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

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 SARS-CoV-2 pandemic, explored the barriers and facilitators to a policy of universal mask wearing by visitors and healthcare workers and examined the impact of the first year of introduction of the policy on respiratory viral infection rates compared to preceding years adjusted for overall incidence. Education around universal mask wearing was highlighted as being particularly important in policy implementation. A statistically significant fall in respiratory viral infection was observed following introduction.

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 health care workers (HCWs) or visitors. Vulnerability of this patient group to nosocomial infection is well recognised 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 wearing of surgical facemasks by those in contact with at-risk patients was associated with a reduction in parainfluenza infection compared to both a historical control period and to another neighbouring hospital.[3] Despite this evidence, prior to the onset of the SARS-CoV-2 pandemic, the universal wearing of masks in this high-risk setting was not widely adopted and the underlying reasons for this have not been clearly identified. In this study, we sought to qualitatively assess the barriers to routine adoption of universal mask wearing 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 infection with it 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 1 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 en-suite facilities for stem cell transplant recipients.[5] The Virology laboratory at the trust 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), parainfuenza virus 1-4, human metapneumovirus, seasonal coronavirus, rhinovirus and adenovirus. These tests are performed using an in-house multiplex 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 perception of mask use.

Universal mask use

Following completion of the qualitative study, universal mask use for transplant patient care 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 wearing 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 swab, 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 was de-duplicated such that only the first infection with any specific virus in an individual within a March-February year was counted. The study period preceded the first diagnosed case of 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 swab for respiratory viral PCR was 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 (SD) or median with Inter-Quartile Range (IQR) 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 the 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 were then compared with the proportion of diagnoses in the post-intervention period using a 2 proportion Z-test with Yates continuity correction to account for small sample sizes. The results of this analyses present the risk difference (RD), with the associated p-value and 95% confidence interval. A two-tailed p-value of 0.05 was regarded as statistically significant, and data were collected and processed using Excel (Microsoft, Redmond, WA), 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 granted by the Yorkshire & The Humber - Bradford Leeds Research Ethics Committee, reference 18/YH/0222.

Results

Qualitative Study

In total 6 transplant patients (3 autologous and 3 allogeneic) and 7 HCWs (1 doctor, 3 nurses and 3 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 normalisation as a routine measure. Similar themes were identified from both HCW and patient interviews. Education to emphasise 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

A total of 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 1).

Table 2 details the incidence of respiratory viral infection in the two periods with and without adjustment for total population incidence. A fall in 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 inpatients were considered, the adjusted rate of infection fell 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 wearing of masks by care providers is associated with a significant reduction in the incidence of respiratory viral infection in patients undergoing stem cell transplant. This mirrors the findings of Sung et al.[3] who demonstrated a reduction in respiratory viral infection incidence from 10.3% to 4.4% in HSCT recipients at their unit following the introduction of universal mask wearing. The reduction in infections diagnosed as inpatients was particularly marked, consistent with the location of the intervention but raising a question as to 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 randomised controlled trials examining the impact of surgical mask use in community settings have not demonstrated an association with reduced respiratory viral infection risk when worn by either index case, contact or both[7] but the impact may be greater in stem cell transplant recipients due to their motivation and the ability to target education on a well-defined patient cohort. Further encouragement of patient mask-wearing when outside their room or visiting other departments may also provide additional benefit and has become routine during the SARS-CoV-2 pandemic.

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 our 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, it was felt by both HCWs and patients 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 normalised both within and outside the hospital but many of the challenges identified remain.

Study size and incidence limited the ability to draw conclusions about relative impact of the intervention on different viruses and whether the impact is lessened in those with a greater potential for transmission via the airborne route but it should be noted that the airborne route has been show to dominate in rhinovirus transmission, the only individual pathogen for which a statistically significant reduction in incidence was noted, and that the impact of mask wearing by the source of droplet nuclei may be greater than that obtained by the potential recipient wearing the 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 3 of the 5 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; that analysis of only one year of post-intervention infections was possible 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 wearing 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 longstanding, viruses in exacting a particularly severe toll on the most vulnerable patients. This study demonstrates that for such patients, universal mask use is an acceptable and effective intervention to prevent nosocomial respiratory viral disease.

Declarations of interest: none

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Table I Demographics of patients undergoing stem cell transplant in pre- and post-intervention periods

	Pre-intervention	Post-intervention	p-value*
Number of transplants	412	138	
Sex (% female)	154 (37.4%)	58 (42.0%)	0.38
Mean age	55.35	55.64	0.84[#]
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

*p-values are a 2 proportion Z-test with Yates continuity correction, with the exception of [#] which is a two-sample t-test.

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*	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, 3.38)
Influenza B	2	0	0.49	0.00	1210	46	0.06	>0.99	0.06 (-0.23, 0.34)
Parainfluenza 1	2	0	0.49	0.00	145	97	0.97	0.558	0.97 (-0.46, 2.41)
Parainfluenza 2	3	1	0.73	0.72	220	89	0.88	>0.99	0.16 (-1.68, 2.00)
Parainfluenza 3	10	2	2.43	1.45	616	299	3.53	0.341	2.09 (-1.07, 5.24)
Parainfluenza 4	2	1	0.49	0.72	129	58	0.65	>0.99	-0.07 (-1.75, 1.62)
Total parainfluenza	17	4	4.13	2.90	1110	543	6.06	0.224	3.16 (-0.95, 7.27)
Human metapneumovirus	2	1	0.49	0.72	648	414	0.93	>0.99	0.21 (-1.69, 2.10)
Coronavirus	11	2	2.67	1.45	1469	484	2.64	0.635	1.19 (-1.82, 4.20)
Respiratory syncytial virus	5	5	1.21	3.62	597	594	3.62	>0.99	0.00 (-3.60, 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)

Footnote: SCT= Stem Cell Transplant; *p-values are a 2 proportion Z-test with Yates continuity correction between the observed Post-intervention rate per 100 SCT recipients (4th column of data) and the adjusted Pre-intervention rate per 100 SCT recipients (7th column of data).