositioned to a non-AIIR if appropriate filtration devices are used. These patients should be admitted to an intensive care setting. Further, we recommend considering a chest x-ray prior to, or immediately following, admission along with testing for COVID-19 as available and other testing as indicated.

Patients not in extremis must have "1 or more symptoms consistent with COVID-19" identifying them as a PUI. We initially defined these criteria as fever, cough (dry or productive), or shortness of breath (SOB), the most common symptoms in case-based literature to date.[1,5,6,18–23] During the writing of this manuscript, the CDC added a number of new presenting symptoms for COVID-19 including chills, muscle aches, sore throat, vomiting, or diarrhea, and new loss of taste or smell that have been incorporated into our algorithm as in Figure 1.[29] Such changes represent well the challenges we are confronted with during a novel pandemic; the dynamic nature of disease process delineation and the need for continuous revision of management protocols as more data are gathered. As above, these symptoms are screened for on initial evaluation by a nursing triage provider. All patients identified as PUIs are asked to wear a surgical mask throughout their evaluation per CDC guidelines.

Once patients meet PUI criteria, they are risk-stratified by their clinical appearance, vital sign abnormalities, and comorbid conditions by a physician in triage or less often an advanced practice provider and assigned a level of care in our algorithm (color designation).

"Toxic-Pink" are those defined by an acute change in oxygen saturation to <90% at sea level, patients with increased work of breathing, or patients with non-severe encephalopathy. The authors recommend further evaluation of these patients with ED diagnostics as indicated and subsequent admission to an intensive care unit or an acute care unit depending on the severity of their presentation and results of their ED evaluation and management. We again recommend considering a chest x-ray and COVID-19 testing as available for this patient population, with other testing as indicated.

"Needs Workup-Blue" patients are those having chronic comorbidities such as advanced age (>65), cardiopulmonary disease (ie, asthma, chronic obstructive pulmonary disease, or coronary vascular disease), chronic single organ failure, diabetes mellitus, severe obesity, immunocompromise, hematologic disease, or active malignancy (especially patients on chemotherapy). These patients should not have significant vital sign abnormalities, respiratory distress, or a concerning clinical appearance. These risk factors are supported by current CDC recommendations.[30] Given their higher risk for decompensation and poor outcome, these patients should have diagnostics performed in the ED. These may include observation, assessment of exertional O_2 saturation, laboratory or radiographic analysis, electrocardiogram, or other testing as indicated. Although assessment of exertional O_2 saturation has not been externally validated specifically in the setting of COVID-19, there have been a number of studies validating its use in other pulmonary pathologies.[31,32] Hypoxemia has also been shown to be independently associated with in hospital mortality in COVID-19 patients.[33]

These patients may require admission to an acute care unit or be appropriate for discharge depending on their ED evaluation. If admitted, the authors recommend considering the aforementioned chest x-ray along with COVID-19 testing as available and other testing as indicated above. In addition to meeting usual discharge criteria, we recommend patients have reliable housing, access to outpatient COVID-19 testing if indicated, understanding of necessary return precautions, and the ability to return to care. Adherent to CDC guidelines, we also recommend infection control education including explicit instructions for self-isolation and provision of an appropriate COVID-19 educational handout.[29]

"Needs Minimal Workup-Yellow" patients have none of the aforementioned risk factors and can reasonably be dispositioned with minimal testing such as a chest x-ray, electrocardiogram, assessment of exertional O_2 saturation, or COVID-19 testing, as indicated and local resources and guidelines allow. These patients will fit into 1 of 3 categories based on their ED evaluation: they will need admission to an acute care unit, need further workup, or more commonly, be discharged home with the same recommendations as patients above.

The lowest acuity "Does Not Need Workup-Green" patients may be discharged soon after triage and clinician encounter. These patients should have no clinical or historical red flags and should be at low risk of complication or severe disease, with normal vital signs, no significant comorbidities, and no substantial dyspnea. They should also be educated about home isolation, return precautions, and outpatient COVID-19 testing resources as above and can likely be discharged without further testing or evaluation. For efficiency, the authors recommend printing appropriate education materials and work excuses prior to evaluating the patient. The authors recommend weighing the risk and benefits of physical contact or any testing for patients in this category.

5 | PERSONAL PROTECTIVE EQUIPMENT RECOMMENDATIONS

In addition to providing a framework for clinical triage, our algorithm describes the recommended levels of personal protective equipment (PPE) for each type of expected encounter. Significant rates of infection among health care workers and nosocomial infection illustrate the need for adequate clinician protection and infection control.[21,27]

SARS-CoV-2 seems to have a viral shedding pattern similar to influenza.[34,35] High viral loads have been detected in completely asymptomatic patients, calling for a minimum level of protection from respiratory droplets for all clinicians.[30,36] SARS-CoV-2 was also noted in stool in 50% of patients tested, and extensive surface contamination has been reported.[37,38] The potential for stool or fluid transmission suggest the need for concomitant contact precautions for providers within reach of a patient or contaminated surface.[30,34]

The most significant controversy involving SARS-CoV-2 transmission seems to be the potential for routine airborne or aerosol spread. It is thought that the highest risk for airborne transmission occurs during aerosolizing-generating procedures, but the virus has been found to be viable in aerosols for at least 3 h.[24,34] A recent article by Santarpia et al[39] lends more support to the possibility of airborne transmission of the virus even in the absence of aerosolizing-generating procedures. These data would seem to support the use of airborne precautions (N95 respirator use or equivalent) during any PUI or COVID-19-confirmed patient encounter.[35]

The evolving nature of our understanding of disease transmission and subsequent PPE recommendations also reiterates the importance of universal hygiene precautions. Frequent hand hygiene, use of gloves, and cough hygiene protects all patients and providers, and along with patient education measures are essential tenets of infection control even in times of normal operating procedure. The reality of ongoing PPE and other equipment shortages calls for thoughtful resource allocation and informs the 3 discrete levels of PPE recommendations below, particularly in relation to N95 respirator or equivalent use. All PPE use should be adapted to local resource availability and institutional guidelines, and again, it should be noted that in a resource-rich setting without PPE shortages, the authors recommend the use of constant airborne and contact precautions by all providers experiencing close contact with PUIs.

5.1 | Droplet: distance >6 feet (greens, some yellows)

We recommend clinicians approaching all green and yellow patients wear, at minimum, a procedural mask and gloves if remaining at least 6 feet from the patient (a widely accepted range for typical droplet transmission). We recommend clinicians evaluating patients at a distance <6 feet follow the Contact + Droplet precautions below. All PUIs should be given a procedural mask on entry. Clinician exposure to low acuity patients should be rapid and at the safest feasible distance to obtain an accurate assessment of the patient with the minimum amount of PPE necessary to adequately and safely care for a patient.

5.2 | Contact + droplet: distance <6 feet (some yellows, blues, pinks, some reds)

Many well-appearing patients may require more extensive evaluation, typified by those with relevant risk factors and abnormal vital signs as above.[30] For those patients requiring the clinician to approach within 6 feet to auscultate, examine, or intervene, we recommend at minimum a procedural mask, face shield or goggles, isolation gown, and gloves, consistent with WHO, CDC, and Canadian guidelines.[26,29,39] This level of PPE provides respiratory droplet and contact protection.

5.3 | Airborne: invasive procedures expected (red)

Patients presenting in extremis or requiring immediate resuscitation will likely require aggressive respiratory support or invasive procedures. If aerosolizing-generating procedures or significant fluid contamination are anticipated, our pathway prioritizes an N95 mask or equivalent, adds a hair cover (bouffant cap or surgical cap), level 4 impermeable gown, and a second layer of longer gloves in addition to a face mask or goggles to prevent contamination during invasive procedures, all in agreement with WHO, CDC, Canadian, and Chinese recommendations.[26,29,39,40] aerosolizing-generating procedures should be performed in an AIIR as in Figure 1.

6 | LIMITATIONS

We present our algorithm as a structured framework for clinical triage to aid in disposition and to provide PPE recommendations during the unprecedented COVID-19 pandemic. The algorithm is currently in use in the ED of a major academic medical center, where it is serving to standardize practice among clinicians. We believe the algorithm to be evidence-based, but neither it nor the PITA algorithm has been retrospectively or externally validated. The authors fully recognize that data regarding COVID-19 and subsequent recommendations are incomplete and fluid. Much about the virus is unknown, including its exact modes of transmission and subsequent risks of infection to clinicians. This underscores the recommendation that any codified approach to patients during a pandemic must be continually revised as new data becomes available: our algorithm is no exception. It is also important to note that the effect on EDs of COVID-19 has been highly variable, with some facilities seeing a massive influx of patients and some seeing a significant reduction in patient volumes. Any triage algorithm must be adapted to the needs and local practices of the healthcare system in question.

Pandemic triage can have numerous pitfalls including misclassification of patients, underuse of resources, and inappropriate disposition recommendations that the astute clinician should keep in mind. This algorithm was not intended to replace clinical gestalt and medical decisionmaking but rather to augment it. Each patient encounter represents a unique decisionmaking scenario and should be treated as such. Our algorithm also assumes that a facility will have nursing providers available for use in triage as well as a physician or advanced practice providers readily available for further stratification of patients. We recognize that many EDs will not have equivalent capabilities and some aspects of the algorithm may have to be adapted to local circumstances. We support the use of an experienced nursing provider in place of a physician or APP in the triage setting if necessary.

Our algorithm was designed with thoughtful resource allocation in mind and aims to provide adequate protection for the most providers in the setting of limited resources and PPE, an unfortunate and continued reality of the COVID-19 pandemic. Recent data lends more support to the possibility of airborne transmission of the virus even in the absence of aerosolizing-generating procedures.[35] In light of this, the authors again recommend the use of constant airborne and contact precautions by all providers experiencing close contact as with PUIs as resource allocation allows.

7 | CONCLUSION

As the COVID-19 pandemic continues to evolve, so too will our understanding of the best patient care and management strategies. Dynamic changes in WHO and CDC guidelines have already occurred with incorporation of evidence-based clinical features, and it is vital to continually update our approach to any pathogen as new information is obtained. The proposed triage algorithm was designed to facilitate the timely evaluation of PUIs in an organized fashion that optimizes patient triage, minimizes unnecessary clinician exposure, standardizes care, and maximizes appropriate resource use in the setting of an ongoing PPE shortage. These measures will continue to be essential in the coming months. It is the authors' hope that use of this triage algorithm and PPE recommendations will aid frontline emergency clinicians in the ongoing response to COVID-19.

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How to cite this article: Wallace DW, Burleson SL, Heimann MA, et al. An adapted emergency department triage algorithm for the COVID-19 pandemic. *JACEP Open*. 2020;1:1374–1379. https://doi.org/10.1002/emp2.12210