

**COVID EHR Cohort at the University of Wisconsin
(CEC-UW) Project:
Overall and Hospitalized Samples Data Summary**

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COVID EHR Cohort at the University of Wisconsin (CEC-UW) Project: Overall and Hospitalized Samples Data Summary

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Section 1. Overview of the CEC-UW Project

The COVID EHR Cohort at the University of Wisconsin (CEC-UW) project (**Principal Investigator: Michael Fiore, MD, MPH, MBA; Senior Scientist: Timothy Baker, PhD**) is a retrospective cohort study funded by the National Cancer Institute (NCI; CRDF Award #66590). The CEC-UW project was designed to collect and analyze selected patient data from electronic health record (EHR) systems used at 21 participating health systems for patients with COVID-19 (see inclusion criteria below). The overall goal of the CEC-UW project is to evaluate if a broad array of discrete EHR data elements (including smoking and cancer history) are related to COVID severity and outcomes.

Specialized computer programs were developed by CEC-UW project programmers to extract and harmonize EHR-based patient data at the 21 participating health systems. The CEC-UW project collected five different domains of patient data (more details in later sections):

- (1) Patient Information (e.g., demographic variables, height, weight, blood type, patient ZIP code, etc.)
- (2) Encounter-based Variables (e.g., encounter type, vital signs, specific encounter-based ICD-10 diagnoses, COVID-related signs and symptoms)
- (3) Tabulation of all Pre- and Post-COVID ICD-10 diagnoses
- (4) Selected medications
- (5) Selected lab test results

Data extraction code used by the 21 health systems determined whether patients met criteria for inclusion in the CEC-UW project cohort. The extraction code utilized EHR data to evaluate if a patient met one or more of the following three inclusion criteria:

- (1) ICD-10 diagnosis of COVID-19 (U07.1 or J12.82)
- (2) COVID-19 polymerase chain reaction (PCR) test positive result
- (3) COVID-19 antigen test positive result

Interim transfers of data started in mid-2020 and culminated in the final transfer of data in 2022 for all COVID-19 patients who met study inclusion criteria from February 1, 2020, to January 31, 2022. A total of 1.634 million patients met one or more of the criteria for inclusion in the CEC-UW retrospective cohort. The figure on page 5 depicts the names and locations of the 21 participating health systems.

Additional details about the CEC-UW project data extraction and transfer:

- Each patient in the dataset from each health system was assigned an enduring cryptographically processed Patient ID based on the SHA256 algorithm, which

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yielded a 64-character unique and private hash-based message authentication code (HMAC).

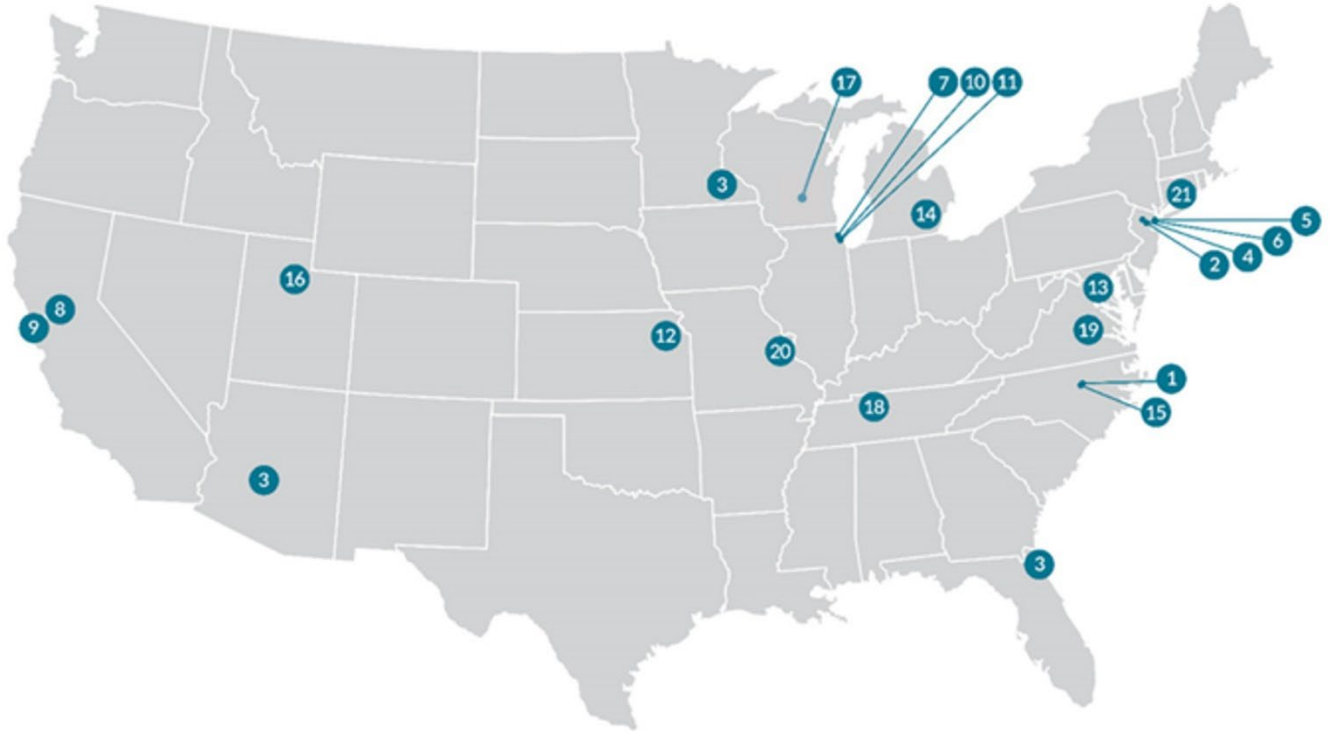
- Secure transfer of data from each of the 21 health systems was accomplished via the transfer of data files to a secure SFTP (secure shell [SSH] File Transfer Protocol) portal located at the CEC-UW Coordinating Center.
- EHR data extraction code was provided via Github to all participating health systems with versions for Oracle-based and SQL-based EHR systems. Extraction code was further customized by the Information Technology (IT) staff at each of 21 health systems to account for health-system-specific EHR structures, tables, formats, and terminologies.
- The data extraction code was designed to locate and export data elements in a relatively uniform manner across the 21 health systems. The customization of the extraction code (i.e., with system-specific modifications) yielded partly harmonized data files for transfer to the CEC-UW Coordinating Center with the same basic set of data files and EHR variables within each data file, thus allowing later processing, additional harmonization, and ultimate merging of the data files across all 21 health systems according to a common set of specifications.

Ethics Statement:

The CEC-UW study was initially approved in May 2020 by the University of Wisconsin-Madison Health Sciences Minimal Risk Institutional Review Board (MR-IRB) with approval for the collection of de-identified EHR data from the 21 health systems. The MR-IRB also determined that the study met criteria for a human subjects research exemption and qualified for a waiver of informed consent under the Federal Common Rule. All participating health systems provided written notice of either their own institution's IRB approval or determination of exemption status before sharing EHR data. In February 2021, the MR-IRB approved a change of protocol to collect a Limited Data Set, allowing the extraction of additional patient information (e.g., death dates, five-digit zip codes) but excluding direct patient identifiers.

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Section 2. Participating Healthcare Systems



1. Duke University
2. Hackensack
3. Mayo
4. Memorial Sloan Kettering
5. Mount Sinai
6. New York University
7. Northwestern University
8. UC Davis
9. UC San Francisco
10. University of Chicago
11. University of Illinois
12. University of Kansas
13. University of Maryland
14. University of Michigan
15. University of North Carolina
16. University of Utah
17. University of Wisconsin
18. Vanderbilt University
19. VA Commonwealth University
20. Washington University
21. Yale University

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Section 3: Inclusion criteria for the CEC-UW Overall Sample

Patients included in the Overall Sample must have met the following three criteria for inclusion:

1. Must have a **COVID Index Date** in the Patient Information Dataset that falls between February 1, 2020, and January 31, 2022; **COVID Index Date** is the date that a patient was first identified by a healthcare system as having COVID-19 via ICD-10 diagnosis or lab test (PCR or Antigen tests)
2. Must have an identifiable **Index Encounter** in the Encounters Dataset that corresponds to the **COVID Index Date**; the **Index Encounter** is an inpatient hospitalization encounter, an outpatient clinic visit, a lab test encounter, or other encounter within the health system where a patient is first diagnosed with an ICD-10 diagnosis of COVID-19 or identified via a positive COVID-19 lab test (PCR or antigen test)
3. Must have either of the following associated with the **Index Encounter** to verify that that the patient had COVID-19 at the time of entry into the CEC-UE cohort:
 - a) An **ICD-10 COVID-19 diagnosis** (U07.1 or J12.82)
 - OR*
 - b) A **positive PCR test or positive Antigen test** result

Across all 21 Health Systems, N = 1,634,378 patients met criteria for inclusion in the Overall Sample.

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Section 4: Overview of the Overall Sample Dataset

The **Overall Sample Dataset** includes all patients meeting criteria for inclusion in the CEC-UW cohort (see **Section 3: Inclusion criteria for the Overall Sample**). The **Overall Sample Dataset** is a customized dataset that combines variables from the five CEC-UW Source Datasets: Patient Information, Diagnosis, Encounters, Medications, and Laboratory Test Results. Customization involved programming to select specific records in the three stacked Source Datasets (multiple records per patient; Encounters, Medications, and Laboratory Test Results Source Datasets). Records selected from the three stacked Source Datasets were processed to yield three wide files (one record per patient) for merging with two wide Source Datasets: Patient Information and Diagnosis. The result of this process is a merged wide file, the **Overall Sample Dataset**, with one record per patient (N=1,634,378 patients).

Selection of Patients, Records, and Variables

- The **Overall Sample Dataset** was created at the CEC-UW Coordinating Center as an SPSS savefile
- The **Overall Sample Dataset** is designed to be a wide file that includes all variables from the two wide Source Datasets, Patient Information and Diagnosis, as well as selected records (but most variables) from the three stacked Source Datasets: Encounters, Medications, and Laboratory Test Results
- All patients in the **Overall Sample** have a **COVID Index Date** which represents the first date that a patient was first identified by a healthcare system as having COVID-19 via ICD-10 diagnosis or lab test (PCR or Antigen tests) and an **Index Encounter** (corresponding to the **COVID Index Date**) in the **Encounter Source Dataset**
- The **Index Encounter** was identified via an **Encounter Source Dataset** variable *PrimaryPosCovidEncounter_Enc* that indicated 1=Yes or 0=No that a specific **Encounter Source Dataset** record was the encounter when a patient was first identified by a healthcare system as having COVID-19
- Records from the three stacked Source Datasets in the **Overall Sample Dataset** are based on the Index Encounter
- All five Source Datasets have a *PatientID* variable to identify the 1,634,378 patients in the Overall Sample; the three stacked Source Datasets also have an *EncounterID* variable that allowed linking of Index Encounter records across the Encounter, Medications, and Laboratory Test Results Source Datasets

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Section 5: Overview of the Hospitalized Sample Dataset

The **Hospitalized Sample Dataset** is a customized dataset that includes all patients meeting specific inclusion criteria as described in **Section 3** for the **Initial Inpatient Encounter**. The **Hospitalized Sample Dataset** combines variables from the five CEC-UW Source Datasets: Patient Information, Diagnosis, Encounters, Medications, and Laboratory Test Results. Customization involved programming to select specific records in the three stacked Source Datasets (multiple records per patient; Encounters, Medications, and Laboratory Test Results Source Datasets). Records selected from the three stacked Source Datasets were processed to yield three wide files (one record per patient) for merging with two wide Source Datasets: Patient Information and Diagnosis. The result of this process is a merged wide file, the **Hospitalized Sample Dataset**, with one record per patient (N=149,989 patients).

Selection of Patients, Records, and Variables

- The **Hospitalized Sample Dataset** was created at the CEC-UW Coordinating Center as an SPSS savefile
- The **Hospitalized Sample Dataset** is designed to be a wide file that includes all variables from the two wide Source Datasets, Patient Information and Diagnosis, as well as selected records (but most variables) from the three stacked Source Datasets: Encounters, Medications, and Laboratory Test Results
- All patients in the **Hospitalized Sample** have a **COVID Index Date** which represents the first date that a patient was first identified by a healthcare system as having COVID-19 via ICD-10 diagnosis or lab test (PCR or Antigen tests) and an **Index Encounter** (corresponding to the **COVID Index Date**) in the Encounter Source Dataset
- The **Index Encounter** was identified via an **Encounter Source Dataset** variable *PrimaryPosCovidEncounter_Enc* that indicated 1=Yes or 0=No that a specific **Encounter Source Dataset** record was the encounter when a patient was first identified by a healthcare system as having COVID-19
- All five Source Datasets have a *PatientID* variable to identify the 149,989 patients in the Hospitalized Sample; the three stacked Source Datasets also have an *EncounterID* variable that allowed linking of records across the Encounter, Medications, and Laboratory Test Results Source Datasets associated with the **Initial Inpatient Encounter**

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Table 1. Number and Percent of Covid-19 Patients by Healthcare System				
Healthcare System	Number and % of Total COVID-19 Cases			
	Overall Sample		Hospitalized Sample	
	N	%	N	%
1. Duke University	73,273	4.5%	5,671	3.8%
2. Hackensack Meridian Health	195,725	12.0%	21,132	14.1%
3. Mayo Clinic	195,139	11.9%	10,665	7.1%
4. Memorial Sloan Kettering	4,510	0.3%	525	0.4%
5. Mount Sinai	77,832	4.8%	9,552	6.4%
6. New York University	109,443	6.7%	11,154	7.4%
7. Northwestern University	145,345	8.9%	13,534	9.0%
8. University of California Davis	24,261	1.5%	1,712	1.1%
9. University of California San Francisco	31,821	1.9%	1,329	0.9%
10. University of Chicago	28,939	1.8%	3,207	2.1%
11. University of Illinois Chicago	17,167	1.1%	1,813	1.2%
12. University of Kansas	32,020	2.0	3,201	2.1%
13. University of Maryland	77,687	4.8%	11,489	7.7%
14. University of Michigan	64,921	4.0%	3,368	2.2%
15. University of North Carolina	121,655	7.4%	13,502	9.0%
16. University of Utah (Huntsman)	75,342	4.6%	2,568	1.7%
17. University of Wisconsin Health	26,074	1.6%	1,863	1.2%
18. Vanderbilt University	49,975	3.1%	4,854	3.2%
19. Virginia Commonwealth University	10,033	0.6%	2,694	1.8%
20. Washington University St Louis	93,583	5.7%	13,089	8.7%
21. Yale New Haven Health System	121,655	7.4%	13,067	8.7%
TOTAL NUMBER	1,634,378	100%	149,989	100%

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Sample	Total Number of Patients	Range of Sample Sizes from the Healthcare Systems
Overall Sample	1,634,378	Minimum: 4,510 Maximum: 195,725
Hospitalized Sample	149,989	Minimum: 525 Maximum: 21,132

COVID-19 Criteria	Number and % of Total Cases			
	Overall Sample		Hospitalized Sample*	
	N	%	N	%
Positive COVID-19 PCR Lab Test Only	676,116	41.4%	8,748	5.8%
Positive COVID-19 Antigen Lab Test Only	4,381	0.3%	N/A	N/A
ICD-10-CM COVID-19 Diagnosis Only	509,767	31.2%%	30,671	20.4%
Positive COVID-19 PCR Lab Test and ICD-10-CM COVID-19 Diagnosis	432,559	26.5%	110,570	73.7%
Positive COVID-19 Antigen Lab Test and ICD-10-CM COVID-19 Diagnosis	11,555	0.7%	N/A	N/A
TOTAL NUMBER	1,634,378	100%	149,9899	100%

*Criteria for the Hospitalized Sample included ICD-10 COVID-19 Diagnosis and positive PCR in a 14-day window around the initial inpatient encounter but did not include antigen test results.

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Table 4. Encounter Type in the Overall Sample Based on the Index (First) Encounter When COVID-19 First Diagnosed		
Type of Encounter	Number and % of Encounter Records	
	N	%
Inpatient	219,673	13.5%
Office Visit Equivalent	799,436	48.9%
Emergency Department	229,728	14.1%
Urgent Care	88,713	5.4%
Other	296,828	18.2%
TOTAL NUMBER	1,634,378	100%

Table 5. Did Patient Receive at Least One Dose of the COVID-19 Vaccination?				
Vaccination Status	Number and % of Cases			
	Overall Sample		Hospitalized Sample	
	N	%	N	%
Yes	693,668	42.4%	56,028	37.4%
No	940,710	57.6%	93,961	62.6%
TOTAL	1,634,378	100%	149,989	100%

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Table 6. All-Cause Mortality and Intubations in 1,634,378 Patients in the Overall Sample*		
Variable	Number and % of Cases	
	N	%
Mortality	35,268	2.2%
Intubations	23,308	1.4%

*Deaths based on death variable in the Patient Information Source Dataset.

Table 7. Mortality and Intubations in 149,989 Patients in the Hospitalized Sample*		
Variable	Number and % of Cases	
	N	%
Mortality	13,062	8.7%
Intubations	19,124	12.8%

*Deaths based on mortality variable in the Encounters Source Dataset.

Table 8. Sex				
Sex	Number and % of Cases			
	Overall Sample		Hospitalized Sample	
	N	%	N	%
Female	896,304	54.8%	76,526	51.0%
Male	737,206	45.1%	73,459	49.0%
Other	849	0.1%	0	0.0%
Missing	19	0.0%	0	0.0%
TOTAL NUMBER	1,634,378	100%	149,989	100%

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Table 9. Age Groups by 10 Year Increments				
Age Group	Number and % of Cases			
	Overall Sample		Hospitalized Sample	
	N	%	N	%
0 - 9 years	111,034	6.8%	2,090	1.4%
10 - 19 years	151,550	9.3%	2,948	2.0%
20 - 29 years	246,968	15.1%	8,878	5.9%
30 - 39 years	260,559	15.9%	13,051	8.7%
40 - 49 years	235,646	14.4%	14,666	9.8%
50 - 59 years	244,573	15.0%	24,097	16.1%
60 - 69 years	196,665	12.0%	30,593	20.4%
70 - 79 years	117,877	7.2%	27,913	18.6%
80 - 89 years	54,387	3.3%	19,230	12.8%
90+ years	15,107	0.9%	6,523	4.3%
Missing	2	0.0	0	0.0%
TOTAL NUMBER	1,634,378	100%	149,989	100%

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Table 10. Age Groups (Five Groups)				
Age Group	Number and % of Cases			
	Overall Sample		Hospitalized Sample	
	N	%	N	%
0 - 17 years	219,986	13.59%	4,045	2.7%
18 - 24 years	160,616	9.8%	4,624	3.1%
25 - 44 years	509,586	31.2%	24,976	16.7%
45 - 64 years	469,826	28.7%	47,598	31.7%
65+ years	274,362	16.8%	68,746	45.8%
Missing	2	0.0%	0	0.0%
TOTAL NUMBER	1,634,378	100%	149,989	100%

Table 11. Mean Age by Sex		
Sex/Gender	Mean Age in Years (SD)	
	Overall Sample (N=1,634,378)	Hospitalized Sample (N=149,989)
Female	42.0 (21.1)	58.8 (21.2)
Male	42.3 (22.1)	60.7 (18.8)
Other	36.0 (17.2)	50.8 (19.6)
OVERALL	42.1 (21.5`)	59.7 (20.1)

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Race Category	Number and % of Cases			
	Overall Sample		Hospitalized Sample	
	N	%	N	%
American Indian/Alaska Native	5,080	0.3%	567	0.4%
Asian	51,140	3.1%	3,991	2.7%
Black or African American	251,418	15.4%	35,769	23.8%
Native Hawaiian or Other Pacific Islander	6,128	0.4%	610	0.4%
White	946,441	57.9%	87,643	58.4%
Other Race (Not Specified)	175,630	10.7%	18,179	12.1%
More Than One Race	9,895	0.6%	646	0.4%
Unknown, Not Reported, or Missing	188,646	11.5%	2,584	1.7%
TOTAL NUMBER	1,634,378	100%	149,989	100%

Ethnicity	Number and % of Cases			
	Overall Sample		Hospitalized Sample	
	N	%	N	%
Not Hispanic or Latino	1,186,064	72.6%	123,659	82.4%
Hispanic or Latino	287,009	17.6%	23,437	15.6%
Unknown, Not Reported, or Missing	161,305	9.9%	2,893	1.9%
OVERALL	1,634,378	100%	149,989	100%

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Table 14. Insurance Status				
Type of Insurance	Number and % of Cases			
	Overall Sample		Hospitalized Sample	
	N	%	N	%
Medicare	285,220	17.5%	75,966	50.6%
Medicaid	190,692	11.7%	19,070	12.7%
Commercial	780,048	47.7%	40,435	27.0%
Uninsured	131,356	8.0%	3,911	2.6%
Other	247,062	15.1%	10,607	7.1%
TOTAL	1,634,378	100%	149,989	100%

Table 15. Cigarette Smoking Status				
Cigarette Smoking Status	Number and % of Cases			
	Overall Sample		Hospitalized Sample	
	N	%	N	%
Current	102,975	6.3%	12,392	8.3%
Former	246,943	15.1%	44,936	30.0%
Never	818,743	50.1%	78,430	52.3%
Unknown, Not Reported, or Missing	465,717	28.5%	14,231	9.5%
TOTAL	1,634,378	100%	149,989	100%

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Table 16. Smokeless Tobacco Use				
Smokeless Status	Number and % of Cases			
	Overall Sample		Hospitalized Sample	
	N	%	N	%
Smokeless, Current	14,349	0.9%	1,769	1.2%
Smokeless, Former	24,771	1.5%	4,331	2.9%
Smokeless, Never	900,788	55.1%	117,173	78.1%
Unknown, Not Reported, or Missing	694,470	42.5%	26,716	17.8%
TOTAL	1,634,378	100%	149,989	100%

Table 17. E-Cigarette Use				
E-Cigarette Status	Number and % of Cases			
	Overall Sample		Hospitalized Sample	
	N	%	N	%
Yes	12,874	0.8%	1,242	0.8%
No	711,326	43.5%	94,062	62.7%
Unknown, Not Reported, or Missing	910,178	55.7%	54,685	36.5%
TOTAL	1,634,378	100%	149,989	100%

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Table 18. Cancer – Past Year Prior to COVID-19				
Type of Cancer	Number and % of Cases			
	Overall Sample		Hospitalized Sample	
	N	%	N	%
Lymphoma	3,168	0.2%	905	0.6%
Leukemia	1,948	0.1%	633	0.4%
Lung/Respiratory	2,385	0.1%	846	0.6%
Rectal	370	0.0%	107	0.1%
Breast (Females Only)	4,278	0.5%	711	0.9%
Prostate (Males Only)	1,869	0.25%	428	0.6%
Pancreas	553	0.0%	192	0.1%
Any Type of Cancer	27,371	1.7%	7,044	4.7%
NOTE: “Any Type of Cancer” includes all the types of cancer in this table as well as other cancers not in the table.				

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Table 19. Medical and Psychiatric Conditions in the Past Year Prior to COVID-19				
Condition	Number and % of Cases			
	Overall Sample (N=189,993)		Hospitalized Sample (N=50,141)	
	N	%	N	%
Asthma	34,014	2.1%	3,398	2.3%
COPD	12,848	0.8%	4,815	3.2%
Diabetes	49,205	3.0%	14,469	9.6%
Coronary Artery Disease or Congestive Heart Failure	39,352	2.4%	13,714	9.1%
Chronic Renal Disease	29,219	1.8%	10,734	7.2%
Immunocompromising Condition	10,458	0.6%	2,138	1.4%
Hypertension	47,568	2.9%	9,557	6.4%
Depression	44,099	2.7%	5,938	4.0%
Anxiety	66,272	4.1%	7,235	4.8%
Alcohol Use Disorder	9,716	0.6%	2,542	1.7%
Pregnancy (Females Only)	21,468	2.4%	4,391	5.7%

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Table 20. BMI Categories				
BMI Category	Number and % of Cases			
	Overall Sample		Hospitalized Sample	
	N	%	N	%
Underweight (BMI <18.5)	27,206	1.7%	4,781	3.2%
Healthy Weight (18.5 - 24.99)	389,308	23.8%	35,609	23.7%
Overweight (25 – 29.99)	382,307	23.4%	42,007	28.0%
Obese (30 or higher)	523,492	32.0%	65,757	43.8%
Unknown, Not Reported, or Missing	312,065	19.1%	1,835	1.2%
TOTAL	1,634,378	100%	149,989	100%

Table 21. Blood Type				
Blood Type	Number and % of Cases			
	Overall Sample		Hospitalized Sample	
	N	%	N	%
A	109,100	6.7%	22,829	15.2%
B	41,888	2.6%	9,404	6.3%
AB	21,331	0.8%	2,702	1.8%
O	143,327	8.8%	29,598	19.7%
Unknown, Not Reported, or Missing	1,327,732	81.2%	85,456	57.0%
TOTAL	1,634,378	100%	149,989	100%

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Table 22. COVID-19 Medication – 30 Days Post-COVID-19				
Medication	Number and % of Cases			
	Overall Sample (N=1,634,387)		Hospitalized Sample (N=148,989)	
	N	%	N	%
Dexamethasone	133,230	8.2%	75,283	50.2%
Remdesivir	76,136	4.7%	60,103	40.1%
Tocilizumab	10,715	0.7%	7,851	5.2%
Any COVID-19 Medication (26 Different Medications)	235,359	14.4%	102,502	68.3%