ORIGINAL RESEARCH

Disaster Medicine

The impact and efficiency of medical screening exams in forward treatment areas at New York City public hospitals during the initial COVID-19 surge

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Abstract

Background: New York City (NYC) emergency departments (EDs) experienced a surge of patients because of coronavirus disease 2019 (COVID-19) in March 2020. NYC Health and Hospitals established rapid medical screening exams (MSE) and each hospital designated areas to perform their MSE. Five of the 11 hospitals created a forward treatment area (FTA) external to the ED to disposition patients before entering who presented with COVID-like symptoms. Three hospitals used paper-based, and 2 used an electronic medical record (EMR)-based MSE. This study evaluated the effectiveness of safely discharging patients home from the FTA while also evaluating the efficiency of using paper-based versus EMR-based MSEs.

Methods: Charts were reviewed using standardized data extraction templates. Patients discharged from the FTA were contacted by phone, and a structured interview captured additional data regarding subsequent clinical courses. Chi-square tests were used to compare proportions of patients hospitalized, as well as proportions of patients with vital signs recorded. Mortality rates were compared with Fisher exact test. A logistic regression model with fixed effects to account for clustering at hospitals was used to compare the odds of being sent to the ED for further evaluation based on vital signs and adjusted for age and sex.

Results: Across 5 EDs, 3335 patients were evaluated in their FTAs from March 17, 2020, to April 27, 2020. A total of 970 (29.1%) patients were referred for further evaluation into the ED, of which 203 (20.9%) were hospitalized and 19 (2.0%) died. Of 2302 patients discharged from the FTA, 182 (7.9%) returned to the ED within 7 days, result-
ing in 42 (1.8%) hospitalizations and 7 (0.3%) deaths. Facilities using EMR-MSE discharged more patients from their FTA (81.9% vs 65.3%, \( P < 0.001 \)) and had similar 7-day return (9.3% vs 7.1%, \( P = 0.055 \)) and mortality rates (0.49% vs 0.20%, \( P = 0.251 \)).

**Conclusion:** MSEs in an FTA are an effective process to disposition patients safely in a high-volume situation. Differences exist in paper- versus EMR-based approaches, suggesting EMR-MSEs provide better data, efficiency, and effectiveness. This suggests prioritizing an EMR-based MSE should be considered in future circumstances.

**KEYWORDS**
COVID-19 surge, emergency, medical screening evaluations, NYC, pandemic, public health preparedness

## 1 INTRODUCTION

### 1.1 Background

Few places in the world had a surge of coronavirus disease 2019 (COVID-19) as drastic as New York City (NYC) in March 2020. Given a population of 8.3 million living within 300 square miles, a poverty rate of 17% and almost 7% living in public housing, NYC is uniquely vulnerable for propagation of communicable diseases.\(^1\)\(^,\)\(^2\) The first known case was discovered just north of NYC on March 2, 2020, with cases doubling almost daily in March.\(^3\)\(^,\)\(^4\) Governor Andrew Cuomo declared a state of disaster on March 7, 2020, closed all non-essential businesses on March 20, 2020, and signed an executive order modifying the definition of “emergency medical services” to facilitate operations of healthcare facilities at surge capacity on March 23, 2020.\(^5\)\(^,\)\(^6\)

Hospitals were overwhelmed with patients with a wide array of complaints from minor symptoms to multi-organ failure secondary to the virus.\(^7\) New York City Health + Hospitals (NYC H+H), the nation’s largest public health care system with 11 acute care facilities, was particularly affected with patient surges. Coupled with country-wide shortages of personal protective equipment, ventilators, beds, and oxygen, the situation mandated rapid adjustments and innovation.\(^8\) The NYC boroughs of the Bronx, Brooklyn, and Queens had a disproportionate impact and burden of COVID-19 in the city.\(^10\)

### 1.2 Importance

Hospital emergency departments (EDs) needed to adapt their medical screening exam (MSE) processes and hospital flow to accommodate the surge in patients. Conventional disaster protocols predominantly account for single day incidents or shorter-term epidemics and are ill-fitted for the large volume of critically ill, infectious patients seen in the novel coronavirus pandemic.\(^9\) As such, a new MSE system was needed to process patients and allocate resources effectively.

Five of the 11 NYC H+H EDs created a forward treatment area (FTA) to perform rapid MSEs physically outside the footprint of the ED. These FTAs varied between the different sites. Some sites had tents in front of the ED, whereas others repurposed parts of the ED, such as the waiting room, to house patients. Each site staffed their FTAs based on available local resources (emergency medicine residents, off-service residents, etc.) but all included attending emergency physicians and advanced practice clinicians. Based on the MSE, clinicians either discharged patients to home directly from the FTA or directed them into the ED for further evaluation.

### 1.3 Goals of this investigation

The primary objectives of this study were to describe the effectiveness of the FTAs, defined as the number of patients dispositioned directly from the FTA, and to assess if discharging patients after a limited MSE led to significant numbers of adverse outcomes, defined as return hospitalizations and deaths after being screened to go home. Secondary analyses were performed to analyze if certain vital signs and demographics were associated with disposition decisions, as well as to assess differences in efficiency and effectiveness between MSEs documented on paper (pMSE) compared to MSEs documented in the electronic medical record (eMSE). For this comparison, efficiency was defined as the successful capture of vital signs.

## 2 METHODS

### 2.1 Study design and setting

This study was a retrospective cohort study of all patients seen and evaluated in ED FTAs during the initial NYC COVID-19 surge from March 17 to April 27, 2020. In addition to chart review, follow-up phone calls were made to patients discharged directly from FTAs to capture subsequent events such as return visits to other hospital EDs or deaths. These follow-up phone calls were initially implemented as part of a quality assurance process for the FTAs. The study took place in 5 safety-net urban hospital EDs in the NYC boroughs of the Bronx, Brooklyn, and Queens, encompassing collectively 375,000 annual ED visits. The 5 hospitals include 3 Level 1 Trauma Centers and 3 large emergency medicine residencies serving limited resource populations.
and are members of the largest public health care system in the United States.

The study was approved by the Biomedical Research Alliance of New York (BRANY) institutional review board. There was no financial support received for this study.

2.2 Medical screening exam processes

Each hospital created its own FTA for rapid MSEs in accordance with Emergency Medical Treatment and Labor Act (EMTALA) regulations. The common elements used in all 5 hospitals included a clinical space outside of the main ED treatment area to use as the FTA, whereas all ambulatory patients presenting to the ED were screened for any COVID-19 like symptoms to be sent first to the FTA, with MSEs performed by physicians or advanced practice clinicians, vital sign assessments, and disposition options including direct discharge home or referral to the ED for further evaluation. Discharged patients were given language-appropriate COVID-19 education material and ED return precautions. Each facility created its own independent workflow to allow customization based on the individual hospital’s resources and processes. A major difference in the implementation of MSE in the FTAs among the 5 EDs was the use of an abbreviated paper-based documentation at some sites compared to EMR documentation at other sites (Figures 1 and 2). The earliest FTA was established on March 17, 2020, and the last one opened on March 26, 2020. The earliest FTA closure was on March 31, 2020, and the last one closed on April 27, 2020.

2.3 Selection of participants

All adult patients (age 18 years and older) with a documented MSE in FTAs in the 5-study hospital EDs were included. The study period was for the entire duration that FTAs were operational.

2.4 Data collection

Retrospective chart review was performed by emergency medicine physicians, physician assistants, and medical students using a standardized data collection form. The following data were collected: patient demographics, initial vital signs, dispositions after MSE, clinical course and final disposition for patients sent to the ED and return visits to one of the 11 hospitals of the health system. For purposes of the study call-back, the students were blinded to the hypothesis and supervised by a senior emergency medicine resident.

To capture return hospital visits at non-affiliate hospitals and other subsequent clinical events, a scripted structured interview was created to collect additional information. These interviews were administered by phone and conducted by physician assistants and medical students blinded to the objectives of the study. For non-English speaking participants, a telephone interpreter was used. At least 3 attempts were made to contact all patients who were discharged directly from the FTAs.

2.5 Outcomes

The primary outcomes were return visits to EDs, hospitalizations, and deaths after discharge from the initial FTA visit. Hospitalizations included inpatient admissions, patients transferred to another hospital for admission, and patients placed in an observation unit. For patients discharged directly from the FTA, hospitalizations were counted if they occurred within 7 days of the original MSE. Secondary outcomes were used to compare FTAs using pMSE to eMSE and included the proportion of patients with vital signs captured, proportion of patients discharged home directly from the FTA, proportion of patients with return ED visits within 7 days, and proportion of patients who died.

2.6 Analysis

Patient counts and descriptive statistics, including percent male/female, median age, and interquartile range for age, were used to summarize the volume and demographics of patients seen in the FTAs and to quantify the volume of patients the MSE process was able to divert away from the EDs. Chi-square tests were used to compare pMSE to eMSE. These comparisons evaluated for differences in the proportions of patients with vital signs recorded, the proportion discharged directly from the FTA, and the proportion with return ED visits within 7 days after being screened to go home during the index visit. Differences in mortality rates between the pMSE and eMSE groups were compared using Fisher exact test. A logistic regression model with fixed effects to account for clustering at hospitals was used to compare the odds of being sent to the ED for further evaluation based on temperature, pulse oximetry, respiratory rate, heart rate, blood pressure, and adjusted for age and sex. Results from the logistic regression are expressed as odds ratios as the ratios tended to be close to one and thus a good approximation of relative risk. Microsoft Excel (version 16; Redmond, WA) was used for data exploration and cleaning, and statistical analyses were performed with STATA (version 16.1; StataCorp, College Station, TX). All statistical tests used an \( \alpha = 0.05 \) level of significance.
### NYC Health + Hospitals Pre-ED Provider Medical Screening Examination (MSE) Record

| Patient Name: | DOB: | Preferred Phone: | Chief complaint: |
|---------------|------|------------------|-----------------|

#### Selected Vital Signs:
- **SpO2:** [ ]
- **Temp:** [ ]

#### Next Destination after MSE:
- [ ] ED
- [ ] ExpressCare
- [ ] COVID Testing Area
- [ ] Home

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A Medical Screening Exam (MSE) was performed for care and services requested by the patient at the time of their presentation for the treatment of an emergency medical condition. Under federal law the term "emergency medical condition" means a medical condition (including emergency labor and delivery) manifesting itself by acute symptoms of sufficient severity (including severe pain) such that the absence of immediate medical attention could reasonably be expected to result in placing the patient's health in jeopardy, serious impairment to bodily functions, or serious dysfunction of any bodily organ or part. In initiating here, I, the above listed practitioner, certify that my MSE demonstrated the patient's condition does not currently meet the definition of an emergency condition as described above.

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Provider initials:

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Provider initials:

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### FIGURE 1
Paper-based medical screening exam (MSE)
3 | RESULTS

FTAs in the 5 hospitals included in this study screened a total of 3335 patient visits during the initial surge of COVID-19 patients in March and April of 2020 (Table 1). Of these patients, 970 (29.1%) were sent to the ED for further evaluation resulting in 203 hospitalizations (20.9% of the ED subgroup) and 19 deaths (2.0%). After screening in the FTAs, 2302 (69.0%) were directly discharged, mostly to home with a small number discharged to alternate care settings (139 to Urgent Care, 1 to OB/GYN clinic) (Table 2; Figure 3). Of the discharged patients who did not have a return visit to one of the NYC H+H EDs, 39.6% were successfully contacted and agreed to participate in the structured inter-
TABLE 1  Patient demographics

|                            | All Hospitals (N = 3,335) | Hospital A (N = 1,352) | Hospital B (N = 633) | Hospital C (N = 343) | Hospital D (N = 634) | Hospital E (N = 373) |
|----------------------------|---------------------------|------------------------|----------------------|----------------------|----------------------|----------------------|
| MSE documentation          | Paper                     | Paper                  | Paper                | EMR                  | EMR                  | EMR                  |
| FTA operational dates      |                           |                        |                      |                      |                      |                      |
| Opening date               | 3/17/20                   | 3/19/20                | 3/25/20              | 3/26/20              | 3/23/20              | 3/17/20              |
| Closing date               | 4/27/20                   | 3/31/20                | 4/27/20              | 4/13/20              | 4/16/20              | 4/22/20              |
| Sex, N (%)                 |                           |                        |                      |                      |                      |                      |
| Male                       | 1,530 (45.9)              | 558 (41.3)             | 324 (51.2)           | 56 (16.3)            | 362 (57.1)           | 230 (61.7)           |
| Female                     | 1,094 (32.8)              | 351 (26.0)             | 276 (43.6)           | 52 (15.2)            | 272 (42.9)           | 143 (38.3)           |
| Not recorded               | 711 (21.3)                | 443 (32.8)             | 33 (5.2)             | 235 (68.5)           | 0 (0)                | 0 (0)                |
| Age, (y)                   |                           |                        |                      |                      |                      |                      |
| Median                     | 45                        | 40                     | 49                   | 47                   | 44                   | 46                   |
| Q1, Q3                     | 34, 55                    | 28, 51                 | 36, 59               | 36, 57.5             | 34, 54               | 37, 57               |

EMR, electronic medical record; FTA, forward treatment area; MSE, medical screening exam.

TABLE 2  Patient dispositions

|                     | Discharged directly from FTA (N = 2,302) | Sent from FTA to ED (N = 970) |
|---------------------|-----------------------------------------|-------------------------------|
| MSE disposition, N  |                                         |                               |
| Home                | 2,162                                   |                               |
| Alternate care sites| 140                                     |                               |
| Returned to ED within 7-days, N (%) | 182 (7.9) |  |

ED, emergency department; FTA, forward treatment area.

TABLE 3  Vital sign capture in EMR- versus paper-based MSE

| Vital sign               | EMR-based MSE | Paper-based MSE | P valueb |
|--------------------------|---------------|-----------------|-----------|
| Temperature recorded, %  | 98.9          | 62.7            | <0.001    |
| SpO2 recorded, %         | 98.9          | 96.8            | <0.001    |
| Heart rate recorded, %   | 99.0          | 53.9            | <0.001    |
| Blood pressure recorded, %| 99.1        | 29.3            | <0.001    |
| Respiratory rate         | 74.4          | 24.5            | <0.001    |

EMR, electronic medical record; MSE, medical screening exam.

aIncludes any blood pressure reading, diastolic or systolic.

bFor Chi-square test.

eMSE documentation was found to be more robust in terms of capturing vital signs (Table 3). This was true not only for vital signs such as heart rate (99.0% vs 53.9%, P < 0.001), blood pressure (99.1% vs 29.3%, P < 0.001), and respiratory rate (74.4% vs 24.5%, P < 0.001) for which the paper documentation did not specifically request this data, but also for temperature (98.9% vs 62.7%, P < 0.001) and pulse oximetry (98.9% vs 96.8%, P < 0.001) that had defined spaces for recording in the paper chart.

Use of an eMSE was also associated with a higher proportion of patients discharged directly from the FTA compared to the pMSE (81.9% vs 65.3%, P < 0.001; Table 4). Differences in the proportion of discharged patients with return ED visits within 7 days and mortalities were not statistically significant between eMSE and pMSE (9.3% vs 7.1%, P = 0.055; 0.49% vs 0.20% for deaths, P = 0.251).

Logistic regression modeling revealed all vital signs except for temperature were associated with the MSE disposition decision (Table 5). The odds of being sent to the ED for further evaluation increased with higher heart rate (odds ratio [OR], 1.02; 95% confidence interval [CI], 1.01–1.03), systolic blood pressure (OR, 1.01; 95% CI, 1.00–1.02), and respiratory rate (OR, 1.13; 95% CI, 1.08–1.19), and with lower pulse oximetry levels (OR, 0.72; 95% CI, 0.66–0.79). Notably, vital signs were significantly lower in the group discharged directly after their MSE as compared to the group initially sent into the ED for further evaluation (1.8% vs 20.9% for hospitalizations, P < 0.001; 0.3% vs 2.0% for deaths, P < 0.001).
FIGURE 3  Patient dispositions and follow-up

TABLE 4  Effectiveness and adverse outcome rate of EMR versus paper-based MSE

|               | EMR-based MSE | Paper-based MSE | P value |
|---------------|---------------|----------------|---------|
| Home, %       | 81.9          | 65.3           | <0.001* |
| Discharged from FTA with ED re-visit within 7 days, % | 9.3          | 7.1            | 0.055*  |
| Deaths after screened to go home, % | 0.49         | 0.20           | 0.251b  |

ED, emergency department; EMR, electronic medical record; FTA, forward treatment area; MSE, medical screening exam.

*Chi-square test.

bFisher exact test.

included as continuous variables in the logistic regression model, so ORs refer to single unit differences in vital signs.

TABLE 5  Logistic regression comparing odds of being sent to ED after MSE based on vital signs, adjusted for age and sex

|                | OR   | 95% CI       | P value |
|----------------|------|--------------|---------|
| Temperature    | 1.22 | 0.74, 2.00   | 0.442   |
| Heart rate     | 1.02 | 1.01, 1.03   | <0.001  |
| Systolic blood pressure | 1.01 | 1.00, 1.02 | 0.019   |
| Respiratory rate | 1.13  | 1.08, 1.19  | <0.001  |
| SpO2  | 0.72  | 0.66, 0.79  | <0.001  |
| Age    | 1.01  | 1.00, 1.02  | 0.032   |
| Sex (male) | 0.83  | 0.60, 1.14  | 0.251   |

CI, confidence interval; ED, emergency department; MSE, medical screening exam; OR, odds ratio.

Vital signs were included as continuous variables in the logistic regression model, thus ORs refer to single unit differences in vital signs.
3.1 | LIMITATIONS

A few limitations existed for this study. This study may not be generalizable to the general population as it included 5 urban public hospitals located in 3 of the 5 NYC boroughs. Six of the other public hospitals in our system did not participate in these processes. These 6 hospitals are in the Bronx (2), Brooklyn (1), and Manhattan (3). Furthermore, more than half of the patients discharged home after a medical screening exam were not able to be reached by phone call and were therefore lost to follow-up. This may include patients who died or revisited the ED at an unaffiliated hospital. This model may not be applicable for smaller hospitals or mass casualty incidents in which a larger proportion of the patients are expected to be acutely ill or requiring medical attention, as many of the patients seen during this study came because of concerns for contracting the coronavirus or had mild or early symptoms only. An additional limitation includes the number of patients seen at one of the pMSE sites (Hospital A) was particularly higher over a shorter duration than the other sites which may have impacted their outcomes and abilities. Indeed, when data from Hospital A is excluded, the remaining pMSE hospitals show a higher rate of temperature and SpO2 capture with no statistical difference between eMSE and pMSE for these 2 vital signs (pMSE temperature recorded 99.0% of the time, Chi-square test comparing eMSE to pMSE with \( P = 0.883 \); pMSE SpO2 recorded 99.5% of time, \( P = 0.149 \)). The remainder of results was unchanged by the exclusion of data from Hospital A. The pMSE form was also created at the crux of the pandemic, whereas the number and criticality of patients were completely unknown as well as complete disease presentation. Thus, the pMSE form was created as simplistic as possible to capture the most relevant data points known at that time thereby potentially limiting its utility.

4 | DISCUSSION

The novel nature of the initial COVID-19 surge and the unknown infectivity rate and route at the time necessitated a new paradigm of assessment especially in the setting of the rapidity of spread and sheer volume of patient presentation. Five of our facilities developed similar external FTAs to improve rapid assessment and intervention, reduce waiting room crowding that could potentially contribute to exposure risk to patients, and limit ED crowding and disease exposure to staff. With the unprecedented strain on hospital resources and bed capacity, space was at a premium and any ability to expedite and redesign care delivery safely was critical. The sheer volume of patients presenting to the ED was well above baseline normal values, the limited knowledge about symptomology was paramount, and patients with seemingly unrelated complaints began to rule in positive for COVID in contrast to the experience of others and the approaches they took such as segregating the EDs between positive and negative patients.\(^{11}\)

The FTAs in the facilities were highly effective in assessing patients and discharging them home in clinically substantial numbers. Furthermore, the adverse event rates, both in return hospitalizations and mortality, were low. These structures were able to maintain EMTALA compliance and save critically starved hospital resources.

It was interesting to note the increased efficiency and effectiveness of the FTA for those using eMSE compared to their counterparts using pMSE. This was apparent in the more complete capture of vital signs, although a paper MSE form including additional fields for vital signs may have yielded different results. This was furthermore observed through the higher proportion of patients discharged directly from the FTA and thereby diverted away from the ED. Despite being more effective in diverting patients away from the ED, the eMSE process was no worse than pMSE in terms of mortality or 7-day return visits. These results suggest that the increased work necessary to fully implement an EMR in an FTA is worth the extra investment in time and resources (eg, registration staffing; internet-enabled and powered devices in nontraditional spaces) to screen patients more effectively and efficiently for discharge.

Although this study was not designed to evaluate COVID-19 screening decision criteria, the behavior of clinicians performing the MSE reveals the significance of particular vital signs. As expected for a primarily respiratory infection, there was a significant association between lower SpO2 and higher respiratory rate and the decision to disposition patients to the ED after MSE. It would be extremely helpful to create these forward treatment areas again, using currently available knowledge for safe evaluation of patients such as those created by the University of Pennsylvania.\(^{12}\) This finding is concerning, however, when also considering the finding that respiratory rate was captured in a considerably lower proportion of patients for both eMSE and pMSE as compared to other vital signs. One possible explanation is that given how tachypnea is a more visually apparent vital sign, it is probable that a clearly tachypneic patient was immediately taken into the ED by the MSE clinician, possibly with limited MSE documentation knowing that full evaluation will be completed by the treatment team. Implementation of MSE specific for COVID-19 should emphasize capturing respiratory rate as an important component to assessing acuity in patients with suspected COVID-19.

The performance of a medical screening exam in a forward treatment area is an effective method to screen patients for early safe discharge or need for full ED assessment in a high-volume novel pandemic situation. Using an EMR format for the MSE had improved efficacy and efficiency than a paper-based format in our scenario. Heart rate, respiratory rate, and pulse oximetry were more predictive than other vital signs for predicting those patients receiving further assessment in the setting of the COVID-19 surge.

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AUTHOR CONTRIBUTIONS
JBM, MD, TT, EW, and SN conceived the study. JBM, TT, MD, KK, CS, JS, MD, RC, RL, RH, SK, EW, DS, and SN supervised the conduct of the trial and data collection. TT, MD, KK, and JS managed the data, including quality control and analysis. TT provided statistical advice on study design and analyzed the data. JBM chaired the data oversight committee. JBM, TT, MD, and SN drafted the manuscript. All authors contributed substantially to its revision. JBM takes responsibility for the paper as a whole.

CONFLICTS OF INTEREST
The authors declare no conflicts of interest.

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