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Respiratory Viral Infections in School KIDS

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Abstract

Background:

The epidemiology of medically attended respiratory viral infections (RVI) is well described, however, the epidemiology of RVI in schools is poorly understood. The goal of our School KIDS study, an ongoing surveillance program, is to understand the epidemiology of respiratory viral pathogens in asymptomatic and symptomatic students/staff and to understand the vaccine effectiveness for COVID-19 and influenza in K-12 schools in order to inform public health.

Methods:

School KIDS is being conducted in the North Kansas City School District (NKC) and is underway; open to all students and staff, with enrollment starting from October 31, 2022. Participants with respiratory symptoms can self-collect a nasal swab at home/school and send it to Children's Mercy. Two follow-up nasal swabs, convalescent samples, are collected one and two weeks after the initial symptomatic test. Symptomatic samples are tested by the QIAstat-Dx Respiratory SARS-CoV-2 Panel; asymptomatic and convalescent samples are tested by the fully automated Hologic Panther Fusion system.

Results:

From November 01, 2022, to February 24, 2023, 298 symptomatic subjects (70 staff and 228 students) were tested; female (191, 64.09%) and males (93, 31.21%). 213 (71.48%) identified as white, 39 (13.09%) Hispanic, 12 (4.03%) black. 140 (46.98%) elementary school aged, 31 (10.40%) high-school, 48 (16.1%) middle-school and 9 (3.0%) Pre-K. Of 467 symptomatic samples tested 233 (49.89%) and 23 (4.93%) samples were positive for 1 virus and >1 virus respectively; 234 (50.11%) where negative. Rhinovirus/Enterovirus, 73, (28.52%) and seasonal coronaviruses, 63, (13.49%) were the top 2 targets detected. Detailed distribution of viral targets is tabulated in Table 1. Of the 190 total convalescent samples tested, 49 (25.79%) were negative following their positive symptomatic counterpart; (32, 16.84%) were positive following their positive symptomatic counterparts with either the same virus (19, 10.00%) or a different virus (13, 6.84%) being detected. 6 samples (3.16%) tested positive following a negative result for their symptomatic counterpart.

Conclusion:

Overall, there is a 49.89% detection rate in symptomatic subjects and a 24.74% detection rate in convalescent samples, with rhinovirus and seasonal coronaviruses being the predominant RVI in school-going children. Most RVI surveillance in children is done in medical settings, but this may not accurately represent the prevalence of infections in children who aren't under medical care. In school COVID-19 testing has provided current data on infection rates and transmission that may differ from community rates. Expanding RVI testing beyond COVID-19 in schools could provide important information to better understand virus epidemiology in K-12 schools.

Introduction

- Children spend one-third of their day in the school setting; however, limited data are available as to the burden of respiratory viruses in K-12 schools.
- Experience with the COVID-19 pandemic highlights that SARS-CoV-2 transmission in school settings differs from community
- The COVID-19 pandemic has resulted in a change in practice as related to viral surveillance testing as COVID-19 testing was routinely offered in community and school settings to reduce school absenteeism. For most schools, this was the first time any type of infectious diseases surveillance testing had been performed on site.

Materials and Methods

Sample Collection

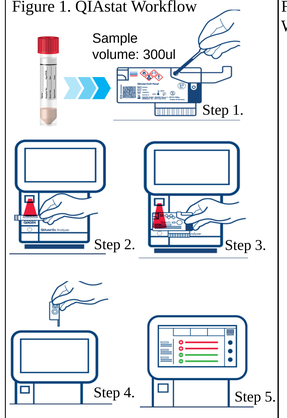
- **Symptomatic samples:** Nasal swabs are either self-collected or collected by a parent/guardian. Testing is performed on the QIAstat-Dx® Respiratory SARS-CoV2 Panel.
- **Surveillance samples:** Nasal swabs are collected by nurses on site at the schools. Testing is performed on the Hologic Panther Fusion multiplex platform.
- **Convalescent samples:** Nasal swabs are collected 1-5 weeks post the initial symptomatic swab; they are used to track the progression or regression of a virus within the symptomatic subject. Testing is performed on the Hologic Panther Fusion multiplex platform.

Table 1. Viral Targets Detected by both Assays

Adenovirus	ADV
Human Corona Virus Cov 229E	Cov 229E
Human Corona Virus HKU1	Cov HKU1
Human Corona Virus NL63	Cov NL63
Human Corona OC43	Cov OC43
Human Metapneumovirus	h.MPV
Influenza A	Flu A
Influenza AH1	Flu AH1
Influenza AH3	Flu AH3
Influenza H1N1	H1N1
Influenza B	Flu B
Para Influenza 1-4	PIV 1
Respiratory Syncytial Virus	RSV
*Rhinovirus, # Rhinovirus/Enterovirus	*RV, # RV/EV
Severe Acute Respiratory Syndrome Coronavirus 2	SARS Cov 2
*Enterovirus 68	*EV-D68

*Hologic Panther Fusion; #QIAstat-Dx® Respiratory SARS-CoV2 Panel

Figure 1. QIAstat Workflow



1. Turnaround time : 67-72 minutes
2. Ct values and amplification curves are reported and exported when a pathogen is detected
3. Results uploaded for data entry and report
4. Report sent out within 24 hours

Figure 2. Hologic Panther Fusion Workflow

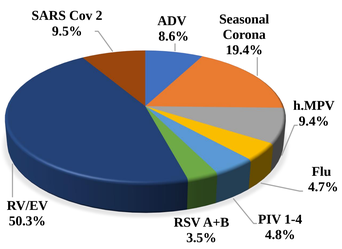
1. Turnaround time for first result: 2.4 hours
2. 335 test can be completed within 8 hours.
3. Ct values reported and exported when a pathogen is detected
4. Results uploaded for data entry and report
5. No report sent out for surveillance subjects

Results

Table 2: Rate of virus detection from different enrollment cohorts

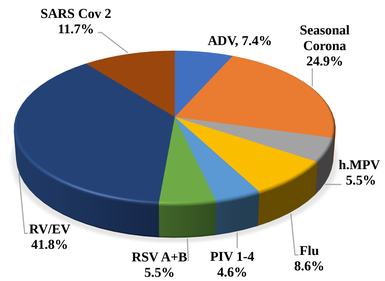
	Total Samples	Total Detected	% Detected	Co-Detections	% of Co-Detections
Symptomatic	635	325	51.2%	32	9.8%
Surveillance	2982	727	24.4%	66	9.1%
Convalescent	561	145	25.8%	12	8.3%
Total	**4178**	**1197**	**28.7%**	**110**	**9.2%**

Figure 3: Overall virus detection



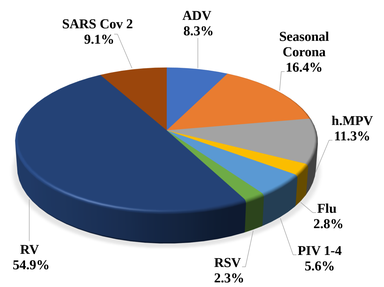
Cov 229E	0.3%
Cov HKU1	5.7%
Cov NL63	10.3%
Cov OC43	3.2%
Flu A	1.1%
Flu AH3	2.7%
H1N1	0.8%
Flu B	0.2%
PIV 1	0.3%
PIV 2	1.8%
PIV 3	1.9%
PIV 4	0.8%

Figure 4: Virus detection in symptomatic samples



Cov HKU1	9.2%
Cov NL63	12.9%
Cov OC43	2.8%
Flu A	0.3%
Flu AH3	5.8%
H1N1	2.5%
PIV 1	1
PIV 2	5
PIV 3	3
PIV 4	6

Figure 5: Virus detection in surveillance samples



Cov 229E	0.4%
Cov HKU1	4.4%
Cov NL63	8.8%
Cov OC43	2.8%
Flu A	1.1%
Flu AH3	1.2%
H1N1	0.1%
Flu B	0.3%
PIV 1	0.4%
PIV 2	1.9%
PIV 3	2.8%
PIV 4	0.6%

Table 3: Rate of virus detection in convalescent samples a) overall b) weekly distribution

a.

Total Symptomatic subjects	Total Convalescent samples collected	No. of Positive Convalescent	Positive %
368	561	145	26.40%

b.

Weeks	No. of Samples Collected	No. of Samples Detected	Percentage
Week 1	50	23	46%
Week 2	95	50	52.60%
Week 3	98	35	35.70%
Week 4	72	22	30.60%
Week 5+	29	7	24.10%

Figure 6: Virus detection in positive convalescent samples a) with respect to initial symptomatic sample b) distribution of viral targets in same virus detection

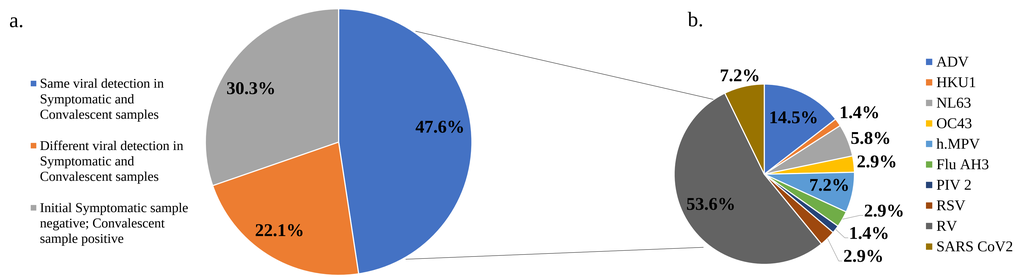
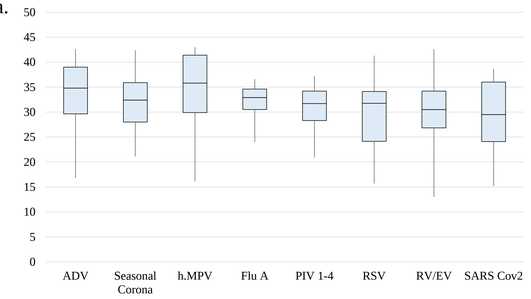


Figure 7: CT value trends for viruses detected a) across all cohorts b) in Symptomatic and Asymptomatic samples

a.



b.

Viral Targets	Symptomatic	Surveillance
ADV	30.3 (24.4-34)	38.3 (32.9-34.4)
Seasonal Corona	28 (24.6-32.5)	34.30 (30.1-36.1)
h.MPV	25.5 (22.7-29.9)	38.1 (32.1-41.6)
Flu A	29.8 (26.8-32.4)	33.4 (31.6-34.9)
PIV 1-4	28.3 (25.3-31.6)	35.0 (32.3-36.8)
RSV	25.5 (22.6-31.5)	33 (25-34.3)
RV/EV	28.1 (24.0-31.1)	30.9 (27.3-34.8)
SARS Cov 2	26.0 (20.2-31.5)	33 (26-38)

*Flu B: Data not sufficient for analysis for charts a and b

Discussion/Conclusion

- The overall viral detection rate in the School KIDS study is 28.7%
- The top 3 viruses detected across the cohorts are: Rhinovirus (50.3%), Cov NL63 (10.3%), SARS Cov2 (9.5%).
- 561 total convalescent samples were collected and the viral detection rate for these samples is 26.1%. The majority of the positive convalescent samples (47.6%) detected the same virus as their initial symptomatic counterpart.
- The symptomatic samples have significantly lower CT values compared to surveillance samples. The lowest CT values for symptomatic samples are for h.MPV and RSV. The lowest CT values for surveillance samples are in RV and RSV.
- School KIDS provides the foundation to bring surveillance platforms into schools and to children outside of the medical setting and by expanding RVI testing beyond COVID-19 in the school setting will provide important information to better understand the epidemiology of viruses in the K-12 school setting.

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