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A Retrospective Review of COVID-19 Testing and Mitigation Strategies at Psychiatric Hospital and Subsequent COVID-19 AcquisitionAbbreviated title: COVID-19 in Behavioral Heath

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Title: A Retrospective Review of COVID-19 Testing and Mitigation Strategies at Psychiatric Hospital and Subsequent COVID-19 Acquisition

Abbreviated title: COVID-19 in Behavioral Heath

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ABSTRACT

Background:

Behavioral health settings present increased challenges in preventing transmission of infectious agents. Characterizing the relative effectiveness of various strategies, including testing for

asymptomatic carriage of SARS-CoV-2 virus, will inform transmission reduction efforts in behavioral health settings.

Methods:

A single-center retrospective study was conducted in an inpatient behavioral health hospital by reviewing COVID-19 mitigation and testing strategies with information collected from discharges between July 1, 2020, and February 28, 2021.

Results:

During the study period, there were 3,694 total discharges and 3,229 unique admitted patients, including 86 (2.7%) patients who had positive SARS-CoV-2 polymerase chain reaction (PCR) test results. Pre-admission testing from non-congregate care settings (38, 44.1%), and testing after an in-hospital exposure (27, 31.4%) were the most common indications for testing among patients with a positive test. Up to 29 (33.7%) potentially acquired the infection during their hospitalization. Asymptomatic screening tests identified approximately two-thirds (55, 64.0%) of potentially contagious patients.

Conclusion:

Asymptomatic screening testing on admission and after exposure and universal masking were strong interventions to prevent SARS-CoV-2 transmission in this investigation Future studies of SARS-CoV-2 and other pathogens in behavioral health settings should endeavor to characterize the effectiveness of infection prevention interventions.

KEYWORDS:

COVID-19, SARS-CoV-2, behavioral health, outbreak investigation

Background

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Mitigation and testing strategies for COVID-19 in congregate settings and healthcare facilities have evolved through the progression of the pandemic, guided by the Centers for Disease Control and Prevention (CDC) and state health departments. Asymptomatic testing recommendations for skilled nursing facility (SNF) residents included testing post exposure, after a positive screen at the point of care, and as part of a whole house strategy if any resident in the facility tested positive[1]. Once antigen tests were more widely available, targeted testing was recommended at the point of care for all individuals being admitted to long term care facilities (LTCFs) and SNFs, including those that were asymptomatic and screened negative [2]. These recommendations were limited to LTCFs and SNFs, and behavioral health facilities, including inpatient psychiatric hospitals, do not have facility type-specific guidance. Nationally, many facilities moved to teleservices and pivoted to increase outpatient treatment options; however, efficient, safe acute psychiatric care access needed to be preserved to limit emergency room long lengths of stay[3,4]. Patients served by these facilities have medical conditions indicated as risks for severe COVID-19 illness, in addition to complex psychiatric diagnoses and congregate care that can impact their ability to adhere to mitigation strategies such as masking and distancing

Existing studies feature information about COVID-19 outbreaks and mitigation strategies in psychiatric hospitals and warn about additional transmission risks that patients face due to the type of care being received and diagnoses [5,6]. A New York psychiatric hospital implemented universal asymptomatic screening tests of admitted patients when the community reached significant transmission levels[7], but due to lower testing capacity early on, some facilities only tested and isolated patients with confirmed exposures or symptoms, rather than trying to prevent transmission from asymptomatic carriers[8]. There is limited published data on the effectiveness of

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other infection prevention interventions to prevent SARS-CoV-2 transmission in behavioral health settings.

Given the intrinsically heightened risk infection transmission in inpatient psychiatric settings, and the increased potential for serious outcomes of infection among patients with mental health disorders[9], studies investigating the effect of specific interventions are needed. The aim of this study is to evaluate the impact that a peri-admission asymptomatic SARS-CoV-2 screening strategy has on the likelihood of SARS-CoV-2 transmission in inpatient behavioral health settings, in the context of other pandemic responses.

METHODS

Study Setting

University of Pittsburgh Medical Center (UPMC) Western Psychiatric Hospital is a 263-bed inpatient facility in Western Pennsylvania, serving a regional network of almost 60 community-based programs. On-site services include 24-hour emergency care, acute inpatient services, transitional care, outpatient treatment, and telepsychiatry. The site's Psychiatric Emergency Services provides approximately 6,000-7,000 patient visits annually, and the study facility admissions account for over 80,000 patient-days prior to the COVID-19 pandemic. Inpatient units (**Table 1**) are defined by diagnosis and age, with all units including a combination of private and semi-private patient rooms, shared locked bathrooms, a locked treatment room, a locked kitchen area where prepared meals are eaten, and a common area used for recreation and treatment; the single exception is the Transitional Recovery Unit, which has unlocked access to a kitchenette and refrigerator. The study facility is one facility in an integrated behavioral health service line that includes community-based programs and serves as both a referral and referring

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location for regional psychiatric care. The study facility transfers patients requiring more specialized medical care to a neighboring acute care medical facility, UPMC Presbyterian Hospital.

TABLE 1: Study Hospital Inpatient Units

Unit	Conditions Treated	Beds, Total	Beds in Semi-Private Rooms (%)
A	Adolescent and adult bipolar disorder	24	8 (33%)
B	Adult trauma	15	10 (67%)
C	General Adult	24	12 (50%)
D	Child and adolescent unit treating children from ages 3-18	26	12 (46%)
E	Concomitant mental illness and COVID-19, as needed, including both yellow (COVID-19 exposed) and red (COVID-19 contagious) zones. Each patient room can be utilized as a locked seclusion room if needed.	7*	0 (0%)
F	Concomitant COVID-19, including both yellow and red zones	12*	10 (83%)
G	Eating disorders	10	6 (60%)
H	Psychotic illnesses such as schizophrenia	29	6 (30%)

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I	Adult substance abuse and psychiatric treatment	26	14 (54%)
J	Geropsychiatric conditions	42	36 (86%)
K	Autism and developmental disorders	28	12 (43%)
L	Transitional Recovery Unit: acute phase severe and persistent mental illness, with support for reintegration	20	6 (30%)
TOTAL		263	142 (54%)

** Unit E: One room was occupied by negative pressure airflow apparatus making six available rooms during most of the follow-up. Unit F: A rounding room was occupied by negative pressure airflow apparatus.*

Study Population

This analysis includes all discharges from July 2020 through February 2021. For each patient admission, demographic characteristics of sex, race, and ethnicity as well as medical risk factors for COVID-19 and psychiatric diagnoses were abstracted from the electronic health record. Many patients had multiple psychiatric diagnoses, but only the primary diagnosis was included unless it was attention deficit hyperactivity disorder, bipolar disorder, depression, or schizophrenia, due to the published evidence of an increased risk of severe illness from COVID-19 for these diagnoses[10]. Psychiatric diagnoses of adjustment, conduct, oppositional defiant, and intermittent explosive disorder were classified as behavioral disturbances. Medical risk factors for severe illness were put into two categories of "increased risk" and "possible increased risk" based on the groupings of evidence available to the CDC[11].

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COVID-19 Mitigation Strategies

Facility wide control measures were implemented due to patients on other units sharing many risk factors other than age. Infection control measures in place throughout the study period of July 2020 to February 2021 where commensurate with CDC recommendations of masking, social distancing, and hand hygiene and environmental cleaning. A complete list of infection control measures is included in **Supplemental Table S1**[12]. The study facility's geriatric unit functions similarly to LTCFs and SNFs given common transmission risks associated with age, existing comorbidities, and living in a congregate setting; therefore, mitigation strategies mirrored those recommended by the CDC for LTCFs and SNFs[1].

When a COVID-19 contagious individual was identified on an inpatient unit, cohorting guidance was used to prevent further transmission by creating different zones[13,14]. Those who tested positive – and therefore considered contagious – were cared for in "red zones". Red zones were geographically confined negative pressure environments created from two clinical flex units caring for a maximum of 18 patients, and were not in use for clinical care otherwise. Healthcare workers providing care in red zones wore eye protection (face shields or goggles), N95 respirators, gowns, and gloves that were changed following hand hygiene moments during all activities within the units. Individuals exposed to COVID-19 but not contagious were cared for in "yellow zones", which is a re-designation of an existing clinical care unit. Individuals in yellow zones who developed symptoms or a positive post-exposure polymerase chain reaction (PCR) test for SARS-CoV-2 were transferred to a red zone. Healthcare workers providing care in yellow zones used droplet and contact isolation precautions including surgical masks with face shields (or goggles), gowns, and gloves during high contact patient care activities and activities where they anticipated splashes and sprays. Group therapy was held with all patients in each

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zone regardless of their diagnosis. Additionally, patients could participate virtually in group sessions with the appropriate unit. If a patient had an increased oxygen requirement of greater than or equal to 6 liters-per-minute or became medically complicated, they were transferred to the adjacent acute care medical hospital.

COVID-19 Testing Strategy

The testing strategy from March 20, 2020 through June 28, 2020 included testing patients upon arrival to the Psychiatric Emergency Services unit who had an oral temperature screen of 100.4 degrees Fahrenheit or greater or answered yes to ≥1 of the following COVID-19 screening questions:

1. Have you been tested for COVID-19 in the past 30 days because you were having symptoms consistent with possible COVID-19 infection?
2. Do you have fever plus either a cough or shortness of breath?
3. Have you had close contact with a person suspected or confirmed to have COVID-19?

After a SARS-CoV-2 cluster in a geriatric unit in the facility in July, and in the setting of the emergence of the more contagious delta variant, three additional asymptomatic screening test strategies were subsequently implemented: patients admitted or with a planned admission to an inpatient unit at the study facility from congregate settings (LTCFs, SNFs, prisons) (6/29/2020); patient admission or planned admission from any source to Unit J (geropsychiatric conditions, 7/29/2020) or Unit K (autism and developmental disorders, 9/8/2020); patient transferred with stays between 3 and 14 days from outside hospital through PsychCare+, a statewide referral service that allows facilities to see real-time bed availability and works with care providers to find the facility that best meets the patient's needs (12/21/2020).

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Patients with any symptoms or signs consistent with COVID-19 during their care within the facility were tested for SARS-CoV-2, throughout the investigation period. If patients were exposed to a known positive but tested negative, they were transferred to or the unit became a yellow zone, and if they tested positive, they were transferred directly to a red zone. If patients had a confirmed positive COVID-19 contact during the admission, post-exposure testing was performed 2-3 days after the exposure. Patients being discharged to a LTCF or SNF underwent asymptomatic testing per the receiving facility's protocols, uniformly within 24-30 hours prior to transfer. The overall testing strategy after implementation of these supplemental measures is presented in **Figure 1**.

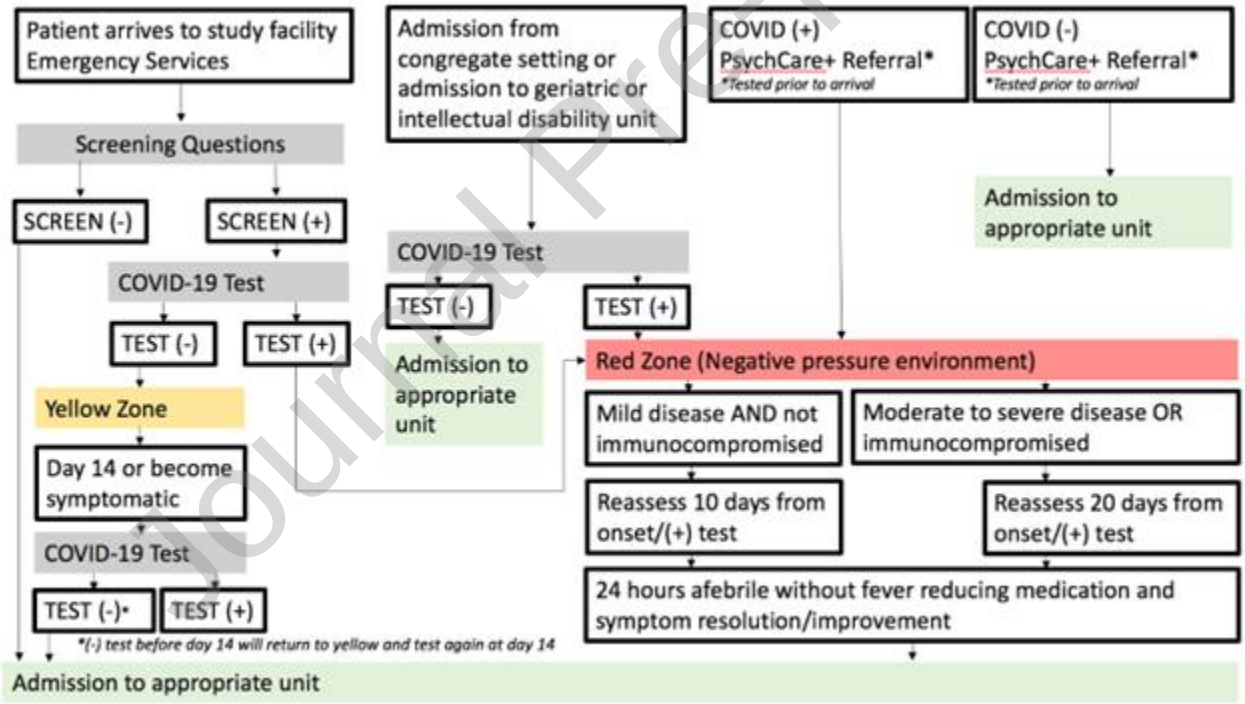

FIGURE 1: Flowchart describing the study intervention (asymptomatic testing strategy) and patient cohorting strategy for COVID-19 contagious patients.

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Note: *A positive screen indicates the patient answered yes to ≥1 of the COVID-19 screening questions. COVID (+) or (-) PsychCare+ indicates that the patient had a positive or negative PCR test no more than 48 hours prior to admission.*

SARS-CoV-2 testing, including both symptomatic testing and asymptomatic screen testing, was performed at a UPMC facility using polymerase chain reaction (PCR) testing from a nasopharyngeal specimen on several platforms (Panther System [Hologic], Xpert Xpress; [Cepheid], laboratory-developed test).

Study Outcome

Patients with positive test results were epidemiologically investigated by the study facility infection preventionist to determine potential source of infection. Positive test results were considered potentially acquired at the study hospital if the patient was admitted to inpatient treatment more than 2 days prior to the positive test and no other case index.

Statistical Analysis

The statistical analysis was performed using R with packages tidyverse, lvplot, hexbin, dplyr, and epiDisplay (R: A Language and Environment for Statistical Computing, 2021, Version 4.0.5)[15]. Binary variables of each individual medical and psychiatric risk factor were created, and age was calculated using date of birth and the patient's most recent admission date. R was used to calculate the frequencies and proportions then input into Microsoft Excel to create tables.

This study underwent formal ethical review and was granted approval as a quality improvement analysis by the UPMC Quality Improvement Review Committee (Project ID 3176).

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RESULTS

Between July 2020 and February 2021, there were 3,694 discharges among 3,229 unique patients. A total of 382 (11.8%) patients had more than one admission, ranging from two to six admissions during the study period (median, 2 admissions). Eighty-six patients had ≥1 positive test result at the time of or subsequent to admission; no patients had more than one admission with a positive test. Demographic and medical information, and psychiatric admission diagnoses, for all patients and patients with ≥1 positive test result are shown in **Table 2**. **Figure 2** depicts the epidemiologic curve of positive cases during the study period. (Healthcare worker cases comprise illness reported to the employer, and none are associated with exposure within the study facility.)

TABLE 2: Demographic and medical characteristics of all inpatients and patients with ≥1 positive SARS-CoV-2 test during the study period

Characteristic (% unless noted)		**Unique Patients (N = 3229)**		**Patients with ≥1 Positive Test Result (N = 86)**	
Demographic characteristics					
Age	Mean (SD) Range	33.2 4.6-95.2	(18.8)	41.5 11.7-92.4	(21.7)

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	Age >65 years	248	(7.7)	17	(19.8)
Sex	Female	1654	(51.2)	43	(50)
Race	White	2149	(66.6)	60	(69.8)
	Black	870	(26.9)	16	(18.6)
	Declined	78	(2.4)	6	(7)
	Not Specified	56	(1.7)	3	(3.5)
	Other	76	(2.4)	1	(1.2)
Ethnicity	Non-Hispanic	2395	(74.2)	65	(75.6)
	Unknown	802	(24.8)	20	(23.3)
	Hispanic	32	(1)	1	(1.2)
COVID-19 associated medical conditions					
Conditions with Increased Risk of COVID-19 complications					

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	Cancer	34	(1.1)	1	(1.2)
	COPD	82	(2.5)	1	(1.2)
	Diabetes	215	(6.7)	0	(11.6)
	Down Syndrome	1	(<0.1)	0	(0)
	Heart Disease	79	(2.4)	5	(5.8)
	Kidney Disease	87	(2.7)	1	(1.2)
	Obesity (BMI ≥ 30)	565	(17.5)	1	(12.8)
	Pregnancy	21	(0.7)	2	(2.3)
	Sickle Cell Anemia	14	(0.4)	0	(0)
	Smoking	882	(27.3)	19	(22.1)

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	No Conditions	1667	(51.6)	44	(51.2)
	Multiple Conditions	367	(11.4)	11	(12.8)
Conditions with possible Increased Risk of COVID-19					
	Asthma	383	(11.9)	5	(5.8)
	Cystic Fibrosis	1	(<0.1)	0	(0)
	Dementia	93	(2.9)	10	(11.6)
	HIV	19	(0.6)	0	(0)
	Hypertension	468	(14.5)	19	(22.1)
	Overweight	45	(1.4)	1	(1.2)
	Liver	2	(<0.1)	0	(0)
	Transplant Status	5	(0.2)	0	(0)

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	No Conditions	2320	(71.8)	55	(64.0)
Psychiatric admission diagnoses					
	ADHD*	231	(7.2)	2	(2.3)
	Bipolar disorder*	398	(12.3)	13	(15.1)
	Depression*	1271	(39.4)	35	(40.7)
	Schizophrenia*	179	(5.5)	4	(4.7)
	Anxiety	42	(1.3)	1	(1.2)
	Autism	91	(2.8)	1	(1.2)
	Behavioral Disturbance	432	(13.4)	5	(5.8)
	Personality Disorder	43	(1.3)	1	(1.2)

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	Psychosis	199	(6.2)	2	(2.3)
	Schizoaffective Disorder	106	(3.3)	7	(8.1)
	Substance Use	56	(1.7)	3	(3.5)
	Suicidal Ideations	26	(0.8)	0	(0)
	No Psychiatric Diagnosis	38	(1.2)	2	(2.3)
	Other	58	(1.8)	2	(2.3)
	Recent Diagnosis	889	(27.6)	17	(19.8)

Note*: ADHD, attention deficit hyperactivity disorder; BMI, body mass index (kilograms per meter squared); COPD, chronic obstructive pulmonary disease; HIV, Human Immunodeficiency Virus; SD, standard deviation. Asterisk denotes psychiatric admission diagnosis with higher*

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odds of contracting COVID-19 observed in Q. Wang et al [10]. Race: Other includes Asian, American Indian, Other Pacific Islander, and Alaska Native.

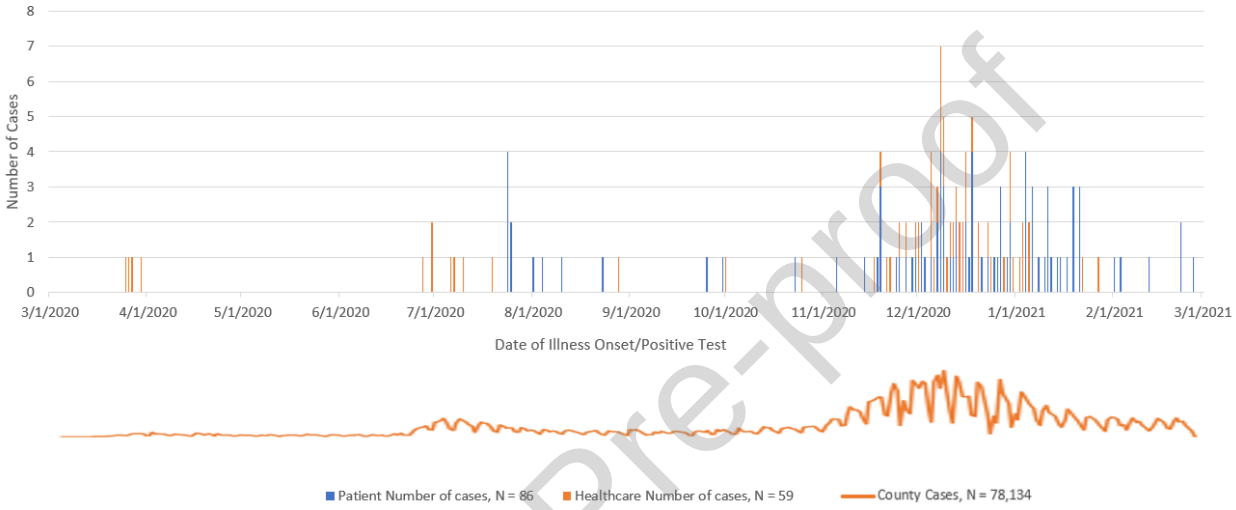

FIGURE 2: Epidemiologic curve of patient and healthcare worker cases of COVID-19 at an inpatient psychiatric facility, March 2020 through February 2021

Test Results by Symptom Status, Indication for Testing and Attribution

During the study period 1,376 tests were performed at the study facility. Additionally, 48 positive tests were reported from testing at other facilities prior to admission. Of the 86 patients with ≥1 positive test result, 31 (36.0%) tests were performed among patients symptomatic at the time of testing and 55 (64.0%) tests were among patients asymptomatic at the time of testing according to review of documentation in the electronic health record. **Table 3** shows the indication for testing, and the number of patients with potentially hospital-acquired and community-acquired COVID-19, by symptom status.

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TABLE 3: SARS-CoV-2 infection by source, testing indication, and symptom status

	Asymptomatic at time of testing (%)	Symptomatic at time of testing (%)	Total
Infection Source			
Community-acquired	38 (66.7)	19 (33.3)	57
Potentially hospital-acquired	17 (58.6)	12 (41.4)	29
Testing indication			
Post-exposure testing, community source	3 (100)	0	3
Post-exposure testing, hospital source	15 (55.6)	12 (44.4)	27
Pre-admission testing performed by a transferring facility	27 (71.1)	11 (28.9)	38
Pre-admission testing, admission from emergency department with a positive screen for exposure or symptoms	3 (27.3)	8 (82.7)	11
Pre-admission asymptomatic testing, direct admission from a congregate care setting	4 (100)	N/A	4
Pre-admission asymptomatic testing, admission from the	3 (100)	N/A	3

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emergency department to a **geriatric unit or autism unit**					
Total	55	(64.0)	31	(36.0)	86

** Three patients that screened positive (one asymptomatic and two symptomatic) received positive PCR results within one week prior to admission.*

All 38 asymptomatic community-acquired infections were placed in appropriate precautions and further transmission was not identified; of the 38, 37 (97%) were identified on admission screening. Among the 17 potentially hospital-acquired infections among asymptomatic patients at the time of testing, 3 (17.6%) subsequently developed symptoms and 0 required medical hospitalization. Seventeen of the 29 (58.6%) study facility acquired positive test results occurred in December 2020 during the height of the third surge. Only 1 of the 17 had a known index case, making it possible the other 16 cases had an exposure to an unidentified positive healthcare worker. Additionally, two (6.9%) of the study facility acquired cases had exposures in the emergency department before they were admitted.

DISCUSSION

In this retrospective observational study of symptomatic and asymptomatic SARS-CoV-2 testing at an inpatient psychiatric hospital March 2020 through February 2021, we found that 86 of 3,229 (2.3%) patients had ≥1 positive SARS-CoV-2 test. Two thirds of the positive tests were among asymptomatic patients; testing pre-transfer and post-exposure had the greatest yield of identifying asymptomatic individuals, and asymptomatic testing identified 58.6% (17/29) of potentially hospital-acquired cases. Asymptomatic screening reduced the risk of transmission on

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the behavioral health unit, and other interventions including universal masking, quarantine and isolation protocols, and distancing procedures also contributed to transmission reduction. Our findings that asymptomatic testing is likely an effective tool to mitigate the risk of transmission in inpatient psychiatric settings when incorporated as part of a comprehensive and risk-oriented prevention program is consistent with previous studies[8,16-18]. Uniquely, our study describes in detail the ways in which asymptomatic (and symptomatic transmission risk was identified.

The goal of the COVID-19 testing strategy is to identify persons transmissible, prevent further transmission, and subsequent infection in the hospital. In this case series, combined with symptom and exposure screening, asymptomatic screening at the time of emergency evaluation appeared effective in identifying potentially contagious individuals and preventing further transmission. Asymptomatic patients could be in the emergency department for up to 48 hours while awaiting a test result; however, the average was 6 to 8 hours. For this reason, there was expedited testing for admissions to the geriatric unit and unit caring for patients with autism or developmental delay.

The greatest success of the testing strategy is the eight asymptomatic positive cases identified before admission to their intended unit (9.3% of all positive test results). Five of these eight cases would have been admitted to the geriatric unit (Unit J), one to the unit treating schizophrenia (Unit H), one to the general adult unit (Unit C), and the final patient to the dual diagnosis unit (Unit I). Therefore, preventing these five additional positive cases from admission directly to the unit likely reduced the number of the study facility acquired cases. One of the eight asymptomatic positive cases resulted from a positive screening, meaning they had a known close contact with someone who tested positive for COVID-19. This case shows that simple screening questions can be effective at preventing transmission. It is important to note that the

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other seven asymptomatic positive cases likely would have been admitted directly to the intended admission unit had only the screening been utilized, proving the asymptomatic testing piece of the mitigation strategy was crucial to the study facility's success. Our findings are consistent with the published experience of both asymptomatic screening and using protocols defining care areas for exposed and COVID-19 contagious patients[16, 17].

Asymptomatic testing of healthcare workers was not routinely performed at the study facility; therefore, we may be unaware of healthcare workers' role as asymptomatic sources of patient infection.

Awaiting asymptomatic screening testing may result in harm from potential exposures – a harm we observed in two suspected study hospital-acquired cases – and delays in receiving timely care. Therefore, the benefit in applying enhanced precautions to asymptomatically infected patients should be balanced against potential harm. In a population that already faces care disparities, it is vital to eliminate additional barriers to care, which the study facility addressed by implementing expedited testing for the most at-risk patients.

It is unknown how many people decided to forgo assessment at the study facility because they tested positive, but it could have increased the proportion of positive test results. Another factor that likely impacted the number of positive tests was those that tested positive prior to a transfer but were unable to be admitted to the study facility, decreased the total number of positive cases, and impacted the quality of care patients received.

This investigation characterizes a single-center experience in the epidemiology of COVID-19, in the context of mitigation measures including asymptomatic screening; as it is not a controlled trial or quasi-experimental study, we cannot draw inference about the relative utility of individual COVID-19 mitigation measures. Limitations in the data include incomplete

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documentation recording of the test reason in patients who tested negative for SARS-CoV-2, which prevented this study from quantifying how many tests were done overall and making comparisons to those who tested positive. Additionally, the delimitation used to classify if a case was potentially facility -acquired was a positive PCR result after day 2 with a known index or greater than 14 days after admission with or without a known index. The incubation period of SARS-CoV-2 virus is highly variable, and the exposure source in the community is often unknown[19]. We have used the conservative surveillance definition of hospital-acquired which will result in an over-estimation of the number of hospital-acquired cases; however, excluding two individuals testing positive after readmission within 14 days, 89% (24/27) and 52% (14/27) of cases defined as hospital-acquired had a length of stay greater than 5 and 14 days, respectively (data not shown).

CONCLUSION

In this descriptive study of COVID-19 epidemiology and control measures in an acute behavioral health facility, we observed that 2.7% of patients with one or more admission had a positive test, of whom one third potentially acquired SARS-CoV-2 virus during the admission. Asymptomatic testing prior to admission and following exposure may have an important role to play in preventing transmission. Due to the congregate nature of care and their psychiatric illnesses, patients cared for in acute care behavioral health settings are vulnerable to transmission of infectious pathogens during their care. Defining effective safeguards against infectious disease transmission in this setting, while permitting effective psychiatric care should be a priority for infection prevention, public health, and behavioral health communities.[20]

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Highlights

- Acute care behavioral health is a high-risk setting for pathogen transmission
- Asymptomatic screening, including pre-admission and post-exposure, may reduce risk
- Investigations into the effectiveness of risk-reduction strategies are needed

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