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Major Article

Role of admission rapid antigen testing (RATs) for COVID-19 on patients transferred from acute hospitals to a postacute rehabilitation setting

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Background: Rapid antigen tests (RATs) are suitable for point-of-care testing, require no laboratory time, and give immediate results. However, are RATs useful for detecting asymptomatic COVID-19 infection when compared with polymerase chain reaction (PCR) testing in health care settings?
Methods: RAT testing was carried out on all new admissions without a history of confirmed COVID-19 infection within 3 months of admission. PCR testing was carried out on all patients with a positive RAT for confirmation purposes. The cycle threshold values of COVID-19-detected results on PCR testing were examined to determine the utility of the RATs.
Results: A total of 1,403 patients were transferred to the postacute rehabilitation unit from January to December 2023. The results of the study revealed an 85% accuracy of RATs with a 15% rate of false-negative results at the time of admission. All patients who had a positive RAT at the time of admission also had a positive PCR test.
Conclusions: This testing algorithm resulted in early detection and prompt isolation of positive cases reducing the likely spread of COVID-19 infection, hospital outbreaks, and bed/ward closures.

BACKGROUND

The role of postacute rehabilitation is to support patients who may require intensive therapies to help them return to the greatest possible level of independent function.[1] The majority of this cohort of patients are over 65 years of age admitted from the acute setting, many with comorbidities. Postacute rehabilitation hospitals often accept patients from multiple acute hospitals. Admitting patients who have spent a considerable amount of time in other health care facilities increases the risk of cross-infection with pathogenic organisms, including respiratory illnesses such as COVID-19.[2]

Managing multiple COVID-19-positive patients is challenging in postacute settings as many facilities have few single-patient

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isolation rooms and are greatly dependent on bays or rooms that can accommodate a number of patients.[3]

The Health Service Executive's (HSE's)—"*Acute Hospital Infection Prevention and Control Precautions for Possible or Confirmed COVID-19 in a Pandemic Setting*" Guidelines recommend not testing asymptomatic hospital-to-hospital transfers. However, after carrying out a risk assessment in early 2023, the Infection Prevention and Control team and senior management at the postacute rehabilitation unit (PARU) made a local decision to continue to rapid antigen test (RAT) all new admissions that did not have a known recent history of COVID-19 infection. However, there are limited data on the utility of the use of RAT in health care settings[4]; therefore, any patient with a positive RAT at the time of admission underwent a subsequent polymerase chain reaction (PCR) test.

The rationale for this intervention was to identify asymptomatic infectious patients at the time of admission who may have gone on to transmit virus to other vulnerable patients within the facility, potentially leading to COVID-19 outbreaks and bed/ward closures.

PCR testing for COVID-19 is regarded as the "gold standard" for diagnosis of COVID-19.[5] It is sometimes referred to as "molecular photocopying," and is a quick and cost-effective method for "copying and amplifying" small DNA segments.[5] SARS-Cov-2 PCR testing of upper respiratory tract samples has emerged as the most important tool for the confirmation of COVID-19.[6] While PCR testing is the most accurate means of detecting COVID-19, there are disadvantages in respect of timeliness of results, especially when samples are sent offsite for processing. The laboratory turn-around times vary as there are multiple stages involved in PCR sample processing, which could lead to delays in reporting, especially if there are high volumes of samples.[7,8] In our experience, it can take 24-48 hours for reports to be available; the turn-around time is extended if samples are taken on Friday or over the weekend due to restricted laboratory opening hours. RATs may therefore have a role in minimizing the transmission of COVID-19 in health care settings, as it enables immediate detection and isolation of infected patients both symptomatic and asymptomatic, breaking the chain of transmission and thus minimizing outbreaks.[9]

However, data on the sensitivity and specificity of RAT in comparison to PCR vary, especially in asymptomatic patients.[10] We, therefore, undertook a real-world evaluation of the utility of RAT in patients admitted to a PARU.

METHODS

During 2023, RATs were carried out on all new admissions to the PARU who did not have a history of recent COVID-19 infection in the previous 3 months; test kits were supplied by the HSE free of charge and ordered through the hospital's stores department. The PARU used the brand OWN COVID-19 Antigen Test Kit (Colloidal Gold) for self-testing. This brand of RAT testing targets the "N2 protein," which is the most significant component of the COVID-19 virus.[11] Education in specimen collection and testing was provided to all staff and a procedure for documentation of testing details and results recording was laid out in line with good clinical governance.

Patients with a positive RAT (symptomatic or asymptomatic) were promptly isolated in a single room with transmission-based precautions in place. Asymptomatic is defined as the absence of any clinically recognizable symptoms.[12] A PCR test was then carried out and referred to the National Virus Reference Laboratory. The results were reported in paper form and by telephone. Between January and June 2023, the PCR samples were tested on Roche Cobas 6800 SARS-CoV-2 assay.

Cycle threshold (Ct) values were available on all "detected" PCR samples until July 2023, before the testing platform changed. "Cycle Threshold," or ("Ct"), refers to the number of times or "cycles" required to replicate target-specific genetic material so that it can be detected. A typical PCR assay is capable of running a maximum of 40 thermal cycles.[13]

Having access to Ct values for the first 15 positive cases provided a picture of the likely viral load in both symptomatic and asymptomatic patients. There is strong evidence to suggest that an asymptomatic presentation is a primary mode of transmission and is common.[14] Transmission from asymptomatic cases can occur, regardless of index vaccination status.[15]

The laboratory then changed location from July 2023, and samples were then tested on Altona RealStar SARS-CoV-2 RT-PCR Kit assay. These samples had passed over a target-specific threshold that deemed them positive.

RESULTS

There were 1403 patients admitted to the PARU from January to December 2023. Table 1 shows a monthly breakdown of the overall number of admissions to the PARU and positive antigen tests detected at the time of admission.

During this time, the PARU managed 91 cases of COVID-19, of which 25 (28%) were detected through RAT at the time of admission: 18 (72%) of these cases were asymptomatic, and 7 (28%) displayed mild symptoms. It is noteworthy that 15% of asymptomatic cases developed symptoms such as a cough, sore throat, GI symptoms, and pyrexia up to 48 hours post admission. This 15% represents the false-positive group of patients that were RAT negative at the time of

Table 1
Monthly numbers of patient admissions to the PARU, the numbers that were RAT positive at the time of admission, and the overall percentage of patients with positive RATs between January and December 2023

Month	Total number of patient admissions for 2023	RAT + on admission	Symptomatic RAT + patients on admission	Asymptomatic RAT + patients on admission	Total % RAT positive on admission during 2023
January	130	4	0	4	3%
February	103	4	0	4	4%
March	140	0	0	0	0%
April	94	2	1	1	2%
May	115	2	0	2	1.7%
June	118	3	2	1	2.5%
July	109	1	1	0	1%
August	120	3	0	3	2.5%
September	117	1	0	1	1%
October	113	0	0	0	0%
November	131	3	2	1	2.5%
December	113	2	1	1	1.8%
	1,403	25	7	18	1.8%

PARU, postacute rehabilitation unit; *RAP*, rapid antigen test.

Table 2
Results of the 25 RAT- and PCR-positive patients between January and December 2023

Case	Month	Assays used for COVID-19 testing	Ct value ORF1ab gene and E gene (first 15 samples)	Ct value threshold (first 15 samples)
1	Jan	Roche Cobas 6800 SARS-CoV-2 assay	20.65, 21.16	40
2	Jan	"	22.4, 22.65	40
3	Jan	"	23.07, 23.37	40
4	Jan	"	20.48, 20.56	40
5	Feb	"	20.73, 20.78	40
6	Feb	"	23.48, 23.5	40
7	Feb	"	18.9, 18.2	40
8	Feb	"	28, 28	40
9	April	"	18, 18	40
10	April	"	16, 16.1	40
11	May	"	21.15, 21.27	40
12	May	"	15.4, 15.37	40
13	June	"	22.8, 23.2	40
14	June	"	20.5, 20.7	40
15	June	"	18.17, 18.44	40
16-25	July-December	Altona RealStar SARS-CoV-2 RT-PCR Kit	Ct value unavailable from patients 16-25	

PARU, postacute rehabilitation unit; *PCR*, polymerase chain reaction.
The Ct values refer to the presence of the targeted genes detected during PCR testing—ORF1 gene and the E gene (envelope) that were available for the first 15 patients. Ct values were unavailable from July 2023, positive samples passed over the specific target threshold that deemed them positive.

admission and then became symptomatic and RAT positive within 48 hours after admission. All 25 cases detected at the time of admission had some level of COVID-19 vaccination, and all were confirmed positive by PCR testing.

Table 2 shows the details of each positive RAT, Ct values of the first 15 cases, and the platform in which they were tested. The available Ct values detected in these cases are significant as they provide us with an understanding that these patients are potentially infectious, regardless of being symptomatic or asymptomatic.

The PARU consists of 5 32-bedded wards that accept admissions from multiple acute hospitals. Table 3 shows a breakdown of the overall incidence of COVID-19 during 2023 in all 5 clinical areas. Each positive case was grouped into 1 of 4 different categories.

Group 1: PARU-acquired COVID-19 represents patients that developed symptoms ≥6 days post admission. For the majority of patients, the incubation period, the duration of time between being exposed to the virus and experiencing symptoms, has been estimated to be 5 to 6 days.[3] Other available literature suggests a conversion period of up to 14 days.[16,17] PARU's surveillance data on COVID-19 outbreak that have been managed within the facility since the beginning of the pandemic report an average conversion time frame of 3 to 6 days. Due to the time frame between admission and testing positive, it is predicted that this group (63%) of patients was exposed to COVID-19 within the PARU. Therefore, these cases are considered to be PARU-acquired COVID-19 infections.

Group 2: PARU admission screening represents all patients who tested positive at the time of admission through RAT testing and subsequent PCR testing. Group 3: Illustrates the group of patients that had a false-negative RAT at the time of admission as they went on to display symptoms and test positive within the first 48 hours post admission.

Group 4: "Other" represents a small group of patients that converted to positive after being informed that they were close contacts to family members/visitors that were COVID-19 positive. Although this group of patients was within the PARU when they contracted COVID-19, it is possible that they contracted the virus from positive family/visitors and not staff or other patients within the PCRU.

DISCUSSION

Numerous studies have sought to calculate the financial expenses arising from infections associated with health care. Despite the fact that these studies vary greatly depending on the setting, it is evident that health care-associated infections have a substantial cost impact on all health care systems in which they have been researched.[18] Additional costs of outbreak management can be driven by additional cleaning, pharmaceuticals, and prolonged length of stay.[18]

Hospital COVID-19 clusters are a result of the virus spreading to non-COVID-19 patients and health care workers and have added a significant strain on health care systems.[19]

COVID-19 outbreaks cause significant disruption to the running of hospitals, including delayed discharges, restricted visiting, and canceled/delayed outpatient appointments.[20,21] For the PARU, the positive experiences of utilizing RATs for admission testing outweigh the negatives. The positive outcomes include assisting in creating safe patient pathways for positive cases, which included creating red zones for multiple positive cases within the facility. It allowed us to report positive cases back to the acute facilities in a timely manner so that they could investigate certain wards within their facilities for COVID-19 close contact monitoring.

The study set out was to investigate the role and reliability of RATs in hospital settings in detecting COVID-19 infection at the time of admission to reduce the onward transmission of virus. The results demonstrated 85% concordance between admission RAT-positive results and confirmatory PCR in both asymptomatic and symptomatic patients at the time of admission, with a false-positive rate of 16% as 5 patients went on to develop symptoms and test positive for COVID-19 within the first 48 hours post admission.

Although PCR testing is defined as the "gold standard" for testing, there are many advantages to utilizing RATs in hospital settings, for example, they are cost-effective and allow for point-of-care testing with immediate results.[22] RAT testing does not involve additional costs such as transportation of specimens to an off-site laboratory and clinical time in follow-up results.

Table 3
Overall PARH surveillance of the incidence of COVID-19 between January and December 2023

Ward	Total number of COVID-19 positives during 2023	Group 1: PARU-acquired COVID-19. Tested positive after 6 d post admission	Group 2: PARU admission screening RAT positive	Group 3: RAT positive within 48 h of admission (false negatives)	Group 4: other
Ward 1	12	9	2	1	0
Ward 2	24	14	6	2	2
Ward 3	26	20	5	1	0
Ward 4	16	9	4	1	2
Ward 5	13	5	8	0	0
Total	91	57 (63%)	25 (28%)	5 (5%)	4 (5%)

Despite the advantages of RATs, there are also drawbacks, for instance, RATs can have low-sensitivity rates and can result in high false-negative results.[23] Nonetheless, the potential benefits of rapid tests outweigh some drawbacks and may assist in tracking the virus's progress.[8]

The 25 symptomatic and asymptomatic patients with a positive RAT result at the time of admission had confirmatory PCR results. All patients that tested positive were promptly isolated as per HSE Guidelines. As it was impossible to determine when the asymptomatic patients became infected, they were isolated with transmission-based precautions for a minimum of 7 days as per HSE Acute Hospital Guidelines.[3]

The Ct values for the first 15 positive patients ranged between 15.4 and 28 representing a likely high viral load, it is probable that both asymptomatic and symptomatic positive cases shed sufficient virus to potentially transmit onward.[12]

One potential concern regarding the use of this pathway was that rehabilitation of asymptomatic positive patients might have been compromised as a result of 7-day isolation with no access to the physio gym or other rehabilitation activities during this time. However, patients did receive therapy in their isolation rooms during this time if they were well enough to partake, and they participated in off-ward activities once their isolation period was complete. Further research is required into the use of RATs as an independent test for curbing the spread of COVID-19.[8]

CONCLUSIONS

PCR testing remains the "gold standard" for COVID-19 diagnosis; however, RAT has been shown to be both reliable and beneficial in detecting infection in a short time frame, especially when PCR testing is carried out off-site with potential delays in reporting. This study demonstrates that RAT of all admissions with PCR confirmation identifies COVID-19 in asymptomatic patients. It is a cost-effective means of reducing transmission of COVID-19 infection within a facility allowing swift isolation of newly diagnosed cases with the implementation of transmission-based precautions. The consequent reduction in the number of COVID-19 close contacts and potential reduction in the likelihood of outbreaks and bed/ward closures benefits patient flow. However, as this was a small study, further studies are required to determine the role of RATs in infection prevention and control.

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