Suboptimal COVID-19 vaccine uptake among hospitalised patients: an opportunity to improve vulnerable, hard-to-reach population vaccine rates

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Abstract

Background: COVID-19 vaccination represents a key preventative part of the Australian public health approach to the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) pandemic. Hospital inpatients are frequently high risk for severe COVID-19 and death. Anecdotes of high-risk inpatients being unvaccinated and a lack of electronic medical record (EMR) visibility of COVID-19 vaccination status prompted the present study as these patients could represent a risk to themselves, staff, other patients and service provision.

Aims: To determine the uptake of COVID-19 vaccine among inpatients at an adult Australian tertiary public hospital and identify reasons for non-vaccination.

Methods: A point-prevalence study of patient-reported COVID-19 vaccine status was conducted on 26 October 2021 through an in-person interview with collection of demographic factors and reasons for non-vaccination.

Results: Of 368 (68% of inpatients) participants, 280 (76%) reported receiving at least one COVID-19 vaccine dose. Vaccination status was associated with older age, having received the flu vaccine, being born in Australia and not requiring an English-language interpreter. The majority (88%) of participants had at least one comorbid risk factor for severe COVID-19. Of the unvaccinated (n = 88), 67% were willing to be vaccinated with 54% of those indicating vaccination in hospital would be helpful and 42% requesting approval from their doctor.

Conclusions: Vaccine uptake in our cohort is suboptimal. Existing public health programmes have failed to reach this high-risk, vulnerable population. Changes to the national vaccination strategy to include a parallel in-hospital programme for all hospital encounters and target culturally and linguistically diverse individuals might improve uptake among this high-risk, hard-to-reach group of patients.

Introduction

Australia has enjoyed enormous success in control and minimisation of direct harm from severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) infection, the virus that causes COVID-19, through a combination of border controls, contact tracing, isolation and quarantine underpinned by a robust public health service. COVID-19 vaccines have been developed and approved with remarkable effectiveness against infection, hospitalisation, severe disease and death.1–3 Local authorities have determined a vaccine uptake rate of 80% in those aged >16 years as a trigger for relaxing restrictions on travel and activities.4 However, the 80% target does not account for granular vaccine uptake rates among vulnerable populations, which may be lower than those reported in the population overall. Several conditions, independent of age, are known to
increase the risk of severe COVID-19 and death, including obesity, diabetes mellitus, cardiovascular disease and being immune compromised.\textsuperscript{5} Tertiary hospitals, including the Royal Adelaide Hospital, care for a diverse range of patients, the majority of whom have one or more risk factors for severe COVID-19. As a health service, we became concerned at anecdotal reports of poor vaccine uptake among subsections of patients admitted to our hospital. These individuals are personally vulnerable to severe COVID-19 and also frequently utilise the services provided at our institution. In light of growing reports of hospital-based COVID-19 outbreaks interstate, these unvaccinated individuals also represent a risk to the ongoing provision of healthcare at our institution. Efforts to audit vaccine uptake among inpatients and outpatients using our institutions’ electronic medical record (EMR) were unsuccessful due to a lack of vaccine recording on the EMR and an inability to audit data held within the Australian Immunisation Register or My Health Record. Currently, clinicians must access a patient’s My Health Record from within the EMR to find evidence of COVID-19 vaccine status. Approximately 8\% of the Australian adult population has opted out of My Health Record and these data are not auditable. Further, many hospital-based clinicians are not aware of this record or how to access it. The EMR provides no prompts regarding vaccination status. Thus, we planned an in-person point-prevalence study conducted through an in-person interview to determine the rate of COVID-19 vaccine uptake among admitted patients on a single day. This method of study allowed us to concurrently determine reasons for non-vaccination. The aim of the study was to determine the rate of uptake among a sample of admitted patients, identify groups with low vaccine uptake and identify reasons for non-vaccination. The objective of the study was to inform public health responses locally to improve vaccine uptake among a vulnerable group of patients and contribute to minimising the risk of COVID-19 outbreaks within the hospital system.

**Methods**

**Setting**

The study was conducted as an observational point-prevalence vaccine uptake study through an in-person interview with each participant by reading from a standardised questionnaire (Supporting Information Appendix S1). The Royal Adelaide Hospital is a 670-bed adult tertiary hospital providing all clinical services including renal and pancreas transplantation, cystic fibrosis, a satellite thoracic organ transplant service, burns, trauma, oncology, haematology, bone marrow transplantation and mental health services. The few services not provided are paediatrics and obstetrics.

**Participants**

All wards where patients are admitted for more than 24 h were included. Acute stay areas (the emergency department, operating theatres, recovery, day surgery and geriatric acute assessment unit) were excluded. The intensive care unit was excluded due to the in-person nature of the interview.

**Study conduct**

Interviewers consisting of hospital-employed medical, nursing and research staff received uniform instructions on undertaking the interview. Prior to patient approach, patients unable to complete the interview independently (e.g. due to cognitive impairment or illness) were identified by their treating team or the ward nurse unit manager, and attempts to contact their substitute decision-maker were made instead. All patients were approached by study staff in conjunction with a member of their treating medical or nursing team. Participation in the interview was voluntary and implied consent was required. All local infection control measures were followed during interviews. Participants were asked if they had received at least one dose of vaccine followed by a series of demographic questions. Those who indicated they were not vaccinated were prompted with a series of potential reasons for non-vaccination and measures to increase their likelihood of getting vaccinated, as well as an opportunity to provide their own reason or measure. Participants could choose multiple answers. The questionnaire was developed to identify groups with known risk factors for severe COVID-19 and those with risk factors for poor access to healthcare and social disadvantage.

Demographics and comorbidity data were confirmed from the EMR. Only data on comorbidities known to be associated with increased risk of severe COVID-19 or COVID-19 mortality were collected.\textsuperscript{5} Vaccination status was not confirmed due to study resource constraints. The study was approved by the Central Adelaide Local Health Network Human Research Ethics Committee (Reference: 15478) and was conducted in accordance with the ethical standards laid down in the Declaration of Helsinki (Brazil, 2013). All participants gave implied consent by participating in the interview. The point-prevalence study was conducted on Tuesday 26 October 2021. A team of 25 interviewers approached the 38 involved wards.
| Characteristic                              | Unvaccinated | Vaccinated | Total, n | P-value |
|--------------------------------------------|--------------|------------|----------|---------|
| **n (%)**                                  | 88 (24)      | 280 (76)   | 368      |         |
| Gender                                     |              |            |          |         |
| Male, n (%)                                | 56 (25)      | 166 (75)   | 222      | 0.533   |
| Female, n (%)                              | 32 (22)      | 114 (78)   | 146      |         |
| Median age [IQR]                           | 60 (45–75)   | 69 (58–79) | 67 (55–79) | 0.0011  |
| Vaccine by age range (years), n (%)        |              |            |          | <0.0001 |
| 18–30                                      | 10 (56)      | 8 (44)     | 18       |         |
| 31–40                                      | 9 (36)       | 16 (64)    | 25       |         |
| 41–50                                      | 9 (32)       | 19 (68)    | 28       |         |
| 51–60                                      | 18 (28)      | 46 (72)    | 64       |         |
| 61–70                                      | 13 (18)      | 60 (82)    | 73       |         |
| 70+                                        | 29 (18)      | 131 (82)   | 160      |         |
| Country of birth, n (%)                    |              |            |          | 0.0081  |
| Australia                                  | 53 (20)      | 211 (80)   | 264      |         |
| United Kingdom                             | 12 (33)      | 24 (67)    | 36       |         |
| Vietnam                                    | 2 (40)       | 3 (60)     | 5        |         |
| China                                      | 1 (25)       | 3 (70)     | 4        |         |
| Italy                                      | 2 (13)       | 13 (87)    | 15       |         |
| Greece                                     | 7 (70)       | 3 (30)     | 10       |         |
| Germany                                    | 1 (20)       | 4 (80)     | 5        |         |
| Other                                      | 10 (34)      | 19 (66)    | 29       |         |
| Country of birth, n (%)                    |              |            |          | 0.0095  |
| Australia                                  | 53 (20)      | 211 (80)   | 264      |         |
| Overseas                                   | 35 (34)      | 69 (66)    | 104      |         |
| Primary language at home, n (%)            |              |            |          |         |
| English                                    | 72 (22)      | 252 (78)   | 324      |         |
| Other                                      | 16 (36)      | 28 (64)    | 44       | 0.058   |
| English interpreter required, n (%)        |              |            |          | 0.0004  |
| Aboriginal and/or Torres Strait Islander, n (%) | 4 (36)   | 7 (64)    | 11       | 0.3021  |
| Group accommodation/nursing home, n (%)    |              |            |          |         |
| Yes                                        | 29 (13)      | 195 (87)   | 224      | <0.0001 |
| No                                         | 58 (43)      | 76 (57)    | 134      |         |
| Unknown                                    | 1 (10)       | 9 (90)     | 10       |         |
| Comorbidities, n (%)                       |              |            |          |         |
| Diabetes                                   | 24 (22)      | 85 (78)    | 109      | 0.69    |
| Chronic lung disease                       | 21 (21)      | 77 (79)    | 98       | 0.58    |
| Cardiovascular disease                     | 29 (18)      | 135 (82)   | 164      | 0.014   |
| Cerebrovascular disease                    | 10 (31)      | 22 (69)    | 32       | 0.38    |
| Active cancer in past 12 months            | 24 (30)      | 55 (70)    | 79       | 0.14    |
| Solid organ transplant                     | 1 (10)       | 9 (90)     | 10       | 0.47    |
| Immunosuppressed                           | 18 (24)      | 57 (76)    | 75       | >0.99   |
| Chronic renal failure                      | 9 (16)       | 49 (84)    | 58       | 0.097   |
| Chronic liver disease                      | 5 (21)       | 19 (79)    | 24       | 0.8098  |
| Pregnant                                   | 0 (0)        | 0 (0)      | 0        | NA      |
| BMI >30                                    | 20 (21)      | 77 (79)    | 97       | 0.377   |
| BMI unknown                                | 22 (24)      | 71 (76)    | 93       | NA      |
| No. comorbidities, n (%)                   |              |            |          |         |
| 0                                          | 13 (29)      | 32 (71)    | 45       | 0.1922  |
| 1                                          | 23 (22)      | 82 (78)    | 105      |         |
| 2                                          | 29 (32)      | 62 (68)    | 91       |         |
| 3                                          | 15 (21)      | 55 (79)    | 70       |         |
| 4                                          | 5 (13)       | 34 (87)    | 39       |         |
| ≥5                                         | 3 (17)       | 15 (83)    | 18       |         |
| Questionnaire conduct, n (%)               |              |            |          |         |
| Interpreter used                           | 4 (50)       | 4 (50)     | 8        |         |
| SDM                                        | 11 (38)      | 18 (62)    | 29       |         |

BMI, body mass index; IQR, interquartile range; SDM, substitute decision-maker.
Analysis

Data analysis was performed using Prism 9 (version 9.2.0(238); GraphPad Software LLC). The primary outcome was vaccination status. Continuous variables were compared using the Mann–Whitney U-test for non-parametric variables. Categorical variables were compared using the Fisher’s exact test or the Chi-squared test. A P-value <0.05 was considered significant.

Results

At 8 am on 26 October 2021, there were 670 patients admitted to the hospital; 538 patients were admitted to included wards. Interviews were conducted with 368 (68%) participants who were available and consented to participate. Over three-quarters (280; 76%) of participants had received at least one dose of a COVID-19 vaccine and 88 (24%) participants had not received any doses of a COVID-19 vaccine prior to 26 October 2021. Table 1 demonstrates the demographics of participants by vaccination status. The median age of the vaccinated participants was higher than the unvaccinated (69 years vs 60 years; P = 0.001). The majority of participants were born in Australia (n = 264; 74%). The vaccination rate among participants born in Australia was higher than those born overseas (211/264 (80%) vs 69/104 (66%); P < 0.001). The vaccination rate was non-significantly higher among those who cited English as their primary language at home (252/324 (78%) vs 28/44 (64%); P = 0.058). Participants requiring an English-language interpreter was associated with lower vaccination rate than participants who did not (5/15 (33%) vs 275/353 (77.9%); P < 0.001). Residence in shared or group accommodation was reported in 32/368 (11%) of participants and was not associated with vaccination status (P = 0.38). Vaccination rate was higher among those who had an influenza vaccine in 2021 (195/224 (87%) vs 76/134 (57%); P < 0.0001). The vaccination rate among those who identified as

| Table 2 Patient-reported reasons for non-vaccination and measures to improve vaccination status |
|---------------------------------|-----------------|-----------------|-----------------|
| Reason for non-vaccination      | Willing to be vaccinated, n (%) | Unwilling to be vaccinated, n (%) | Not answered, n (%) |
| Willing to be vaccinated (n = 88) | 59 (67)         | 27 (31)         | 2 (2)           |
| Reason for non-vaccination      |                  |                 |                 |
| I am booked/booking to receive one | 10 (17)         | 0 (0)           |                 |
| It is too difficult to obtain   | 14 (24)         | 2 (7)           |                 |
| I have been waiting for mRNA vaccines | 5 (8)           | 3 (11)          |                 |
| COVID-19 vaccines are not safe enough | 6 (10)         | 17 (63)         |                 |
| COVID-19 vaccines have side-effects | 13 (22)       | 19 (70)         |                 |
| I plan to wait and see if it is safe, and may get it later | 12 (20) | 10 (37) |                 |
| I do not want to be a guinea pig | 2 (3)           | 8 (30)          |                 |
| I'm concerned about effects on fertility | 0 (0)          | 4 (15)          |                 |
| COVID-19 vaccines are not effective | 1 (2)           | 11 (41)         |                 |
| COVID-19 is not a problem in South Australia | 2 (3) | 4 (15) |                 |
| COVID-19 is not a severe disease | 1 (2)           | 3 (11)          |                 |
| COVID-19 is not a big enough threat for me to get the COVID-19 vaccine | 5 (8) | 6 (22) |                 |
| Family/friend have had bad experiences of the COVID-19 vaccine | 5 (8) | 5 (19) |                 |
| COVID-19 vaccines are not accepted by my religion | 1 (2) | 1 (4) |                 |
| I have a fear of having needles or infections | 4 (7) | 2 (7) |                 |
| I have a medical contraindication to COVID-19 vaccination | 8 (14) | 24 (89) |                 |
| What would assist you in obtaining a COVID-19 vaccine |                  |                 |                 |
| Additional information on safety of the vaccine | 11 (19) | 11 (41) |                 |
| Availability of the vaccine while I am in hospital | 32 (54) | 6 (22) |                 |
| Vaccination in my home/workplace | 7 (12)         | 0 (0)           |                 |
| Additional time off work        | 3 (5)           | 0 (0)           |                 |
| Transport to a vaccine centre   | 12 (20)         | 0 (0)           |                 |
| More availability of the vaccine | 6 (10)         | 1 (4)           |                 |
| Approval from my doctor        | 25 (42)         | 6 (22)          |                 |
| A financial incentive           | 3 (5)           | 2 (7)           |                 |
| The need to be vaccinated to enter public venues (e.g. restaurants/shops) | 5 (8) | 4 (15) |                 |
| My employer requiring me to be vaccinated to work | 6 (10) | 1 (4) |                 |
Aboriginal or Torres Strait Islander was similar to other participants ($P = 0.3$).

Comorbidities associated with increased risk of severe COVID-19 were highly prevalent with 323 (88%) of 368 participants having at least one comorbidity and 218/368 (59%) having ≥2 comorbidities. Vaccination uptake was 71% (32/45) among those with no comorbidities versus 77% (248/323) among those with at least one comorbidity ($P = 0.446$). Postcodes were available for 366 participants, allowing determination of local government area (LGA) of residence (Table S1). There was no association between vaccination status and metropolitan Adelaide LGA or rural versus urban residence ($P = 0.68$).

Reasons for non-vaccination and measures to improve uptake are shown in Table 2. Of the 88 unvaccinated participants, the majority (59/88; 67%) indicated they were willing to be vaccinated, but reported the vaccine was too difficult to obtain, or expressed concern regarding side-effects and/or safety. The majority (32/59; 54%) indicated they would have the vaccine while hospitalised if offered to them, while 25 (42%) reported that approval from their doctor would be helpful. Twenty-seven participants indicated they were unwilling to be vaccinated; 63% and 70% expressed concerns about vaccine safety and/or side-effects, respectively. A large number (24/27; 89%) reported a medical contraindication to vaccination that we did not verify. Of the unwilling, helpful measures to assist them in getting vaccinated were reported as additional information on the safety of the vaccine (11/25; 41%), approval from their doctor (6/25; 41%) and availability of the vaccine while in hospital (6/25; 41%).

**Discussion**

This is the first study reporting COVID-19 vaccination rates among a large sample of inpatients at a tertiary Australian hospital with exploration of reasons for non-vaccination. Only 76% of this cohort were vaccinated against COVID-19 despite the majority being high risk for severe COVID-19. Factors associated with lower vaccination rates in our cohort were younger age, being born overseas and requiring an English-language interpreter. The results suggest that existing public health measures to vaccinate these vulnerable individuals have failed. The majority of the unvaccinated in our cohort were willing to receive vaccination. The unvaccinated frequently cited inhospital vaccination and requiring a doctor’s approval as factors to assist in obtaining a vaccination, suggesting access and counselling has been inadequate for this group. Given these vulnerable patients are likely to require hospitalisation if they contract COVID-19, a vaccination strategy that can identify and target these individuals is required. Such a strategy will have individual patient benefits but also protect the healthcare system from excessive COVID-19 burden.

In our cohort, vaccination status was associated with multiple social determinants of health including the need for an English-language interpreter and being born outside Australia. Individuals from ethnic minorities, those with lower incomes and lower education levels have previously been identified as having lower rates of intention to receive a COVID-19 vaccine.6,7 A surrogate of socioeconomic status, residential LGA, was not associated with vaccination status in our cohort, although this may reflect the small sample size. Despite existing data on the risk groups for non-vaccination, public health measures to target these groups for COVID-19 vaccination do not appear to have been successful in our cohort. Our data suggest efforts to increase vaccination rates requires an approach that is accessible to people of all cultural and linguistic backgrounds. Culturally and linguistically diverse (CALD) groups are already at higher risk of adverse health outcomes.8,9 Similarly, previous international SARS-CoV-2 outbreaks have disproportionally affected CALD communities.10 There is some variation of vaccination rates within some CALD communities with those born in Italy having high vaccination rates compared with low rates among those born in Greece (Table 1); the reasons for this are unclear. Increasing age was also associated with increasing rate of vaccination that might reflect public health messaging or a greater duration of vaccine availability for older individuals.

Among those who were not vaccinated in our cohort, a substantial proportion indicated difficulty with obtaining the vaccine, while a number expressed concerns about safety and side-effects, even among those who indicated they were willing to have the vaccine. These factors are supported by the finding that COVID-19 vaccination status was associated with influenza vaccination in 2021, signifying that those who are vaccinated against COVID-19 might have greater access to healthcare, be more engaged in healthcare and/or have greater healthcare literacy. Previous studies of influenza vaccine uptake have identified those who have risk factors for severe influenza or recently visited their healthcare provider are more likely to be vaccinated.11,12 The vaccination rate in our cohort is numerically lower than the concurrent overall vaccination rate of 79.6% in those aged ≥16 years in South Australia on 26 October 2021.13 Notably, the vaccine-eligible South Australian population is likely to have a lower median age and fewer COVID-19 risk factors than our cohort.
A change in public health vaccination strategy may engage and vaccinate high-risk groups in our cohort who have proven hard to reach via existing programmes. The current national vaccination strategy is focussed on general practitioners, pharmacies and state-run mass vaccination centres that have been unable to reach many in our cohort. Hospital admission represents an important healthcare episode where multiple healthcare staff are able to counsel patients on the need for COVID-19 vaccination. The unvaccinated participants in the present study frequently cited inhospital vaccination as a feature that would assist them getting vaccinated. A parallel hospital-based vaccination programme might assist in vaccinating high-risk and CALD individuals. In order to facilitate inhospital vaccination, system changes to allow rapid and effortless identification of unvaccinated individuals at every hospital encounter is required in conjunction with ready and opportunistic availability of COVID-19 vaccination on site. An emergency department-based programme has had success with this approach for short-stay patients,14 but expansion of the programme to all inpatient, emergency department and outpatient visits may yield considerable results. Administration of vaccines while patients are admitted is not commonplace in adult hospitals; this was indicated as an important measure that might facilitate vaccination for many participants. The unvaccinated participants were disproportionately from a non-English speaking background. Vaccination promotion campaigns that are culturally and language appropriate are required to engage and vaccinate CALD members of the Australian community. Additionally, outreach programmes to deliver vaccines into communities may be required. Some of our cohort identified their health problems and transport access as a barrier to physically visiting a vaccination site; in-home vaccination services might overcome this barrier.

The present study has several limitations. The study was resource and time intensive. However, this was the only method that could reliably determine the vaccination status of inpatients in the absence of auditable data being held on the EMR of our health system. The point-prevalence design and the inperson interview requiring consent produced a discrete sample of willing participants at a single time point that is likely to change over time. The resource-intensive requirements limited our ability to recruit a larger portion of patients who required an English interpreter or required their substitute decision-maker to provide consent. The latter aspect may have inadvertently excluded some participants from residential care facilities (RCF). Government resources dedicated to achieving high vaccine rates in RCF may mean our vaccination rate is lower than the true rate among all admitted patients. Conversely, the implied consent required to participate may have inadvertently excluded unvaccinated individuals who are unwilling to discuss vaccination. The overall effect of these competing factors is unclear; however, the authors speculate they may have balanced each other out to have minimal impact on the results. A further limitation is the patient report of vaccination status that we did not confirm owing to study resource limitations. Multivariate analysis was not performed, but might have allowed better understanding of factors associated with vaccination uptake. Last, our study is from a single centre that might not represent other centres and is not reflective of the overall community vaccine uptake among specific groups. Most participants cited their race/ethnicity as ‘Australian’ (data not shown); the authors speculate the sample was predominantly Caucasian, English-speaking individuals. There were few (3%) Indigenous Australian participants in our study and only 25% of our sample was aged <55 years. Thus, public health measures extrapolated from these data may not be applicable to the wider community. Nonetheless, the primary theme of improving vaccine access, patient-clinician discussions and messaging is likely to be broadly beneficial.

**Conclusion**

Most hospitalised patients have multiple risk factors for severe COVID-19 and death; however, vaccine uptake was suboptimal. Of those who were unvaccinated, the majority were willing to receive COVID-19 vaccinations provided vaccines were made easily available. Those not yet vaccinated represent a hard-to-reach population requiring different strategies. These strategies include developing systems to identify them and taking the COVID-19 vaccinations to the opportunistically, either in hospital or at home through a mobile outreach service. Changes to the national vaccination strategy to include a parallel inhospital programme for all hospital encounters and greater culturally and linguistically appropriate vaccine promotion and delivery services might improve uptake among this high-risk, hard-to-reach group of patients.

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Supporting Information

Additional supporting information may be found in the online version of this article at the publisher’s web-site:

Appendix S1. Questionnaire.
Table S1. Vaccination status by local government area (LGA) of residence.