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# Severe Outcomes, Readmission, and Length of Stay Among COVID-19 Patients with Intellectual and Developmental Disabilities

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## ABSTRACT

**Objectives:** The aim of this study was to evaluate the association between intellectual and developmental disabilities (IDDs) and severe COVID-19 outcomes, 30-day readmission, and/or increased length of stay (LOS) using a large electronic administrative database.

**Methods:** Patients hospitalized with COVID-19 were identified between March 2020 and June 2021 from more than 900 hospitals in the United States. IDDs included intellectual disability, cerebral palsy, Down syndrome, autism spectrum disorder (ASD), and other intellectual disabilities. Outcomes included intensive care unit (ICU) admission, invasive mechanical ventilation (IMV), 30-day readmission, mortality, and LOS.

**Results:** Among 643,765 patients with COVID-19, multivariate models showed that patients with any IDD were at a significantly greater risk of at least 1 severe outcome, 30-day readmission, or longer LOS than patients without any IDD. Compared with those without any IDD, patients with Down syndrome had the greatest odds of ICU admission (odds ratio [OR] and 95% confidence interval [CI]: 1.96 [1.73–2.21]), IMV (OR: 2.37 [2.07–2.70]), and mortality (OR: 2.33 [2.00–2.73]). Patients with ASD and those with Down syndrome both had over a 40% longer mean LOS. Patients with intellectual disabilities had a 23% (12–35%) increased odds of 30-day readmission.

**Conclusions:** Results suggest that patients hospitalized with COVID-19 with IDD have a significantly increased risk of severe outcomes, 30-day readmission, and longer LOS.

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## Background

Intellectual and developmental disabilities (IDDs) are a broad group of conditions characterized by physical impairments and impairments in learning, language, and/or behavior that begin during the developmental period. Comorbidities, immune dysfunction, or difficulty in accessing health care may put individuals with IDD at greater risk of severe COVID-19 outcomes (Kamalakkannan et al., 2021). Population-based studies have predominantly evaluated mortality risk but not other outcomes including length of stay (LOS) and readmission (Clift et al., 2021; Karpur et al., 2021; Perera et al., 2020; Turk et al., 2020). We evaluated whether IDD is associated with intensive care unit (ICU) admission, invasive mechanical ventilation (IMV), 30-day readmission,

all-cause in-hospital mortality, and/or increased LOS using a large electronic administrative database.

## Methods

Data were obtained from the Premier Healthcare Database Special COVID-19 Release (Premier Applied Sciences, 2020), which includes discharge data from more than 900 hospitals representing approximately 20% of annual admissions in the United States (U.S.). Patients with COVID-19 discharged from March 1, 2020, to June 30, 2021, were identified using International Classification of Diseases, Tenth Revision, Clinical Modification (ICD-10-CM) discharge codes of U07.1 (from April 2020) or B97.29 (March 2020 through April 2020). Presence of  $\geq 1$  ICD-10-CM code (codes in Table 1) for intellectual disability, cerebral palsy, Down syndrome, autism spectrum disorder (ASD), and other intellectual disabilities from January 2019 through the index hospitalization was used to ascertain IDD (categories were not mutually exclusive).

Mixed-effects models accounted for clustering by hospitals. Model 1 adjusted for potential confounders including demograph-

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**Table 1**

Characteristics of patients hospitalized with COVID-19 in the Premier Healthcare Database Special COVID-19 Release by IDD status, March 2020–June 2021 (N = 643,765)

	No IDD (n = 634,161)	Intellectual disability (n = 5,507)	Cerebral palsy (n = 2,329)	Down syndrome (n = 1,412)	Autism spectrum disorder (n = 1,525)	Other intellectual disability (n = 1,157)
<b>Patient characteristics</b>						
Age, years						
0–17	5,530 (0.9%)	84 (1.5%)	146 (6.3%)	61 (4.3%)	177 (11.6%)	279 (24.1%)
18–39	72,374 (11.4%)	909 (16.5%)	502 (21.6%)	493 (34.9%)	672 (44.1%)	222 (19.2%)
40–49	62,724 (9.9%)	646 (11.7%)	314 (13.5%)	230 (16.3%)	191 (12.5%)	92 (8.0%)
50–64	171,435 (27.0%)	2,083 (37.8%)	778 (33.4%)	534 (37.8%)	310 (20.3%)	256 (22.1%)
≥65	322,098 (50.8%)	1,785 (32.4%)	589 (25.3%)	94 (6.7%)	175 (11.5%)	308 (26.6%)
Gender						
Female	308,761 (48.7%)	2,149 (39.0%)	946 (40.6%)	663 (47.0%)	367 (24.1%)	494 (42.7%)
Male	325,400 (51.3%)	3,358 (61.0%)	1,383 (59.4%)	749 (53.0%)	1,158 (75.9%)	663 (57.3%)
Race/Ethnicity						
Non-Hispanic White	343,108 (54.1%)	3,576 (64.9%)	1,518 (65.2%)	907 (64.2%)	923 (60.5%)	639 (55.2%)
Non-Hispanic Black	112,596 (17.8%)	1,096 (19.9%)	404 (17.3%)	170 (12.0%)	267 (17.5%)	199 (17.2%)
Hispanic	109,576 (17.3%)	445 (8.1%)	237 (10.2%)	207 (14.7%)	197 (12.9%)	202 (17.5%)
Non-Hispanic Asian	15,632 (2.5%)	67 (1.2%)	32 (1.4%)	29 (2.1%)	34 (2.2%)	30 (2.6%)
Other/Unknown	53,249 (8.4%)	323 (5.9%)	138 (5.9%)	99 (7.0%)	104 (6.8%)	87 (7.5%)
Health insurance						
Medicare	329,246 (51.9%)	4,111 (74.7%)	1,554 (66.7%)	962 (68.1%)	721 (47.3%)	544 (47.0%)
Medicaid	91,405 (14.4%)	1,154 (21.0%)	592 (25.4%)	331 (23.4%)	550 (36.1%)	403 (34.8%)
Private	161,290 (25.4%)	172 (3.1%)	154 (6.6%)	103 (7.3%)	205 (13.4%)	166 (14.3%)
Other	52,220 (8.2%)	70 (1.3%)	29 (1.2%)	16 (1.1%)	49 (3.2%)	44 (3.8%)
Admission month						
≤March 2020	20,417 (3.2%)	275 (5.0%)	114 (4.9%)	68 (4.8%)	72 (4.7%)	39 (3.4%)
April–June 2020	91,830 (14.5%)	1,280 (23.2%)	487 (20.9%)	255 (18.1%)	248 (16.3%)	156 (13.5%)
July–September 2020	95,420 (15.0%)	773 (14.0%)	349 (15.0%)	204 (14.4%)	226 (14.8%)	157 (13.6%)
October–December 2020	207,710 (32.8%)	1,802 (32.7%)	749 (32.2%)	459 (32.5%)	456 (29.9%)	400 (34.6%)
January–March 2021	160,403 (25.3%)	1,120 (20.3%)	506 (21.7%)	313 (22.2%)	395 (25.9%)	296 (25.6%)
April–June 2021	58,381 (9.2%)	257 (4.7%)	124 (5.3%)	113 (8.0%)	128 (8.4%)	109 (9.4%)
Elixhauser comorbidity index*	4.6 ± 9.7	6.2 ± 8.9	10.2 ± 8.0	4.3 ± 8.2	3.6 ± 8.0	7.9 ± 10.2
<b>Hospital characteristics</b>						
Urbanicity						
Urban	558,371 (88.0%)	4,772 (86.7%)	2,073 (89.0%)	1,231 (87.2%)	1,364 (89.4%)	1,040 (89.9%)
Rural	75,790 (12.0%)	735 (13.3%)	256 (11.0%)	181 (12.8%)	161 (10.6%)	117 (10.1%)
Census division						
East North Central	13,508 (2.1%)	173 (3.1%)	72 (3.1%)	42 (3.0%)	42 (2.8%)	37 (3.2%)
East South Central	103,143 (16.3%)	1,573 (28.6%)	479 (20.6%)	292 (20.7%)	345 (22.6%)	205 (17.7%)
Middle Atlantic	103,654 (16.3%)	1,006 (18.3%)	449 (19.3%)	232 (16.4%)	256 (16.8%)	223 (19.3%)
Mountain	28,614 (4.5%)	372 (6.8%)	130 (5.6%)	89 (6.3%)	96 (6.3%)	48 (4.1%)
New England	168,410 (26.6%)	1,213 (22.0%)	528 (22.7%)	294 (20.8%)	375 (24.6%)	244 (21.1%)
Pacific	44,800 (7.1%)	233 (4.2%)	143 (6.1%)	79 (5.6%)	66 (4.3%)	48 (4.1%)
South Atlantic	80,985 (12.8%)	534 (9.7%)	249 (10.7%)	178 (12.6%)	147 (9.6%)	134 (11.6%)
West North Central	49,950 (7.9%)	202 (3.7%)	133 (5.7%)	100 (7.1%)	100 (6.6%)	84 (7.3%)
West South Central	41,097 (6.5%)	201 (3.6%)	146 (6.3%)	106 (7.5%)	98 (6.4%)	134 (11.6%)

\* Higher values suggest a greater degree of comorbidity associated with mortality. Expressed as mean ± standard deviation. Abbreviation: IDDs = intellectual and developmental disabilities. IDDs included the following conditions and corresponding International Classification of Diseases, Tenth Revision, Clinical Modification discharge codes: intellectual disability (F70–79), cerebral palsy (G80), Down syndrome (Q90), autism spectrum disorder (F84), and other intellectual disabilities (F80 [Specific developmental disorders of speech and language], F82 [Specific developmental disorder of motor function], F88 [Other disorders of psychological development], F89 [Unspecified disorder of psychological development], and Q91–Q99 [Chromosomal abnormalities, not elsewhere classified; excluding Down syndrome]). As patients could have more than 1 condition, categories were not mutually exclusive.

ics (age, sex, race/ethnicity), socioeconomic factors (insurance type, urbanicity, U.S. Census Division), and also admission month to account for temporal variations in outcomes. As adjusting for individual comorbidities may lead to collinearity, model 2 further adjusted for the Elixhauser comorbidity index, a commonly used measure of overall comorbidity burden comprising 29 conditions, which outperforms other comorbidity indices in predicting mortality (Moore et al., 2017; Sharabiani et al., 2012). Models 1 and 2 compared individuals with each IDD to individuals without the IDD (e.g., ASD vs. no ASD), whereas model 3 excluded patients with any IDD in the reference group (e.g., ASD vs. no IDD of any type), while controlling for the same covariates in model 2. Statistical software SAS 9.4 was used for statistical analyses.

## Results

Among the 643,765 patients with COVID-19, patients with an IDD were generally younger and more likely to be male than patients without an IDD (Table 1). Table 2 shows adjusted estimates among patients with each IDD compared with patients without an IDD. In all models, patients with an intellectual disability had a 15% to 29% significantly higher mean odds of IMV, readmission,

and mortality. Patients with Down syndrome were at the greatest risk of most outcomes, including approximately a 2-fold significant increased mean odds of ICU admission, IMV, and mortality. Patients with ASD had a 21% to 40% significantly increased odds of ICU admission and IMV. In model 1, individuals with other intellectual disabilities had a 44% to 61% increased odds of ICU admission, IMV, and readmission, although ORs were attenuated slightly in models 2 and 3. All groups were at a significantly higher risk of longer LOS; in all models, patients with Down syndrome or ASD had approximately 40% longer mean LOS.

## Discussion

Among patients hospitalized with COVID-19, results suggest an increased risk of severe COVID-19 outcomes, readmission, and longer LOS among patients with an IDD, compared with those without an IDD. Furthermore, the sample size allowed sufficient disaggregation of IDDs to reveal qualitative differences in risk across conditions and outcomes. For example, although patients with Down syndrome had the highest risk of each outcome for severe COVID-19, there was no increased risk of readmission, possibly owing to survival bias as mortality risk was high. A pre-

**Table 2**

Hospitalization outcomes among patients with IDD compared with patients without IDD in the Premier Healthcare Database Special COVID-19 Release, March 2020–June 2021 (N = 643,765)

	Intellectual disability (n = 5,507)	Cerebral palsy (n = 2,329)	Down syndrome (n = 1,412)	Autism spectrum disorder (n = 1,525)	Other intellectual disability (n = 1,157)
<b>Odds ratios (95% confidence interval)</b>					
<b>ICU admission</b>					
Model 1	<b>1.12 (1.05-1.19)</b>	<b>1.29 (1.18-1.42)</b>	<b>1.97 (1.75-2.23)</b>	<b>1.21 (1.08-1.36)</b>	<b>1.44 (1.26-1.64)</b>
Model 2	1.09 (1.02-1.16)	1.07 (0.98-1.18)	<b>1.95 (1.73-2.20)</b>	<b>1.21 (1.08-1.36)</b>	<b>1.29 (1.13-1.47)</b>
Model 3	1.10 (1.04-1.17)	1.09 (0.99-1.20)	<b>1.96 (1.73-2.21)</b>	<b>1.23 (1.09-1.39)</b>	<b>1.31 (1.15-1.50)</b>
<b>IMV</b>					
Model 1	<b>1.28 (1.19-1.38)</b>	<b>1.32 (1.18-1.47)</b>	<b>2.30 (2.02-2.62)</b>	<b>1.36 (1.17-1.58)</b>	<b>1.61 (1.38-1.89)</b>
Model 2	<b>1.28 (1.19-1.37)</b>	1.10 (0.98-1.23)	<b>2.32 (2.03-2.65)</b>	<b>1.36 (1.17-1.58)</b>	<b>1.42 (1.21-1.67)</b>
Model 3	<b>1.29 (1.20-1.39)</b>	1.12 (1.00-1.25)	<b>2.37 (2.07-2.70)</b>	<b>1.40 (1.21-1.63)</b>	<b>1.45 (1.23-1.70)</b>
<b>30-day readmission</b>					
Model 1	<b>1.25 (1.14-1.37)</b>	1.21 (1.05-1.40)	0.97 (0.79-1.20)	1.07 (0.88-1.30)	<b>1.66 (1.37-2.00)</b>
Model 2	<b>1.23 (1.12-1.35)</b>	1.02 (0.88-1.18)	0.97 (0.78-1.19)	1.08 (0.89-1.31)	<b>1.48 (1.23-1.79)</b>
Model 3	<b>1.23 (1.12-1.35)</b>	1.03 (0.89-1.18)	0.98 (0.79-1.21)	1.09 (0.90-1.33)	<b>1.49 (1.24-1.81)</b>
<b>Mortality</b>					
Model 1	<b>1.15 (1.07-1.25)</b>	1.09 (0.95-1.24)	<b>2.30 (1.97-2.68)</b>	1.29 (1.06-1.55)	1.23 (1.01-1.50)
Model 2	<b>1.16 (1.07-1.26)</b>	0.90 (0.79-1.03)	<b>2.31 (1.98-2.70)</b>	1.31 (1.08-1.58)	1.07 (0.87-1.31)
Model 3	<b>1.17 (1.08-1.26)</b>	0.91 (0.80-1.04)	<b>2.33 (2.00-2.73)</b>	1.33 (1.10-1.61)	1.08 (0.88-1.32)
<b>Percent difference (95% confidence interval)</b>					
<b>Length of stay</b>					
Model 1	<b>1.29 (1.28-1.30)</b>	<b>1.31 (1.29-1.32)</b>	<b>1.45 (1.43-1.47)</b>	<b>1.39 (1.36-1.41)</b>	<b>1.38 (1.35-1.40)</b>
Model 2	<b>1.28 (1.27-1.29)</b>	<b>1.19 (1.17-1.20)</b>	<b>1.44 (1.42-1.46)</b>	<b>1.39 (1.37-1.42)</b>	<b>1.28 (1.26-1.30)</b>
Model 3	<b>1.29 (1.28-1.30)</b>	<b>1.21 (1.19-1.22)</b>	<b>1.46 (1.44-1.49)</b>	<b>1.42 (1.39-1.44)</b>	<b>1.30 (1.27-1.32)</b>

Results are from logistic models for dichotomous outcomes and Poisson models for length of stay.

Level of statistical significance ( $\alpha = 0.05$ ) was adjusted for multiple comparisons using the Bonferroni-Holm method.

Abbreviations: ICU = intensive care unit, IDD = intellectual and developmental disabilities, IMV = invasive mechanical ventilation.

Bolded estimates indicate statistical significance after Bonferroni-Holm adjustment.

Model 1: Age, sex, race/ethnicity, insurance type, admission month, urbanicity, and U.S. Census Division

Model 2: Model 1 covariates and Elixhauser comorbidity index

Model 3: Same covariates as model 2, but reference group excludes patients with any IDD

Categories for intellectual and developmental disabilities are described in detail in the footnote for Table 1.

vious study in England also showed high mortality risk for patients with Down syndrome (Clift et al., 2021). Increased readmission risk and longer LOS among patients with an IDD may be attributed to immune dysfunction, behavioral challenges, and/or greater comorbidities (Akbari et al., 2021; Kamalakannan et al., 2021; Karpur et al., 2021).

Strengths of this study include the large sample from geographically diverse hospitals. Limitations include residual confounding, potential under-ascertainment of events (readmissions were only captured if they occurred in the same hospital as the index admission), and use of ICD-10-CM codes to identify IDDs. Results may not be generalizable to hospitals not reflected in this database. For example, although some evidence suggests triaging practices may decrease access to interventions for patients with IDDs and COVID-19 (Cieza et al., 2021), this study reported an increased risk of IMV, which may be due to differing practices and resource availability among included hospitals.

This study's findings add evidence to consider individuals with IDDs as a high-risk population to prioritize for vaccines and emerging therapies. Additional studies may confirm these findings and identify mechanisms that may be driving risk.

## Competing Interests

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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## Ethics Statement

This study was reviewed by the Centers for Disease Control and Prevention and was determined exempt from institutional review board oversight and informed consent per federal regulations 45 CFR §46.101(b)(4) and 45 CFR §164.506(d)(2)(ii)(B), respectively.

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