Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

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Upgrades to intensive care: The effects of COVID-19 on decision-making in the emergency department

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ABSTRACT

Introduction: The initial surge of critically ill patients in the COVID-19 pandemic severely disrupted processes at acute care hospitals. This study examines the frequency and causes for patients upgraded to intensive care unit (ICU) level care following admission from the emergency department (ED) to non-critical care units.
Methods: The number of ICU upgrades per month was determined, including the percentage of upgrades noted to have non-concordant diagnoses. Charts with non-concordant diagnoses were examined in detail as to the ED medical decision-making, clinical circumstances surrounding the upgrade, and presence of a diagnosis of COVID-19. For each case, a cognitive bias was assigned.
Results: The percentage of upgraded cases with non-concordant diagnoses increased from a baseline range of 14–20% to 41.3%. The majority of upgrades were due to premature closure (72.2%), anchoring (61.1%), and confirmation bias (55.6%).
Conclusion: Consistent with the behavioral literature, this suggests that stressful ambient conditions affect cognitive reasoning processes.

1. Introduction

Stress is defined medically as a physical, emotional or mental factor that causes bodily or mental tension [1]. The COVID-19 pandemic abruptly challenged healthcare with disrupted processes throughout the system. Emergency medicine (EM) physicians experienced physical stress from working long hours with personal protective gear. As the pandemic surged, they sustained mental stress from the urgency of dealing with a novel disease at a point at which diagnostics and therapeutics were uncertain. They also encountered emotional stress from interacting with unprecedented levels of human suffering and the fears of personally contracting this dangerous, highly contagious disease. EM practice may be stressful under the best of conditions, and EM physicians, by predilection, experience and training, prove themselves capable of effective functioning in this milieu.

Empirically, it has been demonstrated that EM physicians, in frequent conditions of urgency and multitasking, may be susceptible to cognitive biases and short cuts in thinking [2]. Acute stress tends to sharpen the mind by activating the fight-or-flight response that is needed to deal actively with an immediate threat [3]. Decision-making in changing and complex conditions is referred to in the neurobehavioral literature as "executive function." [4] Executive function at high levels of stress may lead to rigid thinking and impulsive action, particularly in conditions of "parallel" executive function, when there are multiple stressors at play [5]. The stress of COVID-19, which was above and beyond normal stressors in EM, may have led to progression past the optimum level of acute stress.

The negative effects of stress may manifest as changes in typical decision-making patterns, including that of triage of admitted patients to the floor or the intensive care unit (ICU). The percentage of upgrades of all admissions to the ICU (historically 2–5%) has been used as a quality-of-care indicator, although an imperfect one.[6] Individual institutions have varying thresholds for ICU utilization, and the upgrade itself does not, in and of itself, signify poor quality of care. Sick patients get sicker, and most upgrades are for progression of illness.

This study focuses on unscheduled upgrades of patients to the ICU following admission from the emergency department (ED), specifically those in which the diagnosis was changed after the upgrade. Changes in diagnosis are not uncommon, because further diagnostic studies, consultant evaluations and response to treatments yield substantial information not available at the point of admission. The change from a tentative diagnosis made in the ED, however, may reflect an incomplete thought process behind the admission disposition. In this exploration, we attempt to determine the degree to which diagnoses of upgraded patients changed in comparison to pre-COVID-19 patterns. Using structured parameters for assigning most common cognitive biases, we

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looked for possible altered patterns of decision-making that might correlate with pandemic-induced stress.

2. Methods

This is a retrospective study conducted at an urban, academic, tertiary care center with 95,000 patient visits annually. The study site experienced an abrupt influx of COVID-19 cases from March 2020 through July of 2020. There was a concomitant decrease in ED volume of 30% over that same five-month time period. Compared to the prior year, the distribution of acuity shifted toward a high acuity cohort. During the study period, clinicians did not have access to rapid COVID-19 testing. The overall patient census declined sharply and opening of a new ICU space for Covid-19 patients prevented significant crowding and time-to-admit for non-COVID-19 patients.

We performed retrospective review of patients admitted through the ED to a non-critical level of care and then upgraded within 48 h of admission. Records were compiled by an automated process via the EPIC EMR system. A multidisciplinary ICU Committee reviews upgrades on a quarterly basis. Charts were abstracted for Early Warning Score, qSOFA score, vital sign trends and admission and discharge diagnoses. Patients with stable vital signs, low-risk, non-deteriorating EWS and qSOFA, and no change in diagnosis were considered to have been upgraded for progression of illness. Patients with high EWS or qSOFA 2 or 3, or trending deterioration of vital signs were considered as possible cases of patients who might have been directly admitted to ICU. Those cases then were further evaluated individually for diagnostic concordance independently by a team of one senior EM attending and one EM fellow. Non-concordant diagnosis was defined as a change in primary diagnosis after the upgrade that could have been effected by a change in EM management. There was a 91.9% level of agreement between the two reviewers with a corresponding Cohen's Kappa value of 0.73.

The number of ICU upgrades per month was determined, including the percentage of total upgrades noted to have non-concordant diagnoses. Charts with non-concordant diagnoses were examined in detail as to the ED medical decision-making note and the clinical circumstances surrounding the upgrade. Charts with non-concordant diagnoses directly involving COVID-19 were identified. For all cases with non-concordant diagnoses, a cognitive bias was assigned, according to defined criteria (Table 1). These cognitive biases were chosen because they are some of the most common in existing literature. Each member of the research team, which was comprised of three EM attending physicians, one EM fellow, and one EM resident, independently evaluated each case and assigned a cognitive bias. Multiple biases were assigned if no majority was reached.

Cases were reviewed during the first peak of COVID-19 cases (March 2020–July 2020) and compared to those during the same time frame in the preceding calendar year (March 2019–July 2019). These were further compared to historical data provided by the ICU review committee. Baseline frequency of non-concordant diagnoses in ICU upgrades was calculated form aggregate data of the previous six years.

This study was granted an exemption by the IRB.

Table 1
Defined criteria of common cognitive biases evaluated.

Cognitive Bias	Definition
Availability Heuristic	Overdiagnosis of COVID-19 in context of frequency and severity of this disease
Anchoring Bias	Diagnosis made based on a specific feature of history, physical examination or diagnostic finding
Premature Closure	Diagnosis made before all available data received that would have been available to physician
Confirmation Bias	Relevant information inconsistent with working diagnosis was discounted

3. Results

From March 2020 through July 2020, 3981 patients were evaluated in the ED for suspected COVID-19. Of those patients, 2387 (60.0%) were admitted. The rise in COVID-19 patients was also associated with a concomitant 21.1% decrease in ED volume over the same time period, from 41,433 visits in 2019, to 32,706 visits in 2020. Compared to 2019, 4% more patients were categorized as ESI level I and II, while 4% less were categorized as ESI levels IV and V. The percentage of ESI III patients remained constant from 2019 to 2020.

A total of 24 cases were reviewed and assigned biases, as summarized in Table 2. The increase in the overall number of ICU upgrades in 2019 and 2020 during our study period did not reach statistical significance when using a one-sided Mann-Whitney two sample test ($U = 10$, $p = 0.337$) (Table 3). In the 2020 study period, 19 out of 46 ICU upgrades (41.3%) were associated with non-concordant diagnoses. Only five of these cases were associated with a COVID-19 diagnosis. In comparison, for the same months in 2019, only six out of 54 upgrades (11.1%) demonstrated non-concordant diagnoses. This increase in upgrades due to non-concordant diagnoses did reach statistical significance ($U = 3.5$ $p = 0.038$). Aggregate data from the previous six years (2013–2018) showed 14% of upgrades with non-concordant diagnoses.

Premature closure was the most prominent cognitive bias, present in 72.2% of ICU upgrades due to non-concordant diagnoses in 2020, compared to only 50% of ICU upgrades in 2019. Anchoring was the most prominent non-concordant diagnosis in 2019, in 66.7% of cases. In 2020, it was present in 61.1% of cases. The prevalence of confirmation bias also increased in 2020 (55.6%), compared to 2019 (33.3%). Availability heuristic was least present in both years (Table 4).

4. Discussion

A small body of literature addresses patterns and predictors of patients upgraded to an ICU within 24–48 h following admission from the ED to a non-critical level of care [6]. Reasons for such upgrades have been characterized as progression of illness, mistriage (i.e., those that would have been appropriate for ICU admission initially), non-concordant diagnosis, and new events occurring after admission [7].

Review of all ICU upgrades for a 5-year period from this busy hospital showed 355 such patients (1.3% of all admissions). Prior to COVID-19, non-concordant diagnosis, in which the admission diagnosis differed from primary diagnosis at point of upgrade, or at hospital discharge, was the etiology in 20.1% of all upgrades. In contrast, during the 4-month period beginning March 2020 at the outset of the COVID-19 pandemic, non-concordant diagnosis-related ICU upgrades were found to be 41.3%. This unexpected finding prompted focused review of the same 4-month period in 2019, which found 14.3% non-concordant diagnosis during the matched period. Though the number of patients was small, it was significantly different, and it was in marked contrast to what had been consistent findings on prior monthly review. This raised the question of whether or not the pandemic was associated with changed patterns of medical decision-making.

Croskerry has described the ED as a "natural laboratory for error." [8] Ambient conditions of unpredictability, multitasking, interruptions and high-risk decision-making, in context of time and data constraints, represent a typical work day. As Croskerry points out, the EM physician may make thousands of decisions in a single shift, a density of decision-making greater than any other specialty, possibly greater than that of any other profession. A commentary by Pines suggests that increased ED crowding, resulting in a higher percentage of admissions, might imply less analytic effort in context of patient overload [9]. Greater load of decision-making, that is, may trigger increased use of cognitive short cuts. Neurobiological studies suggest that acute stress affects cognition through activation of the adrenergic axis, whereas ongoing stress tends to involve cortisol levels, with less beneficial effect on

Table 2
ICU upgrades due to non-concordant diagnoses and cognitive biases.

ED diagnosis	ICU Upgrade Diagnosis	Cognitive Biases
March 2019 – June 2019		
AKI, Hyperchloremic Acidosis, Dehydration, Chemotherapy Adverse Reaction, Hypoxia	Respiratory Failure, Atrial Flutter, Tumor Lysis Syndrome	A, PC
Chest Pain	Hypoxic Respiratory Failure, Cardiac Arrest, Multifocal Pneumonia, Mucous Plug, Sepsis	A, PC
Lumbar Transverse Process Fracture, Cocaine Intoxication, Trauma	Cardiac Syncope, Ventricular Bigeminy, Ventricular Tachycardia	A
Pyogenic Arthritis of Right Knee	Pseudogout, Hyperkalemia, Sepsis, Pneumonia	CB, PC
Intractable Headache	Hyponatremia, Pituitary Hemorrhage, Benign Neoplasm of Pituitary Gland	AH
Spontaneous Bacterial Peritonitis	Uremic Encephalopathy, Urinary Tract Infection, Septic Shock	A, CB
March 2020 – June 2020		
Symptomatic Anemia	Esophageal Varices with Acute Hemorrhage,	A
COPD Exacerbation, Hypotension	Lobar Pneumonia, Severe Sepsis, CHF Exacerbation	A, PC
Cellulitis of Left Lower Leg	Septic Shock	AH, CB, PC
Lung Mass, Failure to Thrive	Cerebral Edema, Secondary Malignant Neoplasm of Brain	CB, PC
COPD Exacerbation, Hypoxia, Elevated Troponin, Atrial Fibrillation	Hypoxic and Hypercapnic Respiratory Failure, Urosepsis	PC
Encephalopathy, Elevated Troponin, Alcoholic Hepatitis	Ventricular Fibrillation, Cardiac Arrest, UTI, Sepsis, Rhabdomyolysis, NSTEMI	CB, PC
Acute Pulmonary Edema	Influenza Pneumonia, Suspected COVID19 Pneumonia	A, CB, PC
Pyelonephritis, AKI, Dyspnea	Hypoxic Respiratory Failure, Suspected COVID19 Pneumonia, Suspected Pulmonary Embolism	A, PC
Acute Renal Failure, Dehydration, Fatigue, Delirium	COVID19 Pneumonia, Severe Sepsis with Septic Shock	CB, PC
Spontaneous Bacterial Peritonitis, Liver Failure Without Coma	Hemorrhagic Shock, Esophageal Varices with Bleeding	A, CB, PC,
Acute on Chronic CHF, Suspected COVID19	Acute Intestinal Ischemia, Lactic Acidosis, AKI	CB
Bradycardia, Hypothyroidism, Chest Pain	Pericardial Tamponade	A, CB, PC
AKI, Syncope and Collapse, Hyponatremia	Acute on Chronic Systolic Heart Failure, Cardiogenic Shock	A, PC
Syncope, AKI, NSTEMI	Acute Gastric Ulcer with Hemorrhage, Gastric Varices, Hypovolemic Shock	A, CB
Hypotension, Pre-Syncope, Atrial Fibrillation	Pulmonary Edema, Sepsis, Pleural Effusion, Hypoxic Respiratory Failure	A, AH, CB
ESRD, Hypotension, CHF	Septic Shock, unknown source	PC
New Onset Atrial Fibrillation; Fall, initial Encounter	Acute Ischemic Right PCA Stroke	A
NSTEMI	Saddle Embolus of Pulmonary Artery without Acute Cor Pulmonale	A, PC

ED admission diagnoses and respective ICU upgrade diagnoses along with corresponding primary cognitive biases are reported for all ICU upgrades during the study period. A = Anchoring, AH = Availability Heuristic, CB = Confirmation Bias, PC = Premature Closure, COPD = Chronic Obstructive Pulmonary Disease, CHF = Congestive Heart Failure, NSTEMI = Non-ST Elevation Myocardial Infarction, AKI = Acute Kidney Injury, PE = Pulmonary Embolism.

Table 3
Intensive care unit (ICU) upgrades due to non-concordant diagnoses.

	Total ICU* Upgrades	Upgrades due to non-concordant diagnoses	Non-concordant diagnoses including COVID-19
2019			
March	6	0	0
April	15	4	0
May	8	1	0
June	13	1	0
July	12	0	0
2020			
March	16	7	1
April	7	2	1
May	6	3	2
June	8	4	2
July	9	3	0
Mann-Whiteney Test:			
U statistic	10	3.5	
P-value	0.337	0.038*	

ICU upgrades due to non-concordant diagnoses, and non-concordant diagnoses involving COVID-19 are reported, for March–July 2019 and March–July 2020. Two sample Mann-Whitney test: ICU $upgrades_{2020}$ > ICU $upgrades_{2019}$. ICU = intensive care unit. * indicates statistical significance.

decision-making [10]. It may be that unaccustomed high levels of stress day after day challenge executive function via persistently elevated cortisol levels.

Decisions made without the benefit of obtainable data represent premature closure (impulsive decision-making). The abrupt increased frequency cannot be ascribed to increased patient load, as the number of treated patients decreased by more than 30% during this 4-month interval. With COVID-19 on the forefront of everyone's minds, anchoring and availability bias were likely at play. However, there was less overdiagnosis of COVID-19 than might have been expected. Confirmation bias, in which findings inconsistent with the presumptive diagnosis were ignored, was seen as well, and notably more than in the previous year. Studies of stress effects on decision-making suggest tendencies toward rigid thinking, less analysis and less creativity, as perhaps might manifest in premature closure and confirmation bias. Previous studies have also demonstrated that premature closure is one of the most common causes of diagnostic error [11].

Preventing cognitive biases can be challenging. Some have advocated for the use of a cognitive or diagnostic “time out” to allow a physician a deliberate pause to reflect on the plausibility of a working diagnosis. This allows the clinician to ask themselves “why can't this be something else?” [12] Others have suggested the use of metacognitive strategies by educating physicians on error theory and major types of heuristics and biases. They theorize that through the process of metacognition, physicians can develop cognitive forcing strategies that abort these errors [13]. Any number of these techniques can be employed to reduce the incidence and impact of cognitive biases.

4.1. Limitations

Conclusions of this study are limited in that cognitive psychology and neurobiology are evolving fields of study. Studies of effects of stress on brain function have been performed either in laboratory conditions, or longitudinally on individuals with diagnosed stress disorder. There have not been specific studies on stress-related hormonal effects on EM physicians. This study makes the unquantifiable assumption that physician stress levels spiked during the initial months of the Covid-19 surge. As opposed to a single stressful incident, such as a mass casualty disaster, stress levels persisted during the pandemic.

There are multifactorial influences on cognition, including systems issues. At this institution, early aggressive systems modifications and cooperation between ED physicians, hospitalists and intensivists, maintained ED patient flow. However, the change in ED volumes and amount of available time and resources would have also impacted both the ED patient population and the ED physicians' ability to respond to those patients. The impact of this is also challenging to quantify.

Table 4
Prevalence of cognitive biases in intensive care unit upgrades secondary to non-concordant diagnoses.

Cognitive Bias	2019		2020	
	Number of Cases	Percentage of Cases	Number of Cases	Percentage of Cases
Premature Closure	3	50.0%	13	72.2%
Anchoring	4	66.7%	11	61.1%
Confirmation Bias	2	33.3%	10	55.6%
Availability Heuristic	1	16.7%	3	16.7%

Each case was reviewed and assigned most relevant cognitive biases based on pre-determined definitions. Anchoring, confirmation bias, and premature closure were present in the majority of cases, while the availability heuristic was present in only 16.7%.

While this study focuses on decision-making of ED physicians, all admissions were, in fact, cooperative decisions between ED and inpatient physicians. ICU upgrades involve patients with abrupt clinical deterioration and momentum bias on the part of admitting physicians may have been at play. The clinical spectrum of disease differed from pre-pandemic experience, with the majority of admissions being those of COVID-19 or suspected COVID-19. In that regard, it is striking that ICU upgrades involved majority non-COVID-19 patients.

Specific cognitive biases must be assigned with caution, as there is much overlap and subjectivity in such designations. While the decision of appropriate bias to attach to each individual case of upgrade is debatable, there seemed in this study to be a larger that previously experienced incidence of premature closure. However, premature closure, anchoring and confirmation bias are closely related.

A significant limitation of this study is the limited number of upgraded patients. However, there is extensive previous tracking of ICU upgrades, and there appeared to be marked change in pattern during these initial months of COVID-19. While cognitive bias and the ambient conditions that might accentuate cognitive bias has been addressed in EM literature, knowledge and understanding are drawn from the relatively young fields of cognitive psychology and neurobiology. Studies of thinking patterns under stress have largely been performed under controlled laboratory conditions. We need caution in applying the tentative conclusions of these studies to the actual circumstances of making impactful decisions in risky and rapidly changing conditions.

5. Conclusion

Though it is early to speak of perspective gained form the COVID-19 experience, this retrospective review of ICU upgrades suggests some degree of changes in thought processes working within pandemic conditions. An atypically large percentage of upgrades were found to have change in diagnosis after admission from the ED. Furthermore, the pattern of those upgrades also changed in the early months of COVID-19. Cognitive biases at play seemed to trend toward premature closure, consistent with psychobiological work that has implied stress-induced tendency toward impulsive decision-making. More work remains to be done to further evaluate the relationship between the pandemic, stress, cognitive bias, and decision making.

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Presentations

None.

Declaration of Competing Interest

None.

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