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Children and Young Adults Admitted to a NYC Children's Hospital Had a Similar Rate of Severe COVID-19 Coagulopathy As That Reported in Older Adults

William Beau Mitchell, MD,1 Jennifer G. Davila, MD,2 Janine Keenan, RN,*,3 Jenai Jackson,*,4 Adit Tal, MD,1 Kerry A Morrone, MD,1 Ellen J Silver, PhD,*,5 Sarah H. O’Brien, MD,6 Deepa Manwani, MD7

1Children's Hospital at Montefiore, Bronx, NY
2The Children's Hospital At Montefiore-Aecom, Bronx, NY
3Division of Hematology/Oncology, The Children's Hospital at Montefiore, Bronx, NY
4Albert Einstein College of Medicine, Bronx, NY
5Albert Einstein College of Medicine, Bronx,
6Nationwide Children's Hospital, Columbus, OH
7Division of Pediatric Hematology/Oncology, Department of Pediatrics, Children's Hospital at Montefiore, Albert Einstein College of Medicine, Bronx, NY

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The coagulopathy associated with COVID-19 has not been previously described in children and young adults. We reviewed the clinical and laboratory characteristics of children and young adults admitted for COVID-19 to an urban Children's Hospital in New York City, focusing on coagulation and venous thromboembolism.

Clinical and laboratory data were analyzed from 54 patients aged 2 months to 30 years treated by the Pediatric Hematology service at a single Children's Hospital between January 1 and May 31, 2020. Information was obtained from hospital records with IRB approval.

There was a moderate male predominance, with 32 (59%) males and 22 (41%) females. There were 28 (52%) patients younger than 18 years and 26 (48%) patients 18 - 30 years old. 26% of patients identified as Black, and 57% as Hispanic/Latino, similar to the community demographics in the Bronx in the 2019 census. Obesity was the most prevalent comorbid condition, with 19 (35%) patients having BMI of 30 or higher. There were also 12 (22%) patients with sickle cell anemia.
There were 28 (52%) patients in this cohort with severe and critical illness, as based on established
criteria, and 25 (46%) patients required increased ventilatory support. This was defined by the need
for > 5L nasal cannula, high-flow nasal cannula, non-rebreather, or intubation. 11 patients (20%) had
documented venous thromboembolism (VTE). Four patients died of COVID-19 complications at ages 2
months, 11, 14 and 18 years old. The VTE rate was similar in those patients under 18 years of age (5 of
28, 18%) and those 18 - 30 years of age (6 of 26, 23%). Most (94%) patients had a D-Dimer > 0.5 (upper
limit of normal) at admission and 57% developed peak D-Dimer > 5 ug/mL during their admission.

Elevated D-dimer > 5 was a risk factor for VTE with 3 of 23 (13%) and 7 of 17 (41%) patients developing
VTE with D-dimer < 5 and > 5, respectively (OR 4.7, p=0.042). Patients requiring increased ventilatory
support had a 36% rate of VTE as compared to 1 of 28 (4%) of those without (OR 15.2, p=0.003). Six
of 24 patients on prophylactic anticoagulation developed VTE. One patient developed a pulmonary
embolism 10 days post discharge from the hospital. No patients on anti-Xa-based low molecular weight
heparin prophylaxis developed VTE. None of 12 patients with sickle cell anemia developed VTE, had
peak D-Dimer > 5 ug/mL or required increased ventilatory support.

Hospitalized children and young adults with COVID-19 in our cohort developed a coagulopathy similar
to that of older adults, characterized by elevated D-Dimer and high rate of VTE. This is in contrast to the
published pediatric series out of China and Singapore that described mild illness and did not comment on
VTE rates. Presence of elevated D-dimer or need for increased ventilatory support were significant risk
factors for thrombosis. Patients with sickle cell anemia had a lower risk of VTE and less severe illness.
Anti-Xa monitored thromboprophylaxis may aid in preventing or ameliorating the COVID-19 coagulopathy
in children and young adults. Institutional anticoagulation guidelines were developed based on these observations.

### Table 1. Baseline clinical characteristics and laboratory values of CYA with COVID-19 (n = 54)

| Variable                  | Value            |
|---------------------------|------------------|
| Gender male/female n(%)   | 32 (59)/ 22 (41) |
| Age n(%)                  |                  |
| < 1 year                  | 3 (6)            |
| 1-6 years                 | 4 (7)            |
| 7-12 years                | 11 (20)          |
| 13-18 years               | 10 (19)          |
| 19-30 years               | 26 (48)          |
| Race n(%)                 |                  |
| Black                     | 14 (26)          |
| White                     | 3 (5)            |
| Other                     | 32 (59)          |
| Not reported              | 5 (9)            |
| Ethnicity n(%)            |                  |
| Spanish/Hispanic/Latino   | 31 (57)          |
| Not Spanish/Hispanic/Latino | 21 (39)          |
| Not reported              | 2 (4)            |
| Comorbidity n(%)          |                  |
| Weight/BMI > 100kg/30     | 19 (35)          |
| Diabetes                  | 2 (4)            |
| Prior Thrombosis          | 4 (7)            |
| Sickle cell anemia        | 12 (22)          |
| Severity n(%)             |                  |
| Severe/Critical illness   | 28 (52)          |
| Ventilatory support n(%)  |                  |
| Oxygen > 5L NC            | 25 (46)          |
| Intubated                 | 14 (26)          |
| D-Dimer                   |                  |
| > 5 mcg/mL                | 31 (57)          |
| < 5 mcg/mL                | 23 (43)          |

| Laboratory Finding | Mean (SD, range) |
|--------------------|------------------|
| WBC Peak           | 17.2 (10.9, 2.8 – 55.9) |
| ANC Peak           | 12.9 (9.7, 1.5 – 49.8)  |
| AMC Peak           | 1.6 (0.7, 0.20 – 11)   |
| Hemoglobin Nadir   | 9.7 (2.8, 5.5 – 17.3)  |
| Platelets Peak     | 419 (195, 133 – 909)   |
| Platelets Nadir    | 215 (178, 5 – 877)     |
| Creatinine Peak    | 0.93 (0.97, 0.3 – 5.9) |
| D-Dimer Peak       | 5.7 (5.4, 0.27 - 20)   |
| PT Peak            | 17.0 (4.6, 13.2 – 43.3) |
| PTT Peak           | 61.9 (41.9, 29 - 200)  |
| Fibrinogen Peak    | 651 (304, 227 - 1800)  |

### Table 2: VTE Risk Factors, all patients (n=54)

| Variable                  | Thrombosis Yes/No | %   | OR   | 95% CI       | p    |
|---------------------------|-------------------|-----|------|--------------|------|
| Gender Male               | 7/25              | 22  | 1.26 | 0.320 – 4.957 | .741 |
| Female                    | 18                |     |     |              |      |
| Age 18 > 30y              | 6/20              | 23  | 1.38 | 0.365 – 5.215 | .634 |
| < 18y                     | 5/23              | 18  |     |              |      |
| BMI > 30                  | 4/15              | 21  | 0.99 | 0.248 – 3.949 | .989 |
| < 30                      | 5/15              | 21  |     |              |      |
| Ventilatory support       |                   |     |     |              |      |
| > 5L NC                   | 9/16              | 36  | 15.188 | 0.758 – 131.24 | .003 |
| < 5L NC                   | 1/27              | 4   |     |              |      |
| D-Dimer                   |                   |     |     |              |      |
| > 5 mcg/mL                | 7/10              | 41  | 4.667 | 0.99 – 22.01 | .042 |
| < 5 mcg/mL                | 3/20              | 13  |     |              |      |
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Author notes

* Asterisk with author names denotes non-ASH members.

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