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Short Report

# Universal use of surgical masks is tolerated and prevents respiratory viral infection in stem cell transplant recipients

D.G. Partridge<sup>a,b,\*</sup>, A. Sori<sup>c</sup>, D.J. Green<sup>c</sup>, R. Simpson<sup>c</sup>, B. Poller<sup>d</sup>, M. Raza<sup>e</sup>,  
H. Kaur<sup>f</sup>, H. Jessop<sup>f</sup>, B. Colton<sup>f</sup>, A. Nield<sup>f</sup>, C.M. Evans<sup>b,e</sup>, A. Lee<sup>c</sup>

<sup>a</sup> Department of Microbiology, Sheffield Teaching Hospitals Foundation NHS Trust, Sheffield, UK

<sup>b</sup> Florey Institute for Host–Pathogen Interaction, University of Sheffield, Sheffield, UK

<sup>c</sup> School of Health and Related Research, University of Sheffield, Sheffield, UK

<sup>d</sup> Department of Laboratory Medicine, NHS Lothian, Edinburgh, UK

<sup>e</sup> Department of Virology, Sheffield Teaching Hospitals Foundation NHS Trust, Sheffield, UK

<sup>f</sup> Department of Haematology, Sheffield Teaching Hospitals Foundation NHS Trust, Sheffield, UK

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## SUMMARY

Prevention of respiratory viral infection in stem cell transplant patients is important due to its high risk of adverse outcome. This single-centre, mixed methods study, conducted before the severe acute respiratory syndrome coronavirus-2 pandemic, explored the barriers and facilitators to a policy of universal mask use by visitors and healthcare workers, and examined the impact of the first year of introduction of the policy on respiratory viral infection rates compared with preceding years, adjusted for overall incidence. Education around universal mask use was highlighted as being particularly important in policy implementation. A significant decrease in respiratory viral infection was observed following introduction.

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\* Corresponding author. Address: Department of Microbiology, Sheffield Teaching Hospitals NHS Foundation Trust, Northern General Hospital, Herries Road, Sheffield S5 7AU, UK.

E-mail address: [dpartridge@nhs.net](mailto:dpartridge@nhs.net) (D.G. Partridge).

## Introduction

Respiratory viral infections are a major cause of morbidity in stem cell transplant recipients, and mortality rates of 6–50% have been reported [1]. In contrast, these pathogens typically cause only mild symptoms in immunocompetent individuals, and may therefore be introduced to the hospital unwittingly by healthcare workers (HCWs) or visitors. Vulnerability of this patient group to nosocomial infection is well recognized, with protective isolation in single rooms with appropriate engineering controls, and routine use of protective equipment, including gloves, by staff for direct patient care common to most centres [2]. A previous single-centre study demonstrated that universal use of surgical facemasks by those in contact with at-risk patients was associated with a reduction in parainfluenza infection compared with both a historical control period and another neighbouring hospital [3]. Despite this evidence, prior to the onset of the severe acute respiratory syndrome coronavirus-2 (SARS-CoV-2) pandemic, the universal use of masks in this high-risk setting was not widely adopted and the underlying reasons for this have not been clearly identified. This study sought to qualitatively assess the barriers to routine adoption of universal mask use to assist in its introduction and, subsequently, to validate the infection control benefits of the original study in a further hospital setting.

The emergence of SARS-CoV-2, the disproportionately adverse consequences of SARS-CoV-2 infection in haematology patients [4], and the potential for transmission from asymptomatic or paucisymptomatic individuals, including HCWs, make the need for infection control interventions aimed at preventing viral transmission in this vulnerable group of patients an even more urgent priority, and one that will remain even after a successful vaccination campaign.

## Methods

### Setting and laboratory testing

The Haematology Department at Sheffield Teaching Hospitals NHS Foundation Trust (STH) provides tertiary-level services to over one million people in South Yorkshire and North Derbyshire, and performs approximately 140 stem cell transplants per year. STH has 12 dedicated positive-pressure ventilated lobby protective isolation rooms with HEPA-filtered air and ensuite facilities for stem cell transplant recipients [5]. The Virology Laboratory at STH provides diagnostic serology and molecular virology testing for a similar geographical area. All patients with clinical features suggestive of a viral respiratory tract infection are tested for influenza A/B, respiratory syncytial virus (RSV), parainfluenza virus 1–4, human metapneumovirus, seasonal coronavirus, rhinovirus and adenovirus. These tests are performed using an in-house multiplex polymerase chain reaction (PCR) method validated on the Roche Flow system.

### Qualitative study

Semi-structured interviews were conducted with transplant patients and healthcare workers from the haematology transplant ward between June and August 2018. Patients under the age of 18 years, those unable to provide written informed

consent and those who were clinically unstable were excluded from the study. The interviews were audio-recorded and transcribed. Thematic analysis was performed manually to assess perceptions of mask use.

### Universal mask use

Following completion of the qualitative study, universal mask use for care of transplant patients was introduced on a routine basis in March 2019. All staff members entering patient rooms on the transplant ward were provided with type IIR fluid-resistant surgical masks in the anteroom, donned in conjunction with gloves and aprons, which were already established practice. Signs were placed on the doors of rooms to remind staff of the policy. Patients were provided with written information about the intervention at a pre-transplant clinic assessment, and this was reiterated on admission to the ward. Visitors to the ward were given access to masks, and patients were advised that the use of masks by their visitors might provide additional benefit, but this was not mandated by staff. If patients specifically asked for staff not to wear a mask, staff complied with this request, subject to other clinical indications.

### Assessment of efficacy

Rates of PCR positivity for respiratory viruses from nose and/or throat swabs, sputum or bronchoalveolar lavage taken from patients in the first 30 days post-transplant during the first year of universal mask use (1/3/19–29/2/20) were compared with rates over the period 1/3/15–28/2/18, adjusted for incidence in the adult population served by the laboratory at an individual pathogen level. Data for adenovirus are not shown as there were no positive results in transplant patients in either the pre- or post-intervention periods. All data were de-duplicated such that only the first infection with any specific virus in an individual within a year (March–February) was counted. The study period preceded the first diagnosed case of coronavirus disease 2019 (COVID-19) in a Sheffield patient, and the implementation of enhanced infection control measures related to the novel pathogen. No changes were made to test-requesting protocols during the study period and, specifically, throat swabs for respiratory viral PCR were recommended as a routine investigation for neutropenic sepsis throughout. There were no outbreaks of respiratory virus infection on the unit that led to a change in infection control precautions during either the pre- or post-intervention period. As a transplant unit, staff members were encouraged to be vigilant for symptoms of respiratory viral disease, to be tested should symptoms develop, and to receive their annual influenza vaccination throughout both periods.

### Statistical analysis

Summary statistics such as frequency and mean with standard deviation or median with interquartile range were used as appropriate. In order to take account of potential spikes of particular viruses in a given year, the pre-intervention period diagnoses were adjusted for total laboratory confirmed diagnoses in adults; essentially, creating a direct comparison of the number of observed cases in the post-intervention period with the number of expected cases in the pre-intervention period

based on the community level of total laboratory diagnoses. The proportion of adjusted pre-intervention period cases was then compared with the proportion of diagnoses in the post-intervention period using a two-proportion Z-test with Yates' continuity correction to account for small sample sizes. The results of this analysis present the risk difference (RD), with the associated *P*-value and 95% confidence interval (CI). A two-tailed *P*-value of 0.05 was regarded as significant, and data were collected and processed using Excel (Microsoft Corp., Redmond, WA, USA), with statistical analysis in R Version 4.0.5 [6].

### Consent and ethical approval

Informed consent was obtained from all participants of the qualitative study, and approval was granted by the Yorkshire & The Humber – Bradford Leeds Research Ethics Committee (Reference 18/YH/0222).

## Results

### Qualitative study

In total, six transplant patients (three autologous and three allogeneic) and seven HCWs (one doctor, three nurses and three domestic staff) were interviewed. Following these interviews, data saturation was judged to have occurred, especially for the HCWs. The analysis revealed that both staff and patients were open to the idea of universal mask use. Thematic analysis highlighted physical discomfort and heat, especially on prolonged use; impaired conversation and emotional engagement between patient and HCWs; a feeling of detachment from relatives and partners; time delay due to mask donning; and lack of knowledge of mask effectiveness as the principal barriers to mask use. These were balanced against a number of facilitators including perceived infection control benefit, and the potential adaptability of perceptions about mask use and its normalization as a routine measure. Similar themes were identified from both HCW and patient interviews. Education to emphasize the potential benefit of universal mask use and to reduce anxiety surrounding it was described as being especially important in facilitating the introduction of the intervention.

The findings of the qualitative study were discussed with senior nursing and medical staff, including the stem cell transplant co-ordinators, to ensure that the rationale for the intervention was understood by both patients and HCWs. The supportive responses from interviewed patients were particularly important in facilitating the introduction of universal mask use.

### Assessment of efficacy

In total, 412 and 138 stem cell transplants were undertaken on the unit in the pre- and post-intervention periods, respectively, of which 122 (29.6%) and 37 (26.8%) were allogeneic (Table I).

Table II details the incidence of respiratory viral infection in the two periods, with and without adjustment for total population incidence. A decrease in the adjusted rate of infection from 23.34 to 11.59 per 100 patients was observed (RD 11.7, 95% CI 4.5–19.0; *P*=0.004). When only infections diagnosed as

**Table I**

Demographics of patients undergoing stem cell transplantation in pre- and post-intervention periods

	Pre-intervention	Post-intervention	<i>P</i> -value <sup>a</sup>
Number of transplants	412	138	
Sex (% female)	154 (37.4%)	58 (42.0%)	0.38
Mean age (years)	55.35	55.64	0.84 <sup>b</sup>
Number (%) allogeneic	122 (29.6%)	37 (26.8%)	0.60
Underlying disease			
Multiple myeloma	200 (48.5%)	72 (52.2%)	0.52
Lymphoma	62 (15.0%)	21 (15.2%)	>0.99
Acute myeloid leukaemia	53 (12.9%)	15 (10.9%)	0.64
Acute lymphoblastic leukaemia	18 (4.4%)	4 (2.9%)	0.61
Myelodysplastic syndrome	14 (3.4%)	2 (1.4%)	0.38
Myelofibrosis	7 (1.7%)	1 (0.7%)	0.68
Chronic myeloid leukaemia	6 (1.5%)	1 (0.7%)	0.82
Aplastic anaemia	3 (0.7%)	3 (2.2%)	0.35
Other including non-haematological (e.g. multiple sclerosis)	49 (11.9%)	19 (13.8%)	0.68

<sup>a</sup>*P*-values are a two-proportion Z-test with Yates' continuity correction, with the exception of <sup>b</sup> which is a two-sample *t*-test.

inpatients were considered, the adjusted rate of infection decreased from 19.69 to 7.25 per 100 patients (RD 12.4, 95% CI 6.2–18.7; *P*=0.001).

## Discussion

This study demonstrated that universal use of fluid-resistant surgical masks by care providers is associated with a significant reduction in the incidence of respiratory viral infection in patients undergoing stem cell transplantation. This mirrors the findings of Sung *et al.* [3] who demonstrated a reduction in the incidence of respiratory viral infection from 10.3% to 4.4% in haematopoietic stem cell transplant recipients at their unit following the introduction of universal mask use. The reduction in infections diagnosed as inpatients was particularly marked, consistent with the location of the intervention but raising the question regarding whether further benefit could be gained through advising mask use and other protective measures for patients following discharge both in the community and at outpatient visits. Previous randomized controlled trials examining the impact of surgical mask use in community settings have not demonstrated an association with reduced risk of respiratory viral infection when worn by either the index case, contacts or both [7], but the impact may be greater in stem cell transplant recipients due to their motivation and the ability to target education to a well-defined patient cohort. Further encouragement of patient mask use when outside their room or visiting other departments may also provide additional benefit, and has become routine during the SARS-CoV-2 pandemic.

**Table II**

Numbers and rates of respiratory viral infection in the pre- and post-intervention periods with and without adjustment for overall population incidence

Virus	Number of diagnoses in SCT recipients		Rate per 100 SCT recipients		Total laboratory diagnoses		Population-adjusted pre-intervention rate per 100 patients	P-value <sup>a</sup>	Risk difference per 100 patients (95% CI)
	Pre-intervention (N=412)	Post-intervention (N=138)	Pre-intervention	Post-intervention	Pre-intervention (2015–18)	Post-intervention (2019–20)			
Influenza A	3	0	0.73	0.00	1710	1303	1.66	0.279	1.66 (-0.05 to 3.38)
Influenza B	2	0	0.49	0.00	1210	46	0.06	>0.99	0.06 (-0.23 to 0.34)
Parainfluenza 1	2	0	0.49	0.00	145	97	0.97	0.558	0.97 (-0.46 to 2.41)
Parainfluenza 2	3	1	0.73	0.72	220	89	0.88	>0.99	0.16 (-1.68 to 2.00)
Parainfluenza 3	10	2	2.43	1.45	616	299	3.53	0.341	2.09 (-1.07 to 5.24)
Parainfluenza 4	2	1	0.49	0.72	129	58	0.65	>0.99	-0.07 (-1.75 to 1.62)
Total parainfluenza	17	4	4.13	2.90	1110	543	6.06	0.224	3.16 (-0.95 to 7.27)
Human metapneumovirus	2	1	0.49	0.72	648	414	0.93	>0.99	0.21 (-1.69 to 2.10)
Coronavirus	11	2	2.67	1.45	1469	484	2.64	0.635	1.19 (-1.82 to 4.20)
Respiratory syncytial virus	5	5	1.21	3.62	597	594	3.62	>0.99	0.00 (-3.60 to 3.60)
Rhinovirus	24	4	5.83	2.90	2332	1162	8.71	0.037	5.81 (1.42–10.20)
Total respiratory viral infections	64	16	15.53	11.59	9076	4546	23.34	0.005	11.75 (4.54–18.96)
Inpatient respiratory viral infections	54	10	13.11	7.25	9076	4546	19.69	0.001	12.45 (6.18–18.72)

SCT, stem cell transplant.

<sup>a</sup> P-values are a two-proportion Z-test with Yates' continuity correction between the observed post-intervention rate per 100 SCT recipients (fourth column of data) and the adjusted pre-intervention rate per 100 SCT recipients (seventh column of data).

Stem cell transplant recipients are particularly vulnerable to respiratory viral infection, and this susceptibility to infection confers a responsibility on healthcare providers to use any means necessary to prevent nosocomial transmission. HCW-to-patient transmission is a particular concern in this context as viruses such as parainfluenza usually cause very minor symptoms in the healthy, but can be devastating in the immunocompromised. Despite this concern, there are a number of barriers to the universal use of masks, and these were explored by the qualitative aspect of this study. Not surprisingly, concerns about communication difficulties, both verbal and non-verbal, were dominant themes, as was concern about emotional detachment. These findings are consistent with those of a recent systematic review of potential adverse impacts of mask use [8]. Importantly though, both HCWs and patients felt that these barriers were surmountable through education if a reduction in pathogen transmission could be demonstrated. It is also likely that the barriers will reduce somewhat following the SARS-CoV-2 pandemic, in which mask use has been normalized both within and outside the hospital, but many of the challenges identified remain.

Study size and incidence limited the ability to draw conclusions about the relative impact of the intervention on different viruses, and whether the impact is lessened in viruses with greater potential for transmission via the airborne route. However, it should be noted that while this has been shown to dominate in the transmission of rhinovirus, this was the only individual pathogen for which a significant reduction in incidence was seen. The impact of mask use by the source of droplet nuclei may be greater than that obtained by the potential recipient wearing a mask with the same filtration capacity due to the effect of evaporation and particle size reduction [9,10]. The results appear to demonstrate no impact on RSV transmission, but it should be noted that three of the five cases of RSV in the post-intervention period occurred after the patients had been discharged from hospital, and may reflect community acquisition.

Limitations of this study were its single-centre nature, analysis of post-intervention infections was limited to 1 year due to the COVID-19 pandemic, and the absence of monitoring of compliance with the mask use policy. However, it is of unique relevance at the current time as it demonstrates the benefit of type IIR fluid-resistant surgical mask use in the prevention of viral infection as a single intervention added to the existing precautions taken on the ward.

As we emerge from the pandemic phase, SARS-CoV-2 is likely to persist in the population and join other, more long-standing, viruses in exacting a particularly severe toll on the most vulnerable patients. This study demonstrates that universal mask use is an acceptable and effective intervention to prevent nosocomial respiratory viral disease for such patients.

#### Conflict of interest statement

None declared.

#### Funding sources

None.

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