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ORIGINAL RESEARCH

Clinical characteristics and predictors for hospitalisation during the initial phases of the Delta variant COVID-19 outbreak in Sydney, Australia

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Abstract

Objectives: The COVID-19 Delta variant of concern continues to pose significant challenges to health systems globally, with increased transmissibility and different patient populations affected. In Sydney, a virtual model of care was implemented in response to the COVID-19 pandemic and Special Health Accommodation (SHA) was made available for community patients with COVID-19 who could not isolate at home or needed health support.

Methods: This retrospective observational cohort study of all patients with COVID-19 Delta variant in SHA during the initial phases of the Delta variant outbreak in Sydney describes the demographic and clinical characteristics of patients with Delta variant COVID-19 and determines predictors of need for in-patient hospital admission.

Results: Data from 794 patients were analysed. One hundred and fifty-seven patients (19.8%) were transferred to ED. Of those, 125 were admitted to an in-patient unit (admission rate from ED 79.6%), and of these 30 (24%) went to ICU and seven were intubated. Two patients died within the follow-up period. Age >40 years, obesity, and presence of fever (temperature >37.5°C), hypoxia (oxygen saturation <95%), tachycardia or gastrointestinal symptoms on initial assessment in SHA were independent predictors of in-patient admission with an AUROC of 0.78 (95% confidence interval 0.73, 0.82).

Conclusions: Initial symptoms and vital signs were just as predictive for short-term deterioration as age and pre-existing comorbidities and should be included in future risk prediction models for COVID-19. Based on this, we derive a proposed risk prediction score that incorporates these predictors with further validation required.

Key words: *admission, COVID-19, risk prediction, virtual care.*

Key findings

- Initial symptoms and vital signs were just as predictive for short-term deterioration as age and pre-existing comorbidities and should be included in future risk prediction models for COVID-19.

Introduction

The global COVID-19 pandemic continues to challenge health services worldwide, particularly with the emergence of variants of concern (VoCs). In New South Wales (NSW), Australia, an outbreak of the Delta variant began in Sydney in mid-June 2021 and quickly grew to 2226[1] cases by 26 July 2021. Despite this, the Delta variant remained poorly understood, besides being more transmissible and affecting younger populations compared to the original strain of SARS-CoV-2.[2] In Australia, those who contracted COVID-19 and required additional support to reliably self-isolate were provided temporary accommodation in repurposed health hotel facilities and monitored using virtual or remote telehealth models of care.

Royal Prince Alfred (RPA) Virtual Hospital was one such multidisciplinary model of care that provided clinical care and support to patients and families in homes and Special Health Accommodation (SHA), using models of care that

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combined face-to-face, wearable device monitoring, video and telephone clinical care. SHA comprised four repurposed hotel facilities, with healthcare and supporting staff, that were established in 2020 to accommodate and support returning travellers with acute or chronic health needs.[3] The only criterion for admission to SHA presently was the need to reliably self-isolate outside the home setting after a positive COVID-19 swab, and all patients entering SHA were assessed clinically on admission to assess symptoms, comorbidities and vital signs using remote monitoring devices.

In the context of rapidly increasing numbers of Delta variant COVID-19 positive patients requiring SHA during the 2021 outbreak, there was a need to describe clinical characteristics and stratify risks for clinical deterioration using clinically based data. There were numerous reports on prediction tools for COVID-19; however, most have been derived using data from hospitalised patient and linked to routinely collected administrative data from community settings.[4–6] As a result, the main risk factors reported in current risk tools for clinical deterioration and mortality after COVID-19 have been age and comorbidities, without an appreciation of the relevance of initial symptoms and vital signs in risk stratification. We provide the first report of clinical characteristics of Delta variant infection in a virtual hospital setting in Australia, and hypothesise that initial symptoms and vital signs are just as important risk predictors for deterioration as comorbidities. This would facilitate the development of more clinically oriented risk prediction models and targeted interventions for those at higher risk of deterioration requiring hospital admission, to allow more coordinated approaches to hospital and community health resources during the ongoing pandemic response.

Objective

1. Describe demographic and clinical characteristics of patients with Delta variant COVID-19 managed in SHA during the early stages of the Sydney outbreak June–July 2021.
2. Determine predictors of need for in-patients admission from SHA.

Methods

Design

Retrospective observational study of a cohort of paediatric and adult patients in SHA with diagnosed COVID-19 Delta variant.

Setting

The community COVID-19 virtual model of care implemented by Sydney Local Health District coordinated patient care in both SHA and patient homes. Between 16 June and 26 July 2021, SHA was made available for any community patients with COVID-19 who could not isolate within their own homes and/or needed additional subacute medical, nursing, allied health or mental health support. Admission to SHA included an initial clinical assessment by an RN followed by ongoing nursing assessments, twice daily or more frequently as required, supported by escalation pathways for medical, mental health and social issues. Patients who were escalated because of health concerns including abnormal vital signs, pain including chest pain, headaches and abdominal pain, decreased oral intake, vomiting or diarrhoea were transferred by ambulance to one of eight major teaching hospitals located in metropolitan Sydney. To date, RPA Virtual Hospital has managed 3254 patients with COVID-19 from March 2020 to 26 July 2021. RPA Virtual Hospital has been responsible for the clinical management of around 35% of all COVID-19 Delta variant cases in Sydney from 16 June to 26 July 2021.

Patient population

All paediatric and adult patients with COVID-19 were confirmed by polymerase chain reaction (PCR) test in SHA and assessed by RPA Virtual Hospital during the initial phase of the outbreak between 16 June and 26 July 2021. All patients were positive for the Delta variant, and all received an initial clinical assessment on admission, in person, for patients in SHA by nursing staff with routine collection of variables such as initial symptoms, comorbidities and vital signs at the time of assessment.

Outcome

The outcome of interest was admission to an in-patient ward or ICU to one of eight major teaching hospitals with COVID-19 in-patient bed capacity on any given day.

Data sources

Data were obtained from RPA Virtual Hospital and SHA electronic medical records, observation charts, ED clinical notes and discharge summaries from receiving hospitals. For patients who were transferred to hospital on multiple occasions, only the last transfer was used to prevent duplicate encounters.

Variables

Data variables included demographic details, primary language spoken at home, initial positive COVID-19 swab date, COVID-19-related symptoms on admission to RPA Virtual hospital, comorbidities (any diagnosis of respiratory, cardiac, or endocrine conditions, for example, COPD or asthma, obesity, either type of diabetes, pregnancy and/or any mental health illness documented in the clinical notes was included) vital signs on initial assessment (oxygen saturations on room air, pulse, BP, respiratory rate and temperature) at RPA Virtual Hospital, vaccination status and ED mode of separation (discharged from ED, admitted to ward, ICU) and in-patient length of stay. Vital sign abnormalities were based on upper or lower normal limits for adults and age category for children younger than 16 years based on the standard NSW Health track and trigger observation charts.[7] Days to transfer to the ED were based from the date of initial positive COVID-19 swab.

Statistical analysis

Chi-squared tests were used to compare categorical variables and

TABLE 1. *Baseline characteristics of patients with Delta variant COVID-19 in Special Health Accommodation and comparison of those who were admitted to hospital and those who were not admitted*

	Total, $N = 794$	In-patient admission, $n = 125$	Not admitted, $n = 669$	*P*-value
Age (SD)	32.51 (16.64)	41.0 (18.3)	30.4 (15.5)	<0.001
Age (%)				
0–5	19 (2.4)	1 (0.8)	18 (2.7)	
5–16	61 (7.7)	3 (2.4)	58 (8.7)	
16–40	494 (62.2)	58 (46.4)	436 (65.2)	
40–65	189 (23.8)	47 (37.6)	142 (21.2)	
65+	31 (3.9)	16 (12.8)	15 (2.2)	
English speaking (%)	534 (67.3)	69 (55.2)	465 (69.5)	0.002
Male (%)	440 (55.5)	67 (54.5)	373 (55.6)	0.79
Initial symptoms present on admission (%)	576 (72.5)	118 (75.2)	458 (71.9)	0.41
Fever (%)	87 (11.0)	22 (17.6)	65 (9.7)	0.01
Cough or shortness of breath (%)	404 (50.9)	76 (60.8)	323 (49.0)	0.01
Sore throat (%)	303 (38.2)	38 (30.4)	265 (39.6)	0.05
Headache (%)	186 (23.4)	33 (26.4)	153 (22.9)	0.39
Chest pain (%)	26 (3.3)	4 (3.2)	22 (3.3)	0.95
Gastrointestinal† (%)	68 (8.6)	20 (16.0)	48 (7.2)	<0.001
Anosmia	160 (20.2)	19 (15.2)	141 (21.1)	0.13
Pre-existing comorbidities				
Multiple comorbidities (%)	19 (2.4)	11 (8.8)	8 (1.2)	<0.001
Mental health (%)	50 (6.3)	12 (9.6)	38 (5.7)	0.13
Current smoker (%)	4 (0.5)	2 (1.6)	2 (0.3)	0.06
Respiratory (%)	54 (6.8)	15 (9.6)	39 (6.1)	0.13
Cardiovascular (%)	16 (2.0)	6 (4.8)	10 (1.5)	0.07
Diabetes (%)	46 (5.8)	21 (16.8)	25 (3.7)	<0.001
Obesity (%)	16 (2.0)	10 (8.0)	6 (0.9)	<0.001
Hypertension (%)	80 (10.1)	26 (20.8)	54 (8.1)	<0.001
Pregnant (%)	6 (0.8)	4 (3.2)	2 (0.3)	<0.001
Initial observations				
Temperature >37.5°C	23 (2.9)	14 (11.2)	9 (1.4)	<0.001
O_2 saturation <95%	46 (5.8)	27 (21.6)	19 (2.8)	<0.001
Systolic BP (mean, SD)	121 (14.2)	118 (13.5)	121 (14.0)	0.05
Hypotension‡	108 (13.6)	17 (13.6)	91 (13.6)	0.99
Tachycardia‡	268 (33.8)	52 (41.6)	216 (32.3)	0.04
Tachypnoea‡	15 (1.9)	8 (6.4)	7 (1.05)	<0.001
COVID-19 vaccination	35 (4.4)	2 (1.6)	33 (4.9)	0.10

†Gastrointestinal symptoms were abdominal pain and or diarrhoea. ‡Based on normal upper limit for age groups.

continuous variables compared using Student's *t*-tests for parametric variables and Wilcoxon rank-sum tests for non-parametric continuous variables such as day to escalation. Univariable predictors of the outcome were identified using a significance threshold of $P \leq 0.10$ and entered into a multivariable logistic

TABLE 2. *Multivariable logistic regression model of in-patient admission following COVID-19 in Special Health Accommodation*

Variable	Coefficient	OR	SE	95% CI	*P*-value
Age					
0–5	−0.47	0.62	1.11	0.07, 5.48	0.67
5–16	−0.56	0.57	0.67	0.15, 2.14	0.40
16–40	[Ref]				
40–65	0.65	1.92	0.28	1.12, 2.30	0.02
>65 years	1.95	7.05	0.50	2.64, 18.83	<0.001
Diabetes mellitus	0.74	2.10	0.42	0.91, 4.81	0.08
Obesity	1.48	4.41	0.64	1.26, 15.46	0.02
Cardiovascular	0.39	1.47	0.71	0.37, 5.89	0.58
Hypertension	−0.13	0.88	0.38	0.42, 1.85	0.73
Temperature >37.5°C	1.70	5.46	0.53	1.93, 15.51	0.001
Oxygen saturation <95%	1.92	6.80	0.43	2.95, 15.69	<0.0001
Tachycardia	0.61	1.85	0.25	1.14, 3.01	0.01
Tachypnoea	1.07	2.92	0.66	0.81, 10.58	0.10
Initial symptoms					
Respiratory (cough, shortness of breath and chest pain)	0.15	1.175	0.23	0.74, 1.82	0.477
Fever	0.36	1.402	0.33	0.75, 2.76	0.2911
Gastrointestinal	0.83	2.28	0.33	1.20, 4.42	0.01
Non-English speaking	0.22	1.23	0.24	0.768, 1.956	0.37
COVID-19 vaccination	−1.01	0.349	0.77	0.078, 1.56	0.18

AUROC for logistic regression model 0.80 (95% CI 0.75, 0.84); CI, confidence interval; OR, adjusted odds ratio; SE, standard error.

TABLE 3. *Decreasing Emergency and Life-Threatening Admissions (DELTA) risk score*

Risk factor	Score
Age <16 years	−1
Age 16–40 (ref)	0
Age 40–65 years	1
Age >65 years	3.5
Diabetes	1
Obesity	2
Temperature >37.5°C on initial assessment	3
Oxygen saturation <95% on initial assessment	3
Tachycardia†	1
Gastrointestinal symptoms on initial assessment	1
COVID-immunisation (any)	−2

†Based on upper limits of normal for age groups <16 years.

regression model. Final variables were confirmed using stepwise selection with a selection threshold of $P < 0.05$, with addition of factors thought to be predictive based on *a priori* knowledge. Risk scores were derived from standardised model coefficients from the final logistic regression model. Model discrimination was assessed using area under receiver operating characteristic (AUROC) curve analysis and calibration using the Hosmer–Lemeshow goodness of fit test.

Ethics statement

Approval was gained from the Sydney Local Health District Research Ethics Committee (RPA Zone) and all methods were performed with the relevant guidelines and regulations.

TABLE 4. *Decreasing Emergency and Life-Threatening Admissions risk score probabilities of in-patient admission following COVID-19 in Special Health Accommodation*

Calculated Delta score	$N = 794$ (%)	Risk	Mean probability of admission (95% CI)	Median days to transfer to ED (IQR)
<0	340	Low risk	6% (5, 6)	5 (4–9)
0–1	282	Mild risk	12% (12, 12)	7 (4–9)
1–3.5	114	Moderate risk	28% (27, 29)	6 (4–9)
>3.5	58	High risk	66% (62, 71)	6 (4–8)

CI, confidence interval; IQR, interquartile range.

The Committee granted a waiver of the usual requirement for the consent of the individual for the use of their health information in a research project, in accordance with the *Health Records and Information Privacy Act 2002* (NSW) and the NSW Privacy Commissioner's Statutory guidelines on research and the NHMRC Guidelines approved under Section 95A of the Privacy Act 1988.

Results

Population characteristics

The study population comprised 794 patients in SHA. The average age was 32.5 (SD 16.6) years with 440 (55.6%) identifying as male and 354 (44.4%) identifying as female. One hundred and fifty-seven patients (19.8%) were transferred to ED. Of those, 125 were admitted to an in-patient unit (admission rate from ED 79.6%), and of these 30 (24%) went to ICU and seven were intubated. Two patients died within the follow-up period. The median number of days from initial positive swab to ED escalation was 6 days (interquartile range [IQR] 4–8) and median hospital length of stay for admitted in-patients was 6 days (3–12). Only 4.4% were vaccinated and of those all had had a double dose. Twenty-two patients (2.8%) had a vital sign that was missing from the data set.

Univariable analysis

Table 1 summarises and compares the baseline demographic and clinical characteristics of the study cohort. The most common symptoms on initial assessment were cough or shortness of breath (50.9%), sore throat (38.2%) and headache (23.4%). Univariable predictors for in-patient admission were age (age >40 years), non-English speaking, initial symptoms (fever and respiratory symptoms), comorbidities (diabetes mellitus, hypertension and obesity), gastrointestinal symptoms (abdominal pain or diarrhoea) and initial vital signs (fever, hypoxia and tachycardia).

Multivariable analysis

Table 2 shows the logistic regression model, demonstrating age >40 years, obesity (odds ratio [OR] 4.41; 95% confidence interval [CI] 1.26, 15.46; $P = 0.02$), and presence of fever (OR 5.46; 95% CI 1.93, 15.51; $P = 0.001$), hypoxia (OR 6.80; 95% CI 2.95, 15.69; $P < 0.001$), tachycardia (OR 1.85; 95% CI 1.14, 3.01; $P = 0.01$) and gastrointestinal symptoms (OR 2.30; 95%CI 1.20, 4.42; $P = 0.01$) on initial assessment were strongest independent predictors of in-patient admission with an AUROC of 0.78 (95% CI 0.73, 0.82).

Proposed DELTA risk score

Based on model coefficients from the above logistic regression model, derived risk scores are shown in Table 3, with the sum of these risk scores denoting a probability for in-patient admission as shown in Table 4. We included vaccination status in the final model based on *a priori* knowledge even though the variable did not meet pre-defined significance thresholds. We also excluded pregnancy because of low numbers. We referred to this total risk score as the Decreasing Emergency and Life-Threatening Admission (DELTA) risk score. When DELTA scores were modelled against predicted probabilities from the original logistic regression model, the AUROC of the DELTA risk score was 0.78 (95% CI 0.74, 0.82), Hosmer–Lemeshow test statistic goodness of fit ChisSq 4.26, d$F = 3$, $P = 0.24$. Risk score ranges with median outcome probabilities are shown in Table 4. In summary, each interval increase in risk approximately doubles the probability for in-patient admission. There was no significant difference in median days from initial positive swab to transfer to ED based on risk scores (Kruskal–Wallis $P = 0.94$).

Discussion

This was the first Australian study to describe a cohort of patients with Delta VOC COVID-19 infection in SHA, and the first prediction tool based on clinical parameters obtained from patients with the Delta VOC in a virtual hospital setting. The findings demonstrated that the most important risk factors for hospital admission for Delta variant COVID-19 were the presence of hypoxia or fever or presence of gastrointestinal symptoms on initial assessment in SHA and increasing age. Other important risk factors for clinical deterioration were included pre-existing diabetes mellitus and obesity. The findings supported our hypothesis that initial symptoms and

vital signs on admission to virtual care are an important consideration when risk stratifying patients with early COVID-19.

Several other findings of the present study merit further consideration. Although respiratory symptoms predominated consistent with previous strains, gastrointestinal symptoms had a higher prevalence with the Delta SARS-CoV-2 variant when compared to the Alpha SARS-CoV-2 strain, consistent with recent reports on this variant of concern.[8] This highlights the need to recognise gastrointestinal symptoms not just as a clinical manifestation of the Delta variant, but also an independent risk factor of clinical deterioration. The age of the cohort was lower than previously reported population studies of the original strain of SARS-CoV-2[9] but risk of hospitalisation for children <16 years is low in this cohort in keeping with data from previous outbreaks of non VOC SARS-CoV-2 strains.[10] Mean length of stay for hospital in-patients was 6 days similar to previous reports.[11] The median duration from positive swab to hospital escalation was 6 days (IQR 4–8) with 75% of patients who required hospitalisation deteriorating between days 4 and 8 of illness. This is earlier in illness than previously described with Alpha strain of SARS-CoV-2.[12]

An important implication of the study was the appreciation of the role of initial vital signs and symptoms in risk stratification of patients in the outpatient setting. Community COVID-19 monitoring models of care required an initial risk assessment in order to direct resources towards the cohorts most likely to deteriorate and require hospitalisation.[13] Previous risk assessment models have employed data linkage using routinely collected hospital and general practice data. In a large data registry linkage study of hospital and general practice data over 5000 SARS-CoV-2 positive patients in Europe which included laboratory and vital signs at time of diagnosis where available, age and comorbid status were found to be predictive of hospital admission with an AUROC of 0.82.[14] Yadaw *et al.* reported a risk prediction model which included age, lowest oxygen saturation and type of patient encounter (in-patient or outpatient) in a cohort of patients treated within a hospital system in New York.[15] In a large population-based data linkage cohort in the UK, Nafilyan *et al.* validated the QCovid risk prediction model for short-term mortality following COVID-19 using age, body mass index, ethnicity and a range of pre-existing comorbidities.[16] This is the first Australian study deriving predictors for short-term deterioration because of COVID-19 using data obtained from uniformly performed clinical assessments in an outpatient setting. As patients are monitored outside the hospital setting using wearable devices, future modelling may include real-time physiological parameters such as oxygen saturation trends.

Limitations

The most important limitation of the study was the rapid emergence of other variants of concern, increasing vaccination rates and the use of disease-modifying agents in the last 6 months. For this reason, the DELTA risk score needs to be prospectively validated in patients with other variants such as omicron, and in fully vaccinated populations before it can be recommended in other settings. Given the current situation at the time of writing, the tool was being piloted and prospectively evaluated in SHA, which is different to a normal outpatient setting and we would recommend a similar approach in other settings. The cohort analysed in the present study may not be representative of other communities in Australia and its breadth of socioeconomic determinants of health. In particular, there was a relatively high proportion of non-English speaking patients in the present study, reflective of the population currently residing in the south west and western suburbs of Sydney. The average age of patients in the present study was 32.5 years and indicative of the population in SHA at the time the study was conducted. In addition, SHA prioritises beds for patients for whom self-isolation is difficult because of age, comorbidities, living arrangements or additional support requirements. These situations of vulnerability should be considered when comparing this group to the greater population as a whole.

Other acknowledged limitations include the relatively small sample and evolving vaccination rates in the community which are likely to bias risk estimates associated with the DELTA score. At the time of data collection, only 7.5% of the NSW population were fully vaccinated.[17] The small number of vaccinated patients in this cohort made it difficult to quantify the risk reduction provided by vaccination within this analysis. Experience from other international studies indicates that vaccinations provide significant risk reduction for requiring hospital admission with SARS-CoV-2 Delta strain.[18,19] Although the risk factors described in the DELTA risk score have to value, it will need to be validated in different populations at different stages of the pandemic to confirm its clinical utility. Finally, we did not have information regarding the timing of symptom onset as this is reliant on recall and can be problematic in cases where symptoms were mild.

Conclusion

In a study of patients with Delta variant COVID-19 in SHA, initial symptoms and vital signs were just as predictive for short-term deterioration as age and pre-existing comorbidities and should be included in future risk prediction models for COVID-19. Based on this, we derive a proposed risk prediction score that incorporates these predictors with further validation required.

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Author contributions

Concept (MD, RD), study design (all authors), ethics (SBR, MD, RD), literature search (KB, JB, BC, SBR), data collection (RD, OH, CD, DJ, MS, LM, MD), data analysis (RD, KB, JB, BC, MD), data interpretation (all authors) and manuscript preparation (all authors).

Competing interests

None declared.

Data availability statement

Data that support the findings of this study are available from RPA Virtual Hospital and Special Health Accommodation, Sydney Local Health District, but restrictions apply to the availability of data, and so are not publicly available. They are however available from the authors upon reasonable request and with permission of RPA Virtual Hospital and Special Health Accommodation, Sydney Local Health District.

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