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## Sociodemographic and psychological determinants of influenza vaccine intention amongst recipients of autologous and allogeneic haematopoietic stem cell transplant: a cross-sectional survey of UK transplant recipients using a modified health belief model.

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Manuscripts

1 Sociodemographic and psychological determinants of influenza vaccine intention  
2 amongst recipients of autologous and allogeneic haematopoietic stem cell  
3 transplant: a cross-sectional survey of UK transplant recipients using a modified  
4 health belief model.

5  
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27 36 Abstract  
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29 37  
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31 38 Objectives: Studies exploring vaccination rates amongst haematopoietic stem  
32 cell transplant (HSCT) recipients have focused on physician factors that limit  
33 uptake. Understanding the patient factors that determine vaccination intention  
34 is crucial to delivering a successful vaccination programme. Using a modified  
35 Health Belief Model (mHBM), we conducted a cross-sectional survey with the  
36 objective of exploring the sociodemographic and psychological factors that  
37 determined autologous and allogeneic HSCT recipients' intention to receive the  
38 seasonal inactivated influenza vaccine (SIIV) during the 2015-2016 influenza  
39 season.  
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55 49 Setting: The setting of our study was three tertiary-level, UK NHS autologous and  
56 allogeneic HSCT centres.  
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5 51 Participants: Eligible patients were aged 16 years or over and recipients of  
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7 52 autologous or allogeneic HSCT for any disease indication, with no absolute  
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9 53 contraindication to receiving the SIIV during the next influenza season, and  
10  
11 54 having not received the SIIV since transplant. 93 participants from 3 UK NHS  
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13 55 HSCT centres completed an anonymous study-specific questionnaire. 78.5%  
14  
15 56 were recipients of allogeneic and 21.5% autologous HSCT.  
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20 58 Results: 23.7% of participants expressed low intent to receive the SIIV. patients  
21  
22 59 aged over 65 (OR 0.02, 95% CI 0.01-0.57, p=0.02) and those who had not  
23  
24 60 received the SIIV prior to HSCT (OR 0.04, 0.02-0.56, p=0.02) were more likely to  
25  
26 61 have low intent. A multivariate logistic regression model incorporating  
27  
28 62 constructs of the mHBM was statistically significant (p<0.001) and explained  
29  
30 63 74.7% of variation in SIIV intention. More patients felt that a recommendation  
31  
32 64 from their HSCT team than their General Practitioner would prompt them to  
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34 65 receive the SIIV, and this was most pronounced in those who had low intent.  
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40 67 Conclusions: The mHBM may provide a useful structure for addressing low  
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42 68 vaccine intent amongst HSCT recipients and further interventional studies are  
43  
44 69 warranted. We would encourage HSCT and General practitioners to discuss SIIV  
45  
46 70 intention as a routine part of care.  
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51 72 HRA REC reference 16/WM/0144  
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55 74 Strengths of Study  
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5 76 -To our knowledge this is the first study to explore determinants of influenza  
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7 77 vaccine uptake in a population of haematopoietic stem cell transplant recipients  
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9 78 -Participants from 3 geographically dispersed study sites completed anonymous  
10  
11 79 questionnaires  
12  
13  
14 80 - The questionnaire was based on the established theoretical framework of the  
15  
16 81 Health Belief Model, and questions were specific with regard to vaccine and  
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18 82 2015-2016 season.  
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21  
22 84 Limitations

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24  
25 85 -The study explored intention to receive the inactivated influenza vaccine during  
26  
27 86 the 2015-2016 influenza season. Uptake was not assessed and may differ from  
28  
29 87 intention rates.

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31 88 -The study did not include a qualitative component and there may be additional  
32  
33 89 determinants of influenza vaccine intention not captured here.  
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38 91 Introduction

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42 93 Innate and adaptive immune responses are impaired for months to years  
43  
44 94 following autologous and allogeneic haematopoietic stem cell transplant (HSCT).  
45  
46 95 HSCT recipients are at high risk of morbidity and mortality from influenza  
47  
48 96 viruses[1-3] and guidelines recommend that the seasonal inactivated influenza  
49  
50 97 vaccine (SIIV) is administered annually[4-6]. While the SIIV is recommended by  
51  
52 98 96% of UK NHS allogeneic HSCT programmes[7], uptake rates of only 60-70% in  
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54 99 the first 2 years post HSCT have been reported amongst UK HSCT recipients[8,9].  
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3 100 In both the UK and USA, physicians' familiarity with current guidelines, and  
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5 101 perception of graft-versus-host disease (GvHD) as a contraindication to  
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7 102 vaccination have been identified as factors limiting vaccine uptake rates[8–10].  
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9 103 No studies to-date have explored the patient factors that influence SIIV hesitancy  
10  
11 104 or intention in an HSCT recipient population.  
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16 106 The Health Belief Model (HBM) is a widely used framework for investigating  
17  
18 107 psychosocial determinants of health behaviours[11] and is recognized as an  
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20 108 important predictor of influenza vaccination uptake[12]. The HBM proposes  
21  
22 109 that an individual's engagement in a specific preventative health behaviour is  
23  
24 110 predicated on the following constructs: i) perceived susceptibility to the illness, ii)  
25  
26 111 perceived likelihood of contracting the illness, iii) perceived seriousness of the  
27  
28 112 illness, iv) perceived barriers to engaging in the health behaviour, v) perceived  
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30 113 benefits of the health behaviour, vi) cues to engage in the health behaviour such  
31  
32 114 as advice from a healthcare practitioner and, vii) self-efficacy or the individual's  
33  
34 115 perception of their capability to engage or succeed in the behaviour. Additional  
35  
36 116 emotional constructs may modify the HBM. In particular, worry may modify the  
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38 117 impact of perceived risk of illness; a patient may perceive themselves to be at  
39  
40 118 risk, but unless this is something that worries them they may not engage in a  
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42 119 preventative behaviour[13]. Furthermore, anticipated regret of illness if a health  
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44 120 behaviour is not performed is also recognized as a predictor of intent[14].  
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51 122 The objective of this study was to explore the sociodemographic factors, and the  
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53 123 vaccine and vaccination-specific health-beliefs that are associated with SIIV  
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55 124 intention amongst HSCT recipients, using a HBM modified with the additional  
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3 125 emotional constructs given above (mHBM). A better understanding of such  
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5 126 associations may allow development of targeted strategies that address issues  
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7 127 specific to this unique and complex patient group, with the aim of increasing  
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9 128 influenza vaccine uptake rates.  
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## 13 14 130 Participants and Methods

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### 17 18 132 *Participants*

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22 134 Patients were screened by HSCT nurse specialists for study eligibility during  
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24 135 routine outpatient appointments at 3 study sites in the United Kingdom between  
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26 136 June and September 2016. Eligible patients were aged 16 years or over and  
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28 137 recipients of autologous or allogeneic HSCT for any disease indication, with no  
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30 138 absolute contraindication to receiving the SIIV during the next influenza season,  
31  
32 139 and having not received the SIIV since transplant. All participants gave written  
33  
34 140 informed consent. The study was approved by the Health Research Authority  
35  
36 141 National Research Ethics Committee (Reference 16/WM/0144)

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### 39 40 143 *Study Questionnaire and Health Belief Model*

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44 145 Participants completed a study-specific, anonymous, 42-item, paper-based  
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46 146 questionnaire.  
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51 148 Questions scoped type of HSCT (autologous or allogeneic), disease indication,  
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53 149 time from HSCT, pre-HSCT SIIV receipt, and receipt of non-SIIV vaccines since  
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3 150 HSCT. Sociodemographic questions established age, gender, ethnic background,  
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5 151 educational attainment, relationship status and residential circumstances.

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9 153 Intention to receive the SIIV during the 2016-2017 influenza season, was  
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11 154 assessed by 2 statements phrased in the affirmative (I intend to receive the flu  
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13 155 vaccine next winter) and negative (I will choose not to receive the flu vaccine  
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15 156 next winter). Participants' agreement with each statement was expressed on 5-  
16  
17 157 point Likert scales ranging from strongly disagree to strongly agree.

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22 159 24 health belief statements were mapped to the mHBM with between 2 and 5  
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24 160 statements clustered around each construct (Table 1). Statements pertaining to  
25  
26 161 the cues to vaccination construct were phrased to explore perception of HSCT  
27  
28 162 team and General Practitioner (GP) knowledge of SIIV in the context of HSCT.  
29  
30 163 Participants' perceived impact of a recommendation to receive the SIIV from  
31  
32 164 their HSCT team or GP was explored. Statements about preferred vaccination  
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34 165 location and ease of access to services were also included. Again, participants'  
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36 166 agreement with each statement was expressed on 5-point Likert scales ranging  
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38 167 from strongly disagree to strongly agree.

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44 169 *Statistical Analysis*

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49 171 Statistical analysis was performed with IBM SPSS version 24.

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3 173 For the dependent variable vaccination intention, participants' agreement scores  
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5 174 were summed and dichotomised to a 'high intent' group (intention score > than  
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7 175 neutral value) and a 'low intent' group (intention score  $\leq$  to the neutral value).  
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10 176

11 177 Categorical patient characteristics and sociodemographic factors are reported as  
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13 178 frequencies and percentages. Associations between these variables and SIIV  
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15 179 intention was examined with Pearson's chi-squared test, and Fisher's exact test  
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17 180 when expected values were less than 5.  
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22 182 Internal scale reliability for each cluster of mHBM construct statements was  
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24 183 assessed using Cronbach's  $\alpha$ . A value of  $>0.6$  was considered indicative of  
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184 *Table 1: Health belief statements grouped by construct with associated Cronbach's Alpha Value*

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<b>Health Belief Model Construct (Cronbach's Alpha)</b>	
<b>1. Susceptibility to seasonal influenza (<math>\alpha = 0.83</math>)</b>	
	Now I have had a stem cell transplant I can catch the seasonal flu more easily than other people my age
	Now I have had a stem cell transplant I can catch the seasonal flu more easily than before my transplant
<b>2. Likelihood of catching seasonal influenza (<math>\alpha = 0.91</math>)</b>	
	My chances of catching seasonal flu next winter will be high if I do not receive the seasonal flu vaccine
	I am more likely than other people my age to catch seasonal flu next winter if I do not receive the seasonal flu vaccine
	Now I have had a stem cell transplant it is more likely that I will catch seasonal flu next winter if I do not receive the seasonal flu vaccine
<b>3. Severity of seasonal influenza infection (<math>\alpha = 0.91</math>)</b>	
	If I do not receive the seasonal flu vaccine and caught the seasonal flu next winter this would be a serious illness for me
	If I do not receive the seasonal flu vaccine and caught the seasonal flu next winter this would have a negative impact on my recovery from my stem cell transplant
	If I do not receive the seasonal flu vaccine and caught the seasonal flu next winter I would become more unwell than other people my age
<b>4. Barriers to vaccination (<math>\alpha = 0.84</math>)</b>	
	I am worried about side effects of the seasonal flu vaccine
	If I receive the seasonal flu vaccine next winter it may make me feel unwell with the flu or a flu-like illness
	If I receive the seasonal flu vaccine next winter I am more likely to experience side effects than other people my age
	If I receive the seasonal flu vaccine next winter it may have a negative impact on my recovery from my stem cell transplant
	Now I have had a stem cell transplant the seasonal flu vaccine may not work as well for me as it does for other people my age
<b>5. Benefits of vaccination (<math>\alpha = 0.66</math>)</b>	
	If I receive the seasonal flu vaccine next winter it may help to prevent me from catching the seasonal flu
	If I receive the seasonal flu vaccine next winter it may help to prevent me from passing the seasonal flu to other people around me
	If I receive the seasonal flu vaccine next winter, but still catch the flu, it may help to prevent me from becoming seriously unwell
<b>6. Cues to vaccination (<math>\alpha = 0.76</math>)</b>	

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7 If my transplant team advised me to receive the seasonal flu vaccine next winter I would definitely have it

8 If my GP advised me to receive the seasonal flu vaccine next winter I would definitely have it

9 My GP understands my condition enough to know if the seasonal flu vaccine is right for me

10 My transplant team understand my condition enough to know if the seasonal flu vaccine is right for me

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11 7.Worry ( $\alpha = 0.47$ )

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12 If I receive the seasonal flu vaccine next winter I will worry less about catching the seasonal flu

13 The thought of catching seasonal flu next winter worries me

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14 8.Self-efficacy ( $\alpha = 0.29$ )

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15 I have enough information and am able to decide whether the seasonal flu vaccine is right for me

16 I would find it easy to attend my GP surgery next winter to receive the seasonal flu vaccine

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17 9.Anticipated regret ( $\alpha = 0.15$ )

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18 I would regret it if I decided not to receive the seasonal flu vaccine next winter and became unwell with seasonal flu

19 I would regret it if I decided to receive the seasonal flu vaccine next winter and became unwell with side effects

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3 186 acceptable internal scale reliability [15]. Scale reliability was acceptable for  
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5 187 constructs 1-6 (Table 1) and statement scores were summed to give total  
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7 188 construct scores for each participant. Scale reliability was unacceptable for  
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9 189 constructs 7-9 (Table 1) therefore statements were analysed individually. All  
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11 190 construct scores were analysed as continuous scales, with zero representing a  
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13 191 neutral response (neither agree nor disagree). Mean agreement scores for low  
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15 192 and high intent groups are presented with 95% confidence intervals.  
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20 194 Participants' mean agreement scores for each mHBM construct were compared  
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22 195 between SIIV intention groups using Analysis of Variance (ANOVA).  
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24 196 Homogeneity of variances was confirmed with Levene's statistic. HSCT team and  
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26 197 GP cue scores *within* low and high intent groups were compared with a paired  
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28 198 sample T-Test.  
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33 200 The association between sociodemographic variables, health belief constructs  
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35 201 and seasonal influenza vaccination intention was examined with hierarchical  
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37 202 binary logistic regression. Variables and constructs that were statistically  
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39 203 significant in univariate analysis were included as separate regression blocks.  
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41 204 Statistically significant variables that improved the predictive value ( $p < 0.05$  for  
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43 205 the regression block) were included in the final model.  
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49 207 The assumption of a linear relationship between each independent variable and  
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51 208 log of the outcome variable was tested and confirmed using the Box-Tidwell  
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53 209 procedure[16]. Multicollinearity across all constructs was assessed. No variance  
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3 210 inflation factor was greater than 10, and the mean of values was acceptable at  
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5 211 1.92[17].  
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9 213 There were 10 missing data points from 6 participants across the study. These  
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11 214 were all responses to mHBM statements from the high intent group. Summed  
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13 215 agreement scores were not calculated for that participant for the affected HBM  
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15 216 construct only.  
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20 218 Results  
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25 220 *Patient Characteristics*  
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29 222 Characteristics of 93 study participants are given in Table 2. 78.5% were  
30  
31 223 recipients of allogeneic HSCT and the most frequent disease indication was AML  
32  
33 224 (28.0%). The majority (68.6%) were within the first 6 months post HSCT. 40.9%  
34  
35 225 of participants had received the SIIV before HSCT, and 4.3% had received a non-  
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37 226 influenza vaccine since HSCT. 52.7% of participants were male, and most  
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39 227 (84.9%) were of a white ethnic group.  
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45 229 *SIIV vaccination intention for 2016-2017 influenza season*  
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49 231 71 (76.3%) participants expressed high SIIV intent, while 22 (23.7%) expressed  
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51 232 low SIIV intent.  
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235 Table 2: Characteristics of n=93 study participants. \*Statistically Significant ( $p < 0.05$ )

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Characteristic, n=93	n(%)	high SIIV Intent (%)	p
<b>Gender</b>			
Male	49 (52.7)	81.6	
Female	44 (47.3)	70.5	0.23
<b>Age group</b>			
16-34	22 (23.7)	68.2	
35-54	36 (38.7)	91.7	
55-64	20 (21.5)	75	
65+	15 (16.1)	53.5	0.02*
<b>HSCT Type</b>			
Allogeneic	73 (78.5)	80	
Autologous	20 (21.5)	75.3	0.78
<b>Disease Indication</b>			
Acute lymphoblastic leukaemia (ALL)	11 (11.8)	72.7	
Acute myeloid leukaemia (AML)	26 (28.0)	76.9	
Aplastic Anaemia (AA)	5 (5.4)	60	
Chronic myeloid leukaemia (CML)	5 (5.4)	100	
Hodgkin Lymphoma	9 (9.7)	88.9	
Myelodysplastic syndrome (MDS)	5 (5.4)	60	
Myelofibrosis (MF)	2 (2.2)	50	
Multiple myeloma (MM)	22 (23.7)	77.3	
Non-Hodgkin Lymphoma (NHL)	8 (8.6)	75	0.79
<b>months from HSCT</b>			
0-6	64 (68.8)	81.3	
>6-12	20 (21.5)	70	
> 12	9 (9.7)	55.6	0.18
<b>SIIV before HSCT</b>			
Yes	38 (40.9)	89.5	
No	55 (59.1)	67.3	0.01*
<b>Any non-SIIV vaccine since HSCT</b>			
Yes	4 (4.3)	100	
No	89 (95.7)	75.3	0.26
<b>Ethnicity</b>			
White	79 (84.9)	77.2	
Asian	8 (8.6)	87.5	
Black	3 (3.2)	66.7	
Mixed	2 (2.2)	50	
Other	1 (1.1)	0	0.32
<b>Educational Background</b>			
Higher Education	30 (32.3)	80	
Secondary Education	49 (52.7)	81.6	

Other	3 (3.2)	66.7	
Prefer not to answer	11 (11.8)	45.5	0.07
<b>Living Circumstances</b>			
Renting	25 (26.9)	76	
Home Owner	54 (58.1)	79.6	
Other	10 (10.8)	70	
Prefer not to answer	4 (4.7)	50	0.56
<b>Relationship Status</b>			
Single	23 (24.7)	78.3	
Married / Cohabiting	56(60.2)	80.4	
Divorced / Separated	10 (10.8)	50	
Prefer not to answer	4 (4.4)	75	0.22

237

238 *Sociodemographic and Transplant Variables*

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240 There was a statistically significant difference in SIIV intention between age  
 241 groups ( $p=0.02$ ) (Table 2). Rate of high intent was greatest in the 35-54 age  
 242 group at 91.7%, and lowest at 53.3% in the 65+ age group. There was no  
 243 statistically significant difference in gender ( $p=0.23$ ), ethnicity ( $p=0.32$ ),  
 244 educational background ( $p=0.07$ ), living circumstance ( $p=0.56$ ), or relationship  
 245 status ( $p=0.22$ ) between SIIV intention groups.

246

247 There was no difference in type of HSCT ( $p=0.78$ ) or disease indication ( $p=0.79$ )  
 248 between SIIV intention groups. 81.3% of participants answering within the first  
 249 0-6 months post HSCT had high intent, compared with 70% in those answering  
 250 at 6-12 months, and 55.6% among those answering at >12 months from HSCT,  
 251 however this finding was not statistically significant ( $p=0.18$ ). To determine  
 252 whether there was a difference in health beliefs between participants at different  
 253 time points post HSCT, mean agreement scores for all constructs were compared.



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3 254 There was no difference in mean agreement scores between participants at 0-6  
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5 255 and 6-12 and >12 months post HSCT ( $p>0.05$  in all cases).  
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9 257 There was no association between SIIV intention and receipt of any non-  
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11 258 influenza vaccine since HSCT ( $p=0.26$ ). However, of those who had received the  
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13 259 SIIV prior to HSCT 81.3% had high intent compared with 67.3% of those who  
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15 260 had not ( $p=0.01$ )  
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20 262 *Health Belief Model Constructs*  
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24 264 In univariate analysis, comparing mean construct agreement scores between  
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26 265 SIIV intention groups, participants in the high intent group perceived greater  
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28 266 susceptibility to influenza (2.09 v 0.05,  $p<0.001$ ), a greater likelihood of  
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30 267 contracting influenza (2.58 v -0.45,  $p<0.001$ ) and perceived influenza to be a  
31  
32 268 more severe illness (2.65 v 0.77,  $p=0.002$ ) (Table 3). They also perceived greater  
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34 269 potential benefit from vaccination (2.56 v -0.05,  $p<0.001$ ), and fewer barriers to  
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36 270 vaccination (-1.55 v 1.27,  $p=0.001$ ). Although the two groups expressed similar  
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38 271 levels of worry about catching influenza (0.14 v 0.81,  $p=0.34$ ), participants in the  
39  
40 272 high intent group felt they would worry less about catching influenza if  
41  
42 273 vaccinated compared with the low intent group (0.80 v -0.23,  $p<0.001$ ). They  
43  
44 274 also expressed greater concern about anticipated regret if they caught influenza  
45  
46 275 having not been vaccinated (1.35 v 0.27,  $p<0.001$ ). Level of anticipated regret of  
47  
48 276 experiencing side effects if vaccinated was similarly low across the two groups (-  
49  
50 277 0.09 v 0.13,  $p=0.40$ ). Participants in the high intent group felt more strongly that  
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52 278 they had enough information to make decisions about vaccination (0.81 v 0.14,  
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279 p=0.007) and that it would be easy to attend their general practice surgery for  
 280 vaccination (1.10 v 0.32, p<0.001).

281

282 *Table 3: Mean agreement score values for health belief constructs for low and high*

283 *SIIV intent groups. <sup>a</sup>n=68, <sup>b</sup>n=69, <sup>c</sup>n=70*

Health Belief Model Construct	Low SIIV Intent (n=22)	High SIIV intent (n=71)	p
1. Susceptibility to seasonal influenza	0.05 (-0.70 to 0.70)	2.09 (1.75 to 4.39)	<0.001
2. Likelihood of catching seasonal influenza	-0.45 (-1.39 to 0.40)	2.58 (2.00 to 3.18) <sup>b</sup>	<0.001
3. Severity of Seasonal influenza infection	0.77 (-0.17 to 1.72)	2.65 (2.09 to 3.23) <sup>b</sup>	0.002
4. Barriers to vaccination	1.27 (0.11 to 2.44)	-1.55 (-2.34 to -0.80) <sup>a</sup>	0.001
5. Benefits of vaccination	-0.05 (0.00 to 1.78)	2.56 (2.13 to 3.00)	<0.001
6. Cues to Vaccination			
HSCT team understands my condition	1.14 (0.55 to 1.32)	1.63 (1.52 to 1.75)	<0.001
GP understands my condition	-0.32 (0.83 to 0.13)	0.59 (0.55 to 0.83) <sup>c</sup>	<0.001
7. Worry			
About catching influenza	0.14 (-0.43 to 0.71)	0.39 (0.17 to -0.63)	0.34
Less about catching influenza if vaccinated	-0.23 (0.60 to 0.07)	0.80 (0.61 to 1.00)	<0.001
8. Self-efficacy			
Have enough information to decide about vaccination	0.14 (-0.32 to 0.58)	0.81 (0.61 to 1.00)	0.007
Would find it easy to attend GP for vaccination	0.32 (-0.12 to 1.72)	1.10 (1.89 to 2.00)	<0.001
9. Anticipated regret			
of catching flu if not vaccinated	0.27 (-0.21 to 0.74)	1.35 (1.18-1.52)	<0.001
of side effects if vaccinated	-0.09 (-0.15 to 0.37)	0.13 (-0.12 to 0.39)	0.4

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3 287 A multivariate regression model (Table 4) was statistically significant when  
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5 288 compared with a constant only model ( $p < 0.001$ ) indicating that this set of  
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7 289 variables and constructs distinguishes reliably between HSCT recipients who  
8  
9 290 express low and high SIIV intent. There was a moderately strong relationship  
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11 291 with 74.7% (Nagelkerke  $R^2$ ) of variation in vaccination intention explained by  
12  
13 292 the overall model. GP ( $p = 0.24$ ) and HSCT Team (0.18) cues to vaccination, self-  
14  
15 293 efficacy ( $p = 0.37$ ) and anticipated regret ( $p = 0.78$ ) constructs did not significantly  
16  
17 294 improve predictive value and so were not included in the final model. Age and  
18  
19 295 pre-HSCT SIIV vaccination receipt remained independent predictors of SIIV  
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21 296 intention, with those aged  $> 65$  (OR 0.02, 95%CI 0.01-0.57,  $p = 0.02$ ) and those  
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23 297 who had not received SIIV before HSCT (OR 0.4, 95%CI 0.02-0.56,  $p = 0.02$ ) more  
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25 298 likely to be in the low intent group. A greater perceived benefit of vaccination  
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27 299 was the strongest predictor of being in the high intent group (OR 2.96, 95%CI  
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29 300 1.29-6.81,  $p = 0.01$ ). Although the constructs susceptibility to influenza,  
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31 301 likelihood of contracting influenza, severity of influenza infection, barriers to  
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33 302 vaccination and worry about catching influenza improved the predictive value of  
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35 303 the overall multivariate model, they did not independently predict vaccination  
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37 304 intention.

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312 *Table 4 Multivariate logistic regression model predicting odds of high SIIV intent.*

313 *Overall model was statistically significant compared with a constant only model*

314 *( $p < 0.001$ ). \*Statistically significant independent predictor ( $p < 0.05$ )*

315

Variable	Odds Ratio of high SIIV Intent (95% CI)	P
Age >65	0.02 (0.01-0.57)	0.02*
No SIIV before HSCT	0.04 (0.02-0.56)	0.02*
Benefits of vaccination	2.96 (1.29-6.81)	0.01*
Susceptibility to seasonal Influenza	0.96 (0.33-2.78)	0.64
Likelihood of catching seasonal influenza	1.68 (0.86-3.26)	0.13
Severity of seasonal influenza infection	0.69 (0.39-1.21)	0.20
Barriers to vaccination	0.69 (0.57-0.99)	0.05
Worry less about catching seasonal influenza if vaccinated	4.99 (1.01-24.77)	0.05

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318 *Cues to Vaccination and Preferred Vaccination Location*

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320 Considering their HSCT team and GPs, both high (1.63 v 0.59,  $p < 0.001$ ) and low  
 321 intent groups (1.14 v -0.32,  $p < 0.001$ ) agreed more strongly with statements that  
 322 their HSCT team understands their condition enough to know if the influenza  
 323 vaccine is right for them. Patients were also asked how much they agreed with  
 324 the statement that they would definitely have the vaccine if their GP or HSCT  
 325 team recommended it. Agreement scores were dichotomized to low agreement  
 326 ( $\leq$  neutral value) and high agreement ( $>$  neutral value). Of those 22 patients with  
 327 low intent, 90% agreed that they would receive the vaccine if their HSCT Team

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3 328 recommended it, and only 22.7% if their GP recommended it, compared with  
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5 329 98.6% and 90.0% respectively in the high intent group.  
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9 331 Participant responses to the statement *I would prefer to have the seasonal*  
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11 332 *influenza vaccine next winter at my transplant centre instead of my GP surgery*  
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13 333 were categorized into prefers HSCT centre, prefers GP surgery or no preference.  
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15 334 Of the low intent group, over half (54.5%) favoured vaccination at their HSCT  
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17 335 centre, with only a minority (4.5%) favouring vaccination at their GP surgery. Of  
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19 336 those with high intent 43.7% favoured vaccination at their HSCT programme,  
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21 337 compared with 29.6% at their GP surgery although these findings did not reach  
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23 338 statistical significance (p=0.05).  
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29 340 Discussion  
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33 342 To our knowledge, this is the first study to explore sociodemographic factors and  
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35 343 psychological determinants of SIIV intention amongst HSCT recipients. Patients  
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37 344 from 3 geographically dispersed study sites completed anonymous  
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39 345 questionnaires. We identified low SIIV intent in approximately a quarter of  
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41 346 participants. Participants' SIIV uptake during the 2016-2017 UK influenza  
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43 347 season was not evaluated, and uptake may not be equivalent to intent rates  
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45 348 reported here.  
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51 350 Constructs of a mHBM were significant determinants of SIIV intention.52  
53 351 Strategies tailored to a population and their specific concerns are the most54  
55 352 effective at improving knowledge and changing attitudes towards vaccination,  
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3 353 and increasing vaccine uptake[18]. Based on our findings, the mHBM may  
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5 354 provide a useful framework for structuring strategies to address low SIIV intent  
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7 355 in the HSCT population. Exploring HSCT recipients increased risk of influenza,  
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9 356 both in terms of susceptibility and severity, discussing the potential benefits of  
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11 357 vaccination, and exploring concerns around side effects may help to promote  
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13 358 vaccine intent and uptake.  
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18 360 A strong association between past vaccination behaviours and future vaccination  
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20 361 intent has been reported[19]. Previous influenza vaccination has been  
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22 362 associated with high intent or uptake in all at risk groups [20,21] and cancer  
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24 363 patients[22] and our findings accord with this. It may therefore be helpful to  
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26 364 explore recipients pre-HSCT SIIV behaviour and discussion rationale for refusal  
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28 365 where appropriate.  
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33 367 It was reassuring to find that none of gender, ethnicity, educational background,  
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35 368 living circumstances or relationship status were associated with vaccine  
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37 369 hesitancy in this study. However, vaccination intention did vary with age. High  
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39 370 intent was greatest at 91.7% in the 35-53 age bracket, but of concern, fell in  
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41 371 those over 65 to 53.5%, which is below the 2015-2016 uptake rate of 71% in the  
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43 372 equivalent UK general population age-group[23]. Older age has been reported as  
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45 373 a barrier to vaccination in a cohort of oncology patients, including some with  
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47 374 haematological malignancy [22]. However, a French study of patients with  
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49 375 secondary immunodeficiency, including haematological disorders, reported  
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51 376 higher vaccination rates in those aged over 65 compared with younger  
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53 377 patients[24]. In a UK study, older age was found to be a predictor of uptake of the  
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3 378 2009 pandemic influenza A vaccine amongst high-risk adults[25]. A meta-  
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5 379 analysis of international studies found inconsistent association between age and  
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7 380 vaccination intent and uptake in the general public, older patients, and those  
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9 381 with chronic disease [19]. It is not apparent from these studies why age impacts  
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11 382 on intent, and there are likely to be a range of social, psychological, financial and  
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13 383 healthcare access issues specific to each study population. Our findings highlight  
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15 384 a specific age group in whom intent is low and may benefit from targeted  
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17 385 intervention. Further evaluation of this finding and exploration of underlying  
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19 386 determinants is warranted.  
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25 388 High SIIV intent was greatest in those recipients within the first 0-6 months'  
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27 389 post-HSCT (81.3%) and lowest at more than 12 months (55.6%) although this  
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29 390 finding was not statistically significant. Longer time from HSCT may be  
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31 391 associated with a change in perceived risk of infection, or concern about vaccine  
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33 392 side effects or efficacy; however, we did not detect any statistically significant  
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35 393 difference in health beliefs at 0-6, 6-12 and > 12 months from HSCT. This finding  
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37 394 suggests there is a need for reinforcement of SIIV intent from healthcare  
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39 395 professionals throughout and beyond the first-year post HSCT.  
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45 397 In both vaccine intention groups, patients expressed greater confidence in their  
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47 398 HSCT team than their GP, with respect to understanding of whether the influenza  
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49 399 vaccine is right for them. Fewer patients felt that a recommendation from their  
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51 400 GP would prompt them to receive the SIIV compared with if their HSCT Team  
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53 401 made the recommendation. This was most marked in the low intent group.  
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55 402 These findings suggest that cues from the HSCT team are important in promoting  
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3 403 vaccination amongst HSCT recipients, and particularly for those with low intent.  
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5 404 Cues from healthcare providers are considered a key factor in promoting  
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7 405 vaccination[19] and a study of Israeli cancer patients identified recommendation  
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9 406 from an oncologist as a significant predictor of vaccine uptake [22]. Our findings  
10  
11 407 accord with this, and suggest that HSCT recipients value the advice of their  
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13 408 specialist team. This highlights the importance of HSCT specialists engaging in  
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15 409 discussion with patients about influenza vaccination. Preference for vaccination  
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17 410 at HSCT centres rather than GP surgeries was similar at 43.7% and 54.5% in low  
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19 411 and high intent groups respectively. In the high intent group, more patients  
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21 412 expressed a preference for vaccination at their GP surgery than in the low intent  
22  
23 413 group. For approximately 50% of those HSCT recipients with both low and high  
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25 414 intent, access to an SIIV service at HSCT centres may facilitate vaccination uptake  
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31 416 None of the transplant variables assessed were associated with SIIV intention.  
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33 417 Current influenza vaccination guidelines are standardized for all HSCT recipients  
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35 418 as evidence is insufficient to recommend modification according to donor type,  
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37 419 stem cell source or conditioning[4,5]. Influenza infections are reported to occur  
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39 420 with higher frequency in allogeneic compared with autologous HSCT recipients  
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41 421 [26,27] and may have a higher associated morbidity and mortality[28] although  
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43 422 this latter finding has not been consistently reported[1]. There was no  
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45 423 difference in vaccination intention between autologous and allogeneic HSCT  
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47 424 recipients. This suggests the unique aspects of allogeneic HSCT, principally GvHD  
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49 425 and the need for immunosuppressive therapy, do not contribute to increased  
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51 426 influenza vaccination intention in this group compared with autoHSCT recipients.  
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3 428 Conclusion  
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7 430 Our data indicates that the constructs of a mHBM are important determinants of  
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9 431 SIIV intention in the HSCT recipient population. These constructs may be used to  
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11 432 structure interventions addressing low SIIV intent, and prospective studies are  
12  
13 433 warranted. Those aged over 65, and those who had not received the SIIV prior to  
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15 434 HSCT were particularly likely to have low intent and may be target groups. HSCT  
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17 435 recipients strongly value the expertise and recommendation of their transplant  
18  
19 436 team, and we would encourage practitioners to discuss SIIV intention with  
20  
21 437 patients as a routine and important aspect of post-transplant care. Local  
22  
23 438 provision of vaccination services at HSCT centres may serve as an additional  
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25 439 promoter for a proportion of patients.  
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31 441 Authorship Statement  
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38 444 Madrigal and John A Snowden made substantial contributions to the conception  
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40 445 and design of the work, and to analysis and interpretation of data.  
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47 448 Paskar and Erin Hurst made substantial contributions to the acquisition of data.  
48

49 449  
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51 450 All named authors contributed to the drafting and revising for important  
52  
53 451 intellectual content and gave final of the manuscript. All authors agree to be  
54  
55 452 accountable for all aspects of the work in ensuring that questions related to the  
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3 453 accuracy or integrity of any part of the work are appropriately investigated and  
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5 454 resolved.

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9 456 Data sharing statement

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13 458 The study dataset will be made available via Dryad repository and DOI provided

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15 459 following editorial review

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# BMJ Open

## Sociodemographic and psychological determinants of influenza vaccine intention amongst recipients of autologous and allogeneic haematopoietic stem cell transplant: a cross-sectional survey of UK transplant recipients using a modified health belief model.

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Manuscripts

1 Sociodemographic and psychological determinants of influenza vaccine intention  
2 amongst recipients of autologous and allogeneic haematopoietic stem cell  
3 transplant: a cross-sectional survey of UK transplant recipients using a modified  
4 health belief model.

5  
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22 34 The authors have no competing interests to declare

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26 36 Abstract

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31 38 Objectives: Studies exploring vaccination rates amongst haematopoietic stem  
32 cell transplant (HSCT) recipients have focused on physician factors that limit  
33 uptake. Understanding the patient factors that determine vaccination intention  
34 is crucial to delivering a successful vaccination programme. Using a modified  
35 Health Belief Model (mHBM), we conducted a cross-sectional survey with the  
36 objective of exploring the sociodemographic and psychological factors that  
37 determined autologous and allogeneic HSCT recipients' intention to receive the  
38 seasonal inactivated influenza vaccine (SIIV) during the 2015-2016 influenza  
39 season.

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44 48 Setting: The setting of our study was three tertiary-level, UK NHS autologous and  
45 allogeneic HSCT centres.

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5 51 Participants: Eligible patients were aged 16 years or over and recipients of  
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7 52 autologous or allogeneic HSCT for any disease indication, with no absolute  
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9 53 contraindication to receiving the SIIV during the next influenza season, and  
10  
11 54 having not received the SIIV since transplant. 93 participants from 3 UK NHS  
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13 55 HSCT centres completed an anonymous study-specific questionnaire. 78.5%  
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15 56 were recipients of allogeneic and 21.5% autologous HSCT.  
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20 58 Results: 23.7% of participants expressed low intent to receive the SIIV. patients  
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22 59 aged over 65 (OR 0.02, 95% CI 0.01-0.57, p=0.02) and those who had not  
23  
24 60 received the SIIV prior to HSCT (OR 0.04, 0.02-0.56, p=0.02) were more likely to  
25  
26 61 have low intent. A multivariate logistic regression model incorporating  
27  
28 62 constructs of the mHBM was statistically significant (p<0.001) and explained  
29  
30 63 74.7% of variation in SIIV intention. More patients felt that a recommendation  
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32 64 from their HSCT team than their General Practitioner would prompt them to  
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34 65 receive the SIIV, and this was most pronounced in those who had low intent.  
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40 67 Conclusions: The mHBM may provide a useful structure for addressing low  
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42 68 vaccine intent amongst HSCT recipients and further interventional studies are  
43  
44 69 warranted. We would encourage HSCT and General practitioners to discuss SIIV  
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46 70 intention as a routine part of care.  
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51 72 HRA REC reference 16/WM/0144  
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55 74 Strengths of Study  
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5 76 -To our knowledge this is the first study to explore determinants of influenza  
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7 77 vaccine uptake in a population of haematopoietic stem cell transplant recipients  
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9 78 -Participants from 3 geographically dispersed study sites completed anonymous  
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11 79 questionnaires  
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14 80 - The questionnaire was based on the established theoretical framework of the  
15  
16 81 Health Belief Model, and questions were specific with regard to vaccine and  
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18 82 2015-2016 season.  
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23 84 Limitations

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25 85 -The study explored intention to receive the inactivated influenza vaccine during  
26  
27 86 the 2015-2016 influenza season. Uptake was not assessed and may differ from  
28  
29 87 intention rates.  
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34 89 -The number of enrolled participants expressing low vaccination intent was  
35  
36 90 small at 22 (23.7%) and this may bias our data.  
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41 92 Introduction

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45 94 Innate and adaptive immune responses are impaired for months to years  
46  
47 95 following autologous and allogeneic haematopoietic stem cell transplant (HSCT).  
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49 96 HSCT recipients are at high risk of morbidity and mortality from influenza  
50  
51 97 viruses[1-3] and guidelines recommend that the seasonal inactivated influenza  
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53 98 vaccine (SIIV) is administered annually starting 4 to 6 months post HSCT [4-6].  
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55 99 While the SIIV is recommended by 96% of UK NHS allogeneic HSCT  
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3 100 programmes[7], uptake rates of only 60-70% in the first 2 years post HSCT have  
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5 101 been reported amongst UK HSCT recipients[8,9]. The majority of UK allogeneic  
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7 102 HSCT recipients are referred to their General Practitioner (GP) with only 8% of  
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9 103 UK adult allogeneic HSCT programmes offering vaccination services. SIV  
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11 104 efficacy of 65.4-80% has been reported in HSCT recipients, although in small  
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13 105 cohorts [10,11] In both the UK and USA, physicians' familiarity with current  
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15 106 guidelines, and perception of graft-versus-host disease (GvHD) as a  
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17 107 contraindication to vaccination have been identified as factors limiting vaccine  
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19 108 uptake rates[8,9,12]. No studies to-date have explored the patient factors that  
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21 109 influence SIV hesitancy or intention in an HSCT recipient population.  
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25 110  
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27 111 The Health Belief Model (HBM) is a widely used framework for investigating  
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29 112 psychosocial determinants of health behaviours[13] and is recognized as an  
30  
31 113 important predictor of influenza vaccination uptake[14]. The HBM proposes  
32  
33 114 that an individual's engagement in a specific preventative health behaviour is  
34  
35 115 predicated on the following constructs: i) perceived susceptibility to the illness, ii)  
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37 116 perceived likelihood of contracting the illness, iii) perceived seriousness of the  
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39 117 illness, iv) perceived barriers to engaging in the health behaviour, v) perceived  
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41 118 benefits of the health behaviour, vi) cues to engage in the health behaviour such  
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43 119 as advice from a healthcare practitioner and, vii) self-efficacy or the individual's  
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45 120 perception of their capability to engage or succeed in the behaviour. Additional  
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47 121 emotional constructs may modify the HBM. In particular, worry may modify the  
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49 122 impact of perceived risk of illness; a patient may perceive themselves to be at  
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51 123 risk, but unless this is something that worries them they may not engage in a  
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3 124 preventative behaviour[15]. Furthermore, anticipated regret of illness if a health  
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5 125 behaviour is not performed is also recognized as a predictor of intent[16].  
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9 127 The objective of this study was to explore the sociodemographic factors, and the  
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11 128 vaccine and vaccination-specific health-beliefs that are associated with SIIV  
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13 129 intention amongst HSCT recipients, using a HBM modified with the additional  
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15 130 emotional constructs given above (mHBM). A better understanding of such  
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17 131 associations may allow development of targeted strategies that address issues  
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19 132 specific to this unique and complex patient group, with the aim of increasing  
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21 133 influenza vaccine uptake rates.  
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25 135 Participants and Methods

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27 137 *Participants*

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29 139 Patients were screened by HSCT nurse specialists for study eligibility during  
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31 140 routine outpatient appointments at 3 study sites in the United Kingdom between  
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33 141 June and September 2016. Eligible patients were aged 16 years or over and  
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35 142 recipients of autologous or allogeneic HSCT for any disease indication, with no  
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37 143 absolute contraindication to receiving the SIIV during the next influenza season,  
38  
39 144 and having not received the SIIV since transplant. All participants gave written  
40  
41 145 informed consent. The study was approved by the Health Research Authority  
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43 146 National Research Ethics Committee (Reference 16/WM/0144)  
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47 148 *Study Questionnaire and Health Belief Model*

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5 150 Participants completed a study-specific, anonymous, 42-item, paper-based  
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7 151 questionnaire.

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11 153 Questions scoped type of HSCT (autologous or allogeneic), disease indication,  
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13 154 time from HSCT, pre-HSCT SIV receipt, and receipt of non-SIV vaccines since  
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15 155 HSCT. Sociodemographic questions established age, gender, ethnic background,  
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17 156 educational attainment, relationship status and residential circumstances.

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22 158 Intention to receive the SIV during the 2016-2017 influenza season, was  
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24 159 assessed by 2 statements phrased in the affirmative (I intend to receive the flu  
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26 160 vaccine next winter) and negative (I will choose not to receive the flu vaccine  
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28 161 next winter). Participants' agreement with each statement was expressed on 5-  
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30 162 point Likert scales ranging from strongly disagree to strongly agree.

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35 164 24 health belief statements were mapped to the mHBM with between 2 and 5  
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37 165 statements clustered around each construct (Table 1). Statements pertaining to  
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39 166 the cues to vaccination construct were phrased to explore perception of HSCT  
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41 167 team and GP knowledge of SIV in the context of HSCT. Participants' perceived  
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43 168 impact of a recommendation to receive the SIV from their HSCT team or GP was  
44  
45 169 explored. Statements about preferred vaccination location and ease of access to  
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47 170 services were also included. Again, participants' agreement with each statement  
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49 171 was expressed on 5-point Likert scales ranging from strongly disagree to  
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51 172 strongly agree.

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3 174 *Statistical Analysis*  
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7 176 Statistical analysis was performed with IBM SPSS version 24.  
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11 178 For the dependent variable vaccination intention, participants' agreement scores  
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13 179 were summed and dichotomised to a 'high intent' group (intention score > than  
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15 180 neutral value) and a 'low intent' group (intention score  $\leq$  to the neutral value).  
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17 181  
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19 182 Categorical patient characteristics and sociodemographic factors are reported as  
20

21 183 frequencies and percentages. Associations between these variables and SIIV  
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23 184 intention was examined with Pearson's chi-squared test, and Fisher's exact test  
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25 185 when expected values were less than 5.  
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29 187 Internal scale reliability for each cluster of mHBM construct statements was  
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31 188 assessed using Cronbach's  $\alpha$ . A value of  $>0.6$  was considered indicative of  
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189 *Table 1: Health belief statements grouped by construct with associated Cronbach's Alpha Value*

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<b>Health Belief Model Construct (Cronbach's Alpha)</b>
<b>1. Susceptibility to seasonal influenza (<math>\alpha = 0.83</math>)</b>
Now I have had a stem cell transplant I can catch the seasonal flu more easily than other people my age
Now I have had a stem cell transplant I can catch the seasonal flu more easily than before my transplant
<b>2. Likelihood of catching seasonal influenza (<math>\alpha = 0.91</math>)</b>
My chances of catching seasonal flu next winter will be high if I do not receive the seasonal flu vaccine
I am more likely than other people my age to catch seasonal flu next winter if I do not receive the seasonal flu vaccine
Now I have had a stem cell transplant it is more likely that I will catch seasonal flu next winter if I do not receive the seasonal flu vaccine
<b>3. Severity of seasonal influenza infection (<math>\alpha = 0.91</math>)</b>
If I do not receive the seasonal flu vaccine and caught the seasonal flu next winter this would be a serious illness for me
If I do not receive the seasonal flu vaccine and caught the seasonal flu next winter this would have a negative impact on my recovery from my stem cell transplant
If I do not receive the seasonal flu vaccine and caught the seasonal flu next winter I would become more unwell than other people my age
<b>4. Barriers to vaccination (<math>\alpha = 0.84</math>)</b>
I am worried about side effects of the seasonal flu vaccine
If I receive the seasonal flu vaccine next winter it may make me feel unwell with the flu or a flu-like illness
If I receive the seasonal flu vaccine next winter I am more likely to experience side effects than other people my age
If I receive the seasonal flu vaccine next winter it may have a negative impact on my recovery from my stem cell transplant
Now I have had a stem cell transplant the seasonal flu vaccine may not work as well for me as it does for other people my age
<b>5. Benefits of vaccination (<math>\alpha = 0.66</math>)</b>
If I receive the seasonal flu vaccine next winter it may help to prevent me from catching the seasonal flu
If I receive the seasonal flu vaccine next winter it may help to prevent me from passing the seasonal flu to other people around me
If I receive the seasonal flu vaccine next winter, but still catch the flu, it may help to prevent me from becoming seriously unwell
<b>6. Cues to vaccination (<math>\alpha = 0.76</math>)</b>



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7 If my transplant team advised me to receive the seasonal flu vaccine next winter I would definitely have it

8 If my GP advised me to receive the seasonal flu vaccine next winter I would definitely have it

9 My GP understands my condition enough to know if the seasonal flu vaccine is right for me

10 My transplant team understand my condition enough to know if the seasonal flu vaccine is right for me

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11 7.Worry ( $\alpha = 0.47$ )

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12 If I receive the seasonal flu vaccine next winter I will worry less about catching the seasonal flu

13 The thought of catching seasonal flu next winter worries me

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14 8.Self-efficacy ( $\alpha = 0.29$ )

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15 I have enough information and am able to decide whether the seasonal flu vaccine is right for me

16 I would find it easy to attend my GP surgery next winter to receive the seasonal flu vaccine

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17 9.Anticipated regret ( $\alpha = 0.15$ )

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18 I would regret it if I decided not to receive the seasonal flu vaccine next winter and became unwell with seasonal flu

19 I would regret it if I decided to receive the seasonal flu vaccine next winter and became unwell with side effects

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3 191 acceptable internal scale reliability [17]. Scale reliability was acceptable for  
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5 192 constructs 1-6 (Table 1) and statement scores were summed to give total  
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7 193 construct scores for each participant. Scale reliability was unacceptable for  
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9 194 constructs 7-9 (Table 1) therefore statements were analysed individually. All  
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11 195 construct scores were analysed as continuous scales, with zero representing a  
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13 196 neutral response (neither agree nor disagree). Mean agreement scores for low  
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15 197 and high intent groups are presented with 95% confidence intervals.  
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20 199 Participants' mean agreement scores for each mHBM construct were compared  
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22 200 between SIIV intention groups using Analysis of Variance (ANOVA).  
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24 201 Homogeneity of variances was confirmed with Levene's statistic. HSCT team and  
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26 202 GP cue scores *within* low and high intent groups were compared with a paired  
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28 203 sample T-Test.  
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33 205 The impact of sociodemographic variables and health belief constructs on  
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35 206 seasonal influenza vaccination intention was examined with hierarchical binary  
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37 207 logistic regression. Variables and constructs that were statistically significant in  
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39 208 univariate analysis were included as separate regression blocks. Statistically  
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41 209 significant variables that improved the predictive value ( $p < 0.05$  for the  
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43 210 regression block) were included in the final model.  
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49 212 The assumption of a linear relationship between each independent variable and  
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51 213 log of the outcome variable was tested and confirmed using the Box-Tidwell  
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53 214 procedure[18]. Multicollinearity across all constructs was assessed. No variance  
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3 215 inflation factor was greater than 10, and the mean of values was acceptable at  
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5 216 1.92[19].  
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9 218 There were 10 missing data points from 6 participants across the study. These  
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11 219 were all responses to mHBM statements from the high intent group. Summed  
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13 220 agreement scores were not calculated for that participant for the affected HBM  
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15 221 construct only.  
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18 222 *Patient and Public Involvement*  
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22 224 The study questionnaire was developed with the involvement of volunteers from  
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24 225 the Anthony Nolan patients and families panel. Using an initial draft  
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26 226 questionnaire, think-aloud sessions were conducted to ensure that the  
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28 227 questionnaire was clear, easy to understand, that interpretation of each question  
29  
30 228 was as intended, and that answers were consistent with the question asked.  
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33 229 Volunteers were also asked for their overall feedback on the study questionnaire.  
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36 230 The revised questionnaire was then piloted with volunteer patients who were  
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38 231 asked to complete the questionnaire, keeping note of the time taken, and to  
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40 232 highlight any questions that they had difficulty answering or otherwise found  
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42 233 problematic. The questionnaires were all completed within 10 minutes and no  
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44 234 participants reported difficulty or concerns about the questions. Results will be  
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46 235 disseminated to study participants through their transplant teams, and made  
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48 236 available to participants through open access publication.  
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## 240 Results

241

242 *Patient Characteristics*

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244 Characteristics of 93 study participants are given in Table 2. 78.5% were

245 recipients of allogeneic HSCT and the most frequent disease indication was acute

246 myeloid leukaemia (AML) (28.0%). The majority (68.6%) were within the first 6

247 months post HSCT. 40.9% of participants had received the SIIV before HSCT, and

248 4.3% had received a non-influenza vaccine since HSCT. 52.7% of participants

249 were male, and most (84.9%) were of a white ethnic group.

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251 *SIIV vaccination intention for 2016-2017 influenza season*

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253 71 (76.3%) participants expressed high SIIV intent, while 22 (23.7%) expressed

254 low SIIV intent.

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256

257 *Table 2: Characteristics of n=93 study participants. \*Statistically Significant (p<0.05)*

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Characteristic, n=93	n(%)	high SIIV Intent n(%)	p
<b>Gender</b>			
Male	49 (52.7)	40 (81.6)	
Female	44 (47.3)	31 (70.5)	0.23
<b>Age group</b>			
16-34	22 (23.7)	15 (68.2)	
35-54	36 (38.7)	33 (91.7)	
55-64	20 (21.5)	15 (75)	
65+	15 (16.1)	8 (53.5)	0.02*

<b>HSCT Type</b>			
Allogeneic	73 (78.5)	59 (80.8)	
Autologous	20 (21.5)	15 (75)	0.78
<b>Disease Indication</b>			
Acute lymphoblastic leukaemia (ALL)	11 (11.8)	8(72.7)	
Acute myeloid leukaemia (AML)	26 (28.0)	20 (76.9)	
Aplastic Anaemia (AA)	5 (5.4)	3 (60)	
Chronic myeloid leukaemia (CML)	5 (5.4)	5 (100)	
Hodgkin Lymphoma	9 (9.7)	9 (88.9)	
Myelodysplastic syndrome (MDS)	5 (5.4)	3 (60)	
Myelofibrosis (MF)	2 (2.2)	1 (50)	
Multiple myeloma (MM)	22 (23.7)	17 (77.3)	
Non-Hodgkin Lymphoma (NHL)	8 (8.6)	6 (75)	0.79
<b>months from HSCT</b>			
0-6	64 (68.8)	52 (81.3)	
>6-12	20 (21.5)	14 (70)	
> 12	9 (9.7)	5 (55.6)	0.18
<b>SIIV before HSCT</b>			
Yes	38 (40.9)	34(89.5)	
No	55 (59.1)	37 (67.3)	0.01*
<b>Any non-SIIV vaccine since HSCT</b>			
Yes	4 (4.3)	4 (100)	
No	89 (95.7)	67 (75.3)	0.26
<b>Ethnicity</b>			
White	79 (84.9)	69 (77.2)	
Asian	8 (8.6)	7 (87.5)	
Black	3 (3.2)	2 (66.7)	
Mixed	2 (2.2)	1 (50)	
Other	1 (1.1)	0 (0)	0.32
<b>Educational Background</b>			
Higher Education	30 (32.3)	24 (80)	
Secondary Education	49 (52.7)	40 (81.6)	
Other	3 (3.2)	2 (66.7)	
Prefer not to answer	11 (11.8)	5 (45.5)	0.07
<b>Living Circumstances</b>			
Renting	25 (26.9)	33 (76)	
Home Owner	54 (58.1)	43 (79.6)	
Other	10 (10.8)	7(70)	
Prefer not to answer	4 (4.7)	2 (50)	0.56
<b>Relationship Status</b>			
Single	23 (24.7)	18 (78.3)	
Married / Cohabiting	56(60.2)	45 (80.4)	
Divorced / Separated	10 (10.8)	5 (50)	
Prefer not to answer	4 (4.4)	3 (75)	0.22

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3 260 *Sociodemographic and Transplant Variables*  
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7 262 There was a statistically significant difference in SIIV intention between age  
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9 263 groups (Table 2). Rate of high intent was greatest in the 35-54 age group at  
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11 264 91.7%, and lowest at 53.3% in the 65+ age group. There was no statistically  
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13 265 significant difference in gender, ethnicity, educational background, living  
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15 266 circumstance, or relationship status between SIIV intention groups.  
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20 268 There was no difference in type of HSCT or disease indication between SIIV  
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22 269 intention groups. 81.3% of participants answering within the first 0-6 months  
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24 270 post HSCT had high intent, compared with 70% in those answering at 6-12  
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26 271 months, and 55.6% among those answering at >12 months from HSCT, however  
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28 272 this finding was not statistically significant. To determine whether there was a  
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30 273 difference in health beliefs between participants at different time points post  
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32 274 HSCT, mean agreement scores for all constructs were compared. There was no  
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34 275 difference in mean agreement scores between participants at 0-6 and 6-12  
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36 276 and >12 months post HSCT.  
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42 278 There was no association between SIIV intention and receipt of any non-  
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44 279 influenza vaccine since HSCT. However, of those who had received the SIIV prior  
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46 280 to HSCT 81.3% had high intent compared with 67.3% of those who had not .  
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51 282 *Health Belief Model Constructs*  
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284 In univariate analysis, comparing mean construct agreement scores between  
 285 SIIV intention groups, participants in the high intent group perceived greater  
 286 susceptibility to influenza, a greater likelihood of contracting influenza and  
 287 perceived influenza to be a more severe illness (Table 3). They also perceived  
 288 greater potential benefit from vaccination, and fewer barriers to vaccination.  
 289 Although the two groups expressed similar levels of worry about catching  
 290 influenza, participants in the high intent group felt they would worry less about  
 291 catching influenza if vaccinated compared with the low intent group. They also  
 292 expressed greater concern about anticipated regret if they caught influenza  
 293 having not been vaccinated. Level of anticipated regret of experiencing side  
 294 effects if vaccinated was similarly low across the two groups. Participants in the  
 295 high intent group felt more strongly that they had enough information to make  
 296 decisions about vaccination and that it would be easy to attend their general  
 297 practice surgery for vaccination.

298  
 299 *Table 3: Mean agreement score values for health belief constructs for low and high*  
 300 *SIIV intent groups. <sup>a</sup>n=68, <sup>b</sup>n=69, <sup>c</sup>n=70*

Health Belief Model Construct	Low SIIV Intent (n=22)	High SIIV intent (n=71)	p
1. Susceptibility to seasonal influenza	0.05 (-0.70 to 0.70)	2.09 (1.75 to 4.39)	<0.001
2. Likelihood of catching seasonal influenza	-0.45 (-1.39 to 0.40)	2.58 (2.00 to 3.18) <sup>b</sup>	<0.001
3. Severity of Seasonal influenza infection	0.77 (-0.17 to 1.72)	2.65 (2.09 to 3.23) <sup>b</sup>	0.002
4. Barriers to vaccination	1.27 (0.11 to 2.44)	-1.55 (-2.34 to -0.80) <sup>a</sup>	0.001
5. Benefits of vaccination	-0.05 (0.00 to 1.78)	2.56 (2.13 to 3.00)	<0.001
6. Cues to Vaccination			
HSCT team understands my condition	1.14 (0.55 to 1.32)	1.63 (1.52 to 1.75)	<0.001

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3		GP understands my condition	-0.32 (0.83 to 0.13)	0.59 (0.55 to 0.83) <sup>c</sup> <0.001
4				
5	7. Worry			
6		About catching influenza	0.14 (-0.43 to 0.71)	0.39 (0.17 to -0.63) 0.34
7				
8		Less about catching influenza if vaccinated	-0.23 (0.60 to 0.07)	0.80 (0.61 to 1.00) <0.001
9				
10	8. Self-efficacy			
11				
12		Have enough information to decide about vaccination	0.14 (-0.32 to 0.58)	0.81 (0.61 to 1.00) 0.007
13				
14		Would find it easy to attend GP for vaccination	0.32 (-0.12 to 1.72)	1.10 (1.89 to 2.00) <0.001
15				
16	9. Anticipated regret			
17				
18		of catching flu if not vaccinated	0.27 (-0.21 to 0.74)	1.35 (1.18-1.52) <0.001
19				
20		of side effects if vaccinated	-0.09 (-0.15 to 0.37)	0.13 (-0.12 to 0.39) 0.4
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304 A multivariate regression model (Table 4) was statistically significant when

305 compared with a constant only model indicating that this set of variables and

306 constructs distinguishes reliably between HSCT recipients who express low and

307 high SIIV intent. There was a moderately strong relationship with 74.7%

308 (Nagelkerke R<sup>2</sup>) of variation in vaccination intention explained by the overall

309 model. GP and HSCT Team cues to vaccination, self-efficacy and anticipated

310 regret constructs did not significantly improve predictive value and so were not

311 included in the final model. Age and pre-HSCT SIIV vaccination receipt remained

312 independent predictors of SIIV intention, with those aged >65 and those who had

313 not received SIIV before HSCT more likely to be in the low intent group. A

314 greater perceived benefit of vaccination was the strongest predictor of being in

315 the high intent group. Although the constructs susceptibility to influenza,



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3 316 likelihood of contracting influenza, severity of influenza infection, barriers to  
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5 317 vaccination and worry about catching influenza improved the predictive value of  
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7 318 the overall multivariate model, they did not independently predict vaccination  
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9 319 intention.

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327 *Table 4 Multivariate logistic regression model predicting odds of high SIIV intent.*

328 *Overall model was statistically significant compared with a constant only model*

329 *( $p < 0.001$ ). \*Statistically significant independent predictor ( $p < 0.05$ )*

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Variable	Odds Ratio of high SIIV Intent (95% CI)	p
Age >65	0.02 (0.01-0.57)	0.02*
No SIIV before HSCT	0.04 (0.02-0.56)	0.02*
Benefits of vaccination	2.96 (1.29-6.81)	0.01*
Susceptibility to seasonal Influenza	0.96 (0.33-2.78)	0.64
Likelihood of catching seasonal influenza	1.68 (0.86-3.26)	0.13
Severity of seasonal influenza infection	0.69 (0.39-1.21)	0.20
Barriers to vaccination	0.69 (0.57-0.99)	0.05
Worry less about catching seasonal influenza if vaccinated	4.99 (1.01-24.77)	0.05

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5 333 *Cues to Vaccination and Preferred Vaccination Location*

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9 335 Considering their HSCT team and GPs, both high and low intent groups agreed  
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11 336 more strongly with statements that their HSCT team understands their condition  
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13 337 enough to know if the influenza vaccine is right for them. Patients were also  
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15 338 asked how much they agreed with the statement that they would definitely have  
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17 339 the vaccine if their GP or HSCT team recommended it. Agreement scores were  
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19 340 dichotomized to low agreement ( $\leq$  neutral value) and high agreement ( $>$ neutral  
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21 341 value). Of those 22 patients with low intent, 90% agreed that they would receive  
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23 342 the vaccine if their HSCT Team recommended it, and only 22.7% if their GP  
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25 343 recommended it, compared with 98.6% and 90.0% respectively in the high  
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27 344 intent group.

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33 346 Participant responses to the statement *I would prefer to have the seasonal*  
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35 347 *influenza vaccine next winter at my transplant centre instead of my GP surgery*  
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37 348 were categorized into prefers HSCT centre, prefers GP surgery or no preference.  
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39 349 Of the low intent group, over half (54.5%) favoured vaccination at their HSCT  
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41 350 centre, with only a minority (4.5%) favouring vaccination at their GP surgery. Of  
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43 351 those with high intent 43.7% favoured vaccination at their HSCT programme,  
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45 352 compared with 29.6% at their GP surgery although these findings did not reach  
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47 353 statistical significance ( $p=0.05$ ).

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53 355 Discussion

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3 357 To our knowledge, this is the first study to explore sociodemographic factors and  
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5 358 psychological determinants of SIIV intention amongst HSCT recipients. Patients  
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7 359 from 3 geographically dispersed study sites completed anonymous  
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9 360 questionnaires. Approximately a quarter of participants expressed low SIIV  
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11 361 intent. While this is in keeping with previously reported SIIV uptake rates of 60-  
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13 362 70% [8,9], the small absolute number of participants expressing low SIIV intent  
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15 363 in our study may bias our data. Participants' SIIV uptake during the 2016-2017  
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17 364 UK influenza season was not evaluated, and uptake in this cohort may not be  
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19 365 equivalent to intent rates reported here.  
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27 367 Constructs of a mHBM were significant determinants of SIIV intention.  
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29 368 Strategies tailored to a population and their specific concerns are the most  
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31 369 effective at improving knowledge and changing attitudes towards vaccination,  
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33 370 and increasing vaccine uptake[20]. Based on our findings, the mHBM may  
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35 371 provide a useful framework for structuring strategies to address low SIIV intent  
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37 372 in the HSCT population. Exploring HSCT recipients increased risk of influenza,  
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39 373 both in terms of susceptibility and severity, discussing the potential benefits of  
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41 374 vaccination, and exploring concerns around side effects may help to promote  
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43 375 vaccine intent and uptake.  
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47 377 A strong association between past vaccination behaviours and future vaccination  
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49 378 intent has been reported[21]. Previous influenza vaccination has been  
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51 379 associated with high intent or uptake in all at risk groups [22,23] and cancer  
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53 380 patients[24] and our findings accord with this. It may therefore be helpful to  
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3 381 explore recipients pre-HSCT SIV behaviour and discussion rationale for refusal  
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5 382 where appropriate.  
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9 384 It was reassuring to find that none of gender, ethnicity, educational background,  
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11 385 living circumstances or relationship status were associated with vaccine  
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13 386 hesitancy in this study. However, vaccination intention did vary with age. High  
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15 387 intent was greatest at 91.7% in the 35-53 age bracket, but of concern, fell in  
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17 388 those over 65 to 53.5%, which is below the 2015-2016 uptake rate of 71% in the  
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19 389 equivalent UK general population age-group[25]. Older age has been reported as  
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21 390 a barrier to vaccination in a cohort of oncology patients, including some with  
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23 391 haematological malignancy [24]. However, a French study of patients with  
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25 392 secondary immunodeficiency, including haematological disorders, reported  
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27 393 higher vaccination rates in those aged over 65 compared with younger  
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29 394 patients[26]. In a UK study, older age was found to be a predictor of uptake of the  
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31 395 2009 pandemic influenza A vaccine amongst high-risk adults[27]. A meta-  
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33 396 analysis of international studies found inconsistent association between age and  
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35 397 vaccination intent and uptake in the general public, older patients, and those  
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37 398 with chronic disease [21]. It is not apparent from these studies why age impacts  
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39 399 on intent, and there are likely to be a range of social, psychological, financial and  
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41 400 healthcare access issues specific to each study population. Our findings highlight  
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43 401 a specific age group in whom intent is low and may benefit from targeted  
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45 402 intervention. Further evaluation of this finding and exploration of underlying  
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47 403 determinants is warranted.  
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3 405 High SIIV intent was greatest in those recipients within the first 0-6 months'  
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5 406 post-HSCT (81.3%) and lowest at more than 12 months (55.6%) although this  
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7 407 finding was not statistically significant. Longer time from HSCT may be  
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9 408 associated with a change in perceived risk of infection, or concern about vaccine  
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11 409 side effects or efficacy; however, we did not detect any statistically significant  
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13 410 difference in health beliefs at 0-6, 6-12 and > 12 months from HSCT. This finding  
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15 411 suggests there is a need for reinforcement of SIIV intent from healthcare  
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17 412 professionals throughout and beyond the first-year post HSCT.  
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23 414 In both vaccine intention groups, patients expressed greater confidence in their  
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25 415 HSCT team than their GP, with respect to understanding of whether the influenza  
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27 416 vaccine is right for them. Fewer patients felt that a recommendation from their  
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29 417 GP would prompt them to receive the SIIV compared with if their HSCT Team  
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31 418 made the recommendation. This was most marked in the low intent group.

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33 419 These findings suggest that cues from the HSCT team are important in promoting  
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35 420 vaccination amongst HSCT recipients, and particularly for those with low intent.

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38 421 Cues from healthcare providers are considered a key factor in promoting  
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40 422 vaccination[21] and a study of Israeli cancer patients identified recommendation  
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42 423 from an oncologist as a significant predictor of vaccine uptake [24]. Our findings  
43  
44 424 accord with this, and suggest that HSCT recipients value the advice of their  
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46 425 specialist team. This highlights the importance of HSCT specialists engaging in  
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48 426 discussion with patients about influenza vaccination. Preference for vaccination  
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50 427 at HSCT centres rather than GP surgeries was similar at 43.7% and 54.5% in low  
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52 428 and high intent groups respectively. In the high intent group, more patients  
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54 429 expressed a preference for vaccination at their GP surgery than in the low intent  
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3 430 group. For approximately 50% of those HSCT recipients with both low and high  
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5 431 intent, access to an SIIV service at HSCT centres may facilitate vaccination uptake  
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9 433 None of the transplant variables assessed were associated with SIIV intention.  
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11 434 Current influenza vaccination guidelines are standardized for all HSCT recipients  
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13 435 as evidence is insufficient to recommend modification according to donor type,  
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15 436 stem cell source or conditioning[4,5]. Influenza infections are reported to occur  
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17 437 with higher frequency in allogeneic compared with autologous HSCT recipients  
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19 438 [28,29] and may have a higher associated morbidity and mortality[30] although  
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21 439 this latter finding has not been consistently reported[1]. There was no  
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23 440 difference in vaccination intention between autologous and allogeneic HSCT  
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25 441 recipients. This suggests the unique aspects of allogeneic HSCT, principally GvHD  
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27 442 and the need for immunosuppressive therapy, do not contribute to increased  
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29 443 influenza vaccination intention in this group compared with autoHSCT recipients.  
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#### 36 445 Conclusion

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40 447 Our data indicate that the constructs of a mHBM are important determinants of  
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42 448 SIIV intention in the HSCT recipient population. These constructs may be used to  
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44 449 develop interventions addressing low SIIV intent For example, SIIV uptake  
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46 450 amongst HSCT recipients may be promoted by public health authorities and  
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48 451 patient support groups with messages adapted from our findings. Future  
49  
50 452 prospective studies to investigate the efficacy of such intervention are warranted.  
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52 453 HSCT recipients strongly value the expertise and recommendation of their  
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54 454 transplant team, and we would encourage practitioners to discuss SIIV intention  
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3 455 with all patients as a routine and important aspect of post-transplant care.  
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5 456 Furthermore, those aged over 65, and those who had not received the SIIV prior  
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7 457 to HSCT were particularly likely to have low intent and may be target groups.  
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9 458 Local provision of vaccination services at HSCT centres may serve as an  
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11 459 additional promoter for a proportion of patients and this would require  
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13 460 allocation of resources from health commissioners.  
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#### 28 29 467 Authorship Statement

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33 469 Paul D E Miller, Alice S Forster, Thushan I de Silva, Karl Peggs, Alejandro  
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35 470 Madrigal and John A Snowden all contributed substantially to the design,  
36  
37 471 analysis, and interpretation of data. Hayley Leonard, Chloe Anthias, Michaela  
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39 472 Mayhew, Matthias Klammer, Erin Hurst and Susan Paskar all contributed  
40  
41 473 substantially to the acquisition of data. All authors contributed to drafting the  
42  
43 474 work and/or revising it critically for intellectual content. All authors gave final  
44  
45 475 approval of the version to be published.  
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#### 49 50 51 477 Data sharing statement

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3 479 The study dataset will be made available via Dryad repository and DOI provided  
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5 480 following editorial review  
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For peer review only

# BMJ Open

## Sociodemographic and psychological determinants of influenza vaccine intention amongst recipients of autologous and allogeneic haematopoietic stem cell transplant: a cross-sectional survey of UK transplant recipients using a modified health belief model.

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Manuscripts

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3 1 Sociodemographic and psychological determinants of influenza vaccine intention  
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7 3 transplant: a cross-sectional survey of UK transplant recipients using a modified  
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15  
16 31 number).

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23 34 The authors have no competing interests to declare

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27  
28 36 Abstract

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33 38 Objectives: Studies exploring vaccination rates amongst haematopoietic stem cell  
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35 39 transplant (HSCT) recipients have focused on physician factors that limit uptake.

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37 40 Understanding the patient factors that determine vaccination intention is crucial to  
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39 41 delivering a successful vaccination programme. Using a modified Health Belief

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41 42 Model (mHBM), we conducted a cross-sectional survey with the objective of  
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43 43 exploring the sociodemographic and psychological factors that determined

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45 44 autologous and allogeneic HSCT recipients' intention to receive the seasonal  
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47 45 inactivated influenza vaccine (SIIV) during the 2015-2016 influenza season.

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53 47 Setting: The setting of our study was three tertiary-level, UK NHS autologous and  
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55 48 allogeneic HSCT centres.

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5 50 Participants: Eligible patients were aged 16 years or over and recipients of  
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7 51 autologous or allogeneic HSCT for any disease indication, with no absolute  
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9 52 contraindication to receiving the SIIV during the next influenza season, and having  
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11 53 not received the SIIV since transplant. 93 participants from 3 UK NHS HSCT centres  
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14 54 completed an anonymous study-specific questionnaire. 78.5% were recipients of  
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16 55 allogeneic and 21.5% autologous HSCT.

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21 57 Results: 23.7% of participants expressed low intent to receive the SIIV. patients aged  
22  
23 58 over 65 (OR 0.02, 95% CI 0.01-0.57, p=0.02) and those who had not received the SIIV  
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25 59 prior to HSCT (OR 0.04, 0.02-0.56, p=0.02) were less likely to have high intent. A  
26  
27 60 multivariate logistic regression model incorporating constructs of the mHBM was  
28  
29 61 statistically significant (p<0.001) and explained 74.7% of variation in SIIV intention.  
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31 62 More patients felt that a recommendation from their HSCT team than their General  
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33 63 Practitioner would prompt them to receive the SIIV, and this was most pronounced  
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35 64 in those who had low intent.

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41 66 Conclusions: The mHBM may provide a useful structure for addressing low vaccine  
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43 67 intent amongst HSCT recipients and further interventional studies are warranted.  
44  
45 68 We would encourage HSCT and General practitioners to discuss SIIV intention as a  
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47 69 routine part of care.

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51 7052  
53 71 HRA REC reference 16/WM/014454  
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3 73 Strengths of Study  
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7 75 - The study questionnaire was based on the established theoretical framework of the  
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10 76 Health Belief Model, and questions were specific with regard to vaccine and 2015-  
11  
12 77 2016 season.  
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16 79 -Participants from 3 geographically dispersed study sites completed anonymous  
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19 80 questionnaires  
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23 82 Limitations  
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26 83 -The study explored intention to receive the inactivated influenza vaccine during the  
27  
28 84 2015-2016 influenza season. Uptake was not assessed and may differ from intention  
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30 85 rates.  
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35 87 -The number of enrolled participants expressing low vaccination intent was small at  
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37 88 22 (23.7%) and this may bias our data.  
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42 90 -The study did not include a qualitative component and there may be additional  
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44 91 determinants of influenza vaccine intention not captured here.  
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51 94 Introduction  
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3 96 Innate and adaptive immune responses are impaired for months to years following  
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5 97 autologous and allogeneic haematopoietic stem cell transplant (HSCT). Immune  
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7 98 impairment following autologous HSCT is secondary to the administration of  
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9 99 immunosuppressive conditioning regimens. In the setting of allogeneic HSCT,  
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12 100 chronic graft versus host disease (GvHD) may also contribute to immune impairment  
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14 101 and dysfunction through thymic atrophy [1,2] and functional hyposplenism [3], and  
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16 102 the mainstay of GvHD treatment is immunosuppressive therapy. Infection is  
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18 103 therefore an important complication of both autologous and allogeneic HSCT, and  
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21 104 recipients are at high risk of morbidity and mortality from influenza viruses[4–6].  
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23 105 Guidelines recommend that the seasonal inactivated influenza vaccine (SIIV) is  
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25 106 administered annually starting 4 to 6 months post HSCT [7,8], including patients with  
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28 107 GvHD[9] While the SIIV is recommended by 96% of UK NHS allogeneic HSCT  
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31 108 programmes[8], uptake rates of only 60-70% in the first 2 years post HSCT have been  
32  
33 109 reported amongst UK HSCT recipients[10,11]. The majority of UK allogeneic HSCT  
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35 110 recipients are referred to their General Practitioner (GP) with only 8% of UK adult  
36  
37 111 allogeneic HSCT programmes offering vaccination services. SIIV efficacy of 65.4-80%  
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39 112 has been reported in HSCT recipients, although in small cohorts [12,13] In both the  
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42 113 UK and USA, physicians' familiarity with current guidelines, and perception of GvHD  
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44 114 as a contraindication to vaccination have been identified as factors limiting vaccine  
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46 115 uptake rates[10,11,14]. No studies to-date have explored the patient factors that  
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49 116 influence SIIV hesitancy or intention in an HSCT recipient population.  
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51 117  
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53 118 The Health Belief Model (HBM) is a widely used framework for investigating  
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55 119 psychosocial determinants of health behaviours[15] and is recognized as an

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3 120 important predictor of influenza vaccination uptake[16]. The HBM proposes that an  
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5 121 individual's engagement in a specific preventative health behaviour is predicated on  
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7 122 the following constructs: i) perceived susceptibility to the illness, ii) perceived  
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9 123 likelihood of contracting the illness, iii) perceived seriousness of the illness, iv)  
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11 124 perceived barriers to engaging in the health behaviour, v) perceived benefits of the  
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13 125 health behaviour, vi) cues to engage in the health behaviour such as advice from a  
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15 126 healthcare practitioner and, vii) self-efficacy or the individual's perception of their  
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17 127 capability to engage or succeed in the behaviour. Additional emotional constructs  
18  
19 128 may modify the HBM. In particular, worry may modify the impact of perceived risk  
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21 129 of illness; a patient may perceive themselves to be at risk, but unless this is  
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23 130 something that worries them they may not engage in a preventative behaviour[17].  
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26 131 Furthermore, anticipated regret of illness if a health behaviour is not performed is  
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28 132 also recognized as a predictor of intent[18].  
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35 134 The objective of this study was to explore the sociodemographic factors, and the  
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37 135 vaccine and vaccination-specific health-beliefs that are associated with SIIV intention  
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39 136 amongst HSCT recipients, using a HBM modified with the additional emotional  
40  
41 137 constructs given above (mHBM). A better understanding of such associations may  
42  
43 138 allow development of targeted strategies that address issues specific to this unique  
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45 139 and complex patient group, with the aim of increasing influenza vaccine uptake  
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47 140 rates.  
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53 142 Participants and Methods  
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3 144 *Participants*  
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7 146 Patients were screened by HSCT nurse specialists for study eligibility during routine  
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10 147 outpatient appointments between June and September 2016. Participants were  
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12 148 recruited from 3 study sites to reduce geographical bias. Eligible patients were aged  
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14 149 16 years or over and recipients of autologous or allogeneic HSCT for any disease  
15

16 150 indication, with no absolute contraindication to receiving the SIIV during the next  
17

18 151 influenza season, and having not received the SIIV since transplant. All participants  
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20  
21 152 gave written informed consent. The study was approved by the Health Research  
22

23 153 Authority National Research Ethics Committee (Reference 16/WM/0144)  
24

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26 154  
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28 155 *Study Questionnaire and Health Belief Model*  
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30 156  
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32 157 Participants completed a study-specific, 42-item, paper-based questionnaire. The  
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34 158 questionnaire was completed anonymously and returned in sealed envelopes, so  
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36 159 participants felt free to express their belief without influence from their healthcare  
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38 160 team.  
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44 162 Questions scoped type of HSCT (autologous or allogeneic), disease indication, time  
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46 163 from HSCT, pre-HSCT SIIV receipt, and receipt of non-SIIV vaccines since HSCT.  
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48 164 Sociodemographic questions established age, gender, ethnic background,  
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51 165 educational attainment, relationship status and residential circumstances.  
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3 167 Intention to receive the SIIV during the 2016-2017 influenza season, was assessed by  
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5 168 2 statements phrased in the affirmative (I intend to receive the flu vaccine next  
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7 169 winter) and negative (I will choose not to receive the flu vaccine next winter).  
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10 170 Participants' agreement with each statement was expressed on 5-point Likert scales  
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12 171 ranging from strongly disagree to strongly agree.

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14 172  
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16 173 24 health belief statements were mapped to the mHBM with between 2 and 5  
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18 174 statements clustered around each construct (Table 1). Statements pertaining to the  
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20 175 cues to vaccination construct were phrased to explore perception of HSCT team and  
21  
22 176 GP knowledge of SIIV in the context of HSCT. Participants' perceived impact of a  
23  
24 177 recommendation to receive the SIIV from their HSCT team or GP was explored.  
25  
26 178 Statements about preferred vaccination location and ease of access to services were  
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28 179 also included. Again, participants' agreement with each statement was expressed on  
29  
30 180 5-point Likert scales ranging from strongly disagree to strongly agree.  
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### 36 182 *Statistical Analysis*

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38 184 Statistical analysis was performed with IBM SPSS version 24.  
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46 186 For the dependent variable vaccination intention, participants' agreement scores  
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48 187 were summed and dichotomised to a 'high intent' group (intention score > than  
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50 188 neutral value) and a 'low intent' group (intention score  $\leq$  to the neutral value).  
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3 190 Categorical patient characteristics and sociodemographic factors are reported as  
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5 191 frequencies and percentages. Associations between these variables and SIV  
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7 192 intention was examined with Pearson's chi-squared test, and Fisher's exact test  
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9 193 when expected values were less than 5.  
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12 194  
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14 195 Internal scale reliability for each cluster of mHBM construct statements was assessed  
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16 196 using Cronbach's  $\alpha$ . A value of  $>0.6$  was considered indicative of  
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197 *Table 1: Health belief statements grouped by construct with associated Cronbach's Alpha Value*

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<b>Health Belief Model Construct (Cronbach's Alpha)</b>
<b>1. Susceptibility to seasonal influenza (<math>\alpha = 0.83</math>)</b>
Now I have had a stem cell transplant I can catch the seasonal flu more easily than other people my age
Now I have had a stem cell transplant I can catch the seasonal flu more easily than before my transplant
<b>2. Likelihood of catching seasonal influenza (<math>\alpha = 0.91</math>)</b>
My chances of catching seasonal flu next winter will be high if I do not receive the seasonal flu vaccine
I am more likely than other people my age to catch seasonal flu next winter if I do not receive the seasonal flu vaccine
Now I have had a stem cell transplant it is more likely that I will catch seasonal flu next winter if I do not receive the seasonal flu vaccine
<b>3. Severity of seasonal influenza infection (<math>\alpha = 0.91</math>)</b>
If I do not receive the seasonal flu vaccine and caught the seasonal flu next winter this would be a serious illness for me
If I do not receive the seasonal flu vaccine and caught the seasonal flu next winter this would have a negative impact on my recovery from my stem cell transplant
If I do not receive the seasonal flu vaccine and caught the seasonal flu next winter I would become more unwell than other people my age
<b>4. Barriers to vaccination (<math>\alpha = 0.84</math>)</b>
I am worried about side effects of the seasonal flu vaccine
If I receive the seasonal flu vaccine next winter it may make me feel unwell with the flu or a flu-like illness
If I receive the seasonal flu vaccine next winter I am more likely to experience side effects than other people my age
If I receive the seasonal flu vaccine next winter it may have a negative impact on my recovery from my stem cell transplant
Now I have had a stem cell transplant the seasonal flu vaccine may not work as well for me as it does for other people my age
<b>5. Benefits of vaccination (<math>\alpha = 0.66</math>)</b>
If I receive the seasonal flu vaccine next winter it may help to prevent me from catching the seasonal flu
If I receive the seasonal flu vaccine next winter it may help to prevent me from passing the seasonal flu to other people around me
If I receive the seasonal flu vaccine next winter, but still catch the flu, it may help to prevent me from becoming seriously unwell
<b>6. Cues to vaccination (<math>\alpha = 0.76</math>)</b>

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7 If my transplant team advised me to receive the seasonal flu vaccine next winter I would definitely have it

8 If my GP advised me to receive the seasonal flu vaccine next winter I would definitely have it

9 My GP understands my condition enough to know if the seasonal flu vaccine is right for me

10 My transplant team understand my condition enough to know if the seasonal flu vaccine is right for me

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11 7.Worry ( $\alpha = 0.47$ )

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12 If I receive the seasonal flu vaccine next winter I will worry less about catching the seasonal flu

13 The thought of catching seasonal flu next winter worries me

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14 8.Self-efficacy ( $\alpha = 0.29$ )

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15 I have enough information and am able to decide whether the seasonal flu vaccine is right for me

16 I would find it easy to attend my GP surgery next winter to receive the seasonal flu vaccine

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17 9.Anticipated regret ( $\alpha = 0.15$ )

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18 I would regret it if I decided not to receive the seasonal flu vaccine next winter and became unwell with seasonal flu

19 I would regret it if I decided to receive the seasonal flu vaccine next winter and became unwell with side effects

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3 199 acceptable internal scale reliability [19]. Scale reliability was acceptable for  
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5 200 constructs 1-6 (Table 1) and statement scores were summed to give total construct  
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7 201 scores for each participant. Scale reliability was unacceptable for constructs 7-9  
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9 202 (Table 1) therefore statements were analysed individually. All construct scores were  
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11 203 analysed as continuous scales, with zero representing a neutral response (neither  
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13 204 agree nor disagree). Mean agreement scores for low and high intent groups are  
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15 205 presented with 95% confidence intervals.  
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21 207 Participants' mean agreement scores for each mHBM construct were compared  
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23 208 between SIIV intention groups using Analysis of Variance (ANOVA). Homogeneity of  
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25 209 variances was confirmed with Levene's statistic. HSCT team and GP cue scores  
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27 210 *within* low and high intent groups were compared with a paired sample T-Test.  
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32 212 The impact of sociodemographic variables and health belief constructs on seasonal  
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34 213 influenza vaccination intention was examined with hierarchical binary logistic  
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36 214 regression. Variables and constructs that were statistically significant in univariate  
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38 215 analysis were included as separate regression blocks. Statistically significant  
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40 216 variables that improved the predictive value ( $p < 0.05$  for the regression block) were  
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42 217 included in the final model.  
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48 219 The assumption of a linear relationship between each independent variable and log  
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50 220 of the outcome variable was tested and confirmed using the Box-Tidwell  
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52 221 procedure[20]. Multicollinearity across all constructs was assessed. No variance  
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3 222 inflation factor was greater than 10, and the mean of values was acceptable at

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5 223 1.92[21].

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9 225 There were 10 missing data points from 6 participants across the study. These were

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11 226 all responses to mHBM statements from the high intent group. Summed agreement

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13 227 scores were not calculated for that participant for the affected HBM construct only.

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17 229 *Patient and Public Involvement*

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21 231 The study questionnaire was developed with the involvement of volunteers from the

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23 232 Anthony Nolan patients and families panel. Using an initial draft questionnaire,

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25 233 think-aloud sessions were conducted to ensure that the questionnaire was clear,

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27 234 easy to understand, that interpretation of each question was as intended, and that

28  
29 235 answers were consistent with the question asked. Volunteers were also asked for

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31 236 their overall feedback on the study questionnaire. The revised questionnaire was

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33 237 then piloted with volunteer patients who were asked to complete the questionnaire,

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35 238 keeping note of the time taken, and to highlight any questions that they had

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37 239 difficulty answering or otherwise found problematic. The questionnaires were all

38  
39 240 completed within 10 minutes and no participants reported difficulty or concerns

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41 241 about the questions. Results will be disseminated to study participants through

42  
43 242 their transplant teams, and made available to participants through open access

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45 243 publication.

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247 Results

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249 *Patient Characteristics*

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251 Characteristics of 93 study participants are given in Table 2. 78.5% were recipients  
 252 of allogeneic HSCT and the most frequent disease indication was acute myeloid  
 253 leukaemia (AML) (28.0%). The majority (68.6%) were within the first 6 months post  
 254 HSCT. 40.9% of participants had received the SIIV before HSCT, and 4.3% had  
 255 received a non-influenza vaccine since HSCT. 52.7% of participants were male, and  
 256 most (84.9%) were of a white ethnic group.

257

258 *SIIV vaccination intention for 2016-2017 influenza season*

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260 71 (76.3%) participants expressed high SIIV intent, while 22 (23.7%) expressed low  
 261 SIIV intent.

262

263

264 *Table 2: Characteristics of n=93 study participants. \*Statistically Significant (p<0.05)*

265

Characteristic, n=93	n(%)	high SIIV Intent n(%)	p
<b>Gender</b>			
Male	49 (52.7)	40 (81.6)	
Female	44 (47.3)	31 (70.5)	0.23
<b>Age group</b>			
16-34	22 (23.7)	15 (68.2)	

1				
2				
3	35-54	36 (38.7)	33 (91.7)	
4	55-64	20 (21.5)	15 (75)	
5	65+	15 (16.1)	8 (53.5)	0.02*
6	<b>HSCT Type</b>			
7	Allogeneic	73 (78.5)	59 (80.8)	
8	Autologous	20 (21.5)	15 (75)	0.78
9				
10	<b>Disease Indication</b>			
11	Acute lymphoblastic leukaemia (ALL)	11 (11.8)	8(72.7)	
12	Acute myeloid leukaemia (AML)	26 (28.0)	20 (76.9)	
13	Aplastic Anaemia (AA)	5 (5.4)	3 (60)	
14	Chronic myeloid leukaemia (CML)	5 (5.4)	5 (100)	
15	Hodgkin Lymphoma	9 (9.7)	9 (88.9)	
16	Myelodysplastic syndrome (MDS)	5 (5.4)	3 (60)	
17	Myelofibrosis (MF)	2 (2.2)	1 (50)	
18	Multiple myeloma (MM)	22 (23.7)	17 (77.3)	
19	Non-Hodgkin Lymphoma (NHL)	8 (8.6)	6 (75)	0.79
20				
21	<b>months from HSCT</b>			
22	0-6	64 (68.8)	52 (81.3)	
23	>6-12	20 (21.5)	14 (70)	
24	> 12	9 (9.7)	5 (55.6)	0.18
25				
26	<b>SIIV before HSCT</b>			
27	Yes	38 (40.9)	34(89.5)	
28	No	55 (59.1)	37 (67.3)	0.01*
29				
30	<b>Any non-SIIV vaccine since HSCT</b>			
31	Yes	4 (4.3)	4 (100)	
32	No	89 (95.7)	67 (75.3)	0.26
33				
34	<b>Ethnicity</b>			
35	White	79 (84.9)	69 (77.2)	
36	Asian	8 (8.6)	7 (87.5)	
37	Black	3 (3.2)	2 (66.7)	
38	Mixed	2 (2.2)	1 (50)	
39	Other	1 (1.1)	0 (0)	0.32
40				
41	<b>Educational Background</b>			
42	Higher Education	30 (32.3)	24 (80)	
43	Secondary Education	49 (52.7)	40 (81.6)	
44	Other	3 (3.2)	2 (66.7)	
45	Prefer not to answer	11 (11.8)	5 (45.5)	0.07
46				
47	<b>Living Circumstances</b>			
48	Renting	25 (26.9)	33 (76)	
49	Home Owner	54 (58.1)	43 (79.6)	
50	Other	10 (10.8)	7(70)	
51	Prefer not to answer	4 (4.7)	2 (50)	0.56
52				
53	<b>Relationship Status</b>			
54	Single	23 (24.7)	18 (78.3)	
55	Married / Cohabiting	56(60.2)	45 (80.4)	
56	Divorced / Separated	10 (10.8)	5 (50)	
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289

290 In univariate analysis, comparing mean construct agreement scores between SIV

291 intention groups, participants in the high intent group perceived greater

292 susceptibility to influenza, a greater likelihood of contracting influenza and

293 perceived influenza to be a more severe illness (Table 3). They also perceived

294 greater potential benefit from vaccination, and fewer barriers to vaccination.

295 Although the two groups expressed similar levels of worry about catching influenza,

296 participants in the high intent group felt they would worry less about catching

297 influenza if vaccinated compared with the low intent group. They also expressed

298 greater concern about anticipated regret if they caught influenza having not been

299 vaccinated. Level of anticipated regret of experiencing side effects if vaccinated was

300 similarly low across the two groups. Participants in the high intent group felt more

301 strongly that they had enough information to make decisions about vaccination and

302 that it would be easy to attend their general practice surgery for vaccination.

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313 *Table 3: Mean agreement score values for health belief constructs for low and high*  
 314 *SIIV intent groups. <sup>a</sup>n=68, <sup>b</sup>n=69, <sup>c</sup>n=70*

Health Belief Model Construct	Low SIIV Intent (n=22)	High SIIV intent (n=71)	p
1. Susceptibility to seasonal influenza	0.05 (-0.70 to 0.70)	2.09 (1.75 to 4.39)	<0.001
2. Likelihood of catching seasonal influenza	-0.45 (-1.39 to 0.40)	2.58 (2.00 to 3.18) <sup>b</sup>	<0.001
3. Severity of Seasonal influenza infection	0.77 (-0.17 to 1.72)	2.65 (2.09 to 3.23) <sup>b</sup>	0.002
4. Barriers to vaccination	1.27 (0.11 to 2.44)	-1.55 (-2.34 to -0.80) <sup>a</sup>	0.001
5. Benefits of vaccination	-0.05 (0.00 to 1.78)	2.56 (2.13 to 3.00)	<0.001
6. Cues to Vaccination			
HSCT team understands my condition	1.14 (0.55 to 1.32)	1.63 (1.52 to 1.75)	<0.001
GP understands my condition	-0.32 (0.83 to 0.13)	0.59 (0.55 to 0.83) <sup>c</sup>	<0.001
7. Worry			
About catching influenza	0.14 (-0.43 to 0.71)	0.39 (0.17 to -0.63)	0.34
Less about catching influenza if vaccinated	-0.23 (0.60 to 0.07)	0.80 (0.61 to 1.00)	<0.001
8. Self-efficacy			
Have enough information to decide about vaccination	0.14 (-0.32 to 0.58)	0.81 (0.61 to 1.00)	0.007
Would find it easy to attend GP for vaccination	0.32 (-0.12 to 1.72)	1.10 (1.89 to 2.00)	<0.001
9. Anticipated regret			
of catching flu if not vaccinated	0.27 (-0.21 to 0.74)	1.35 (1.18-1.52)	<0.001
of side effects if vaccinated	-0.09 (-0.15 to 0.37)	0.13 (-0.12 to 0.39)	0.4

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316 A multivariate regression model (Table 4) was statistically significant when compared  
 317 with a constant only model indicating that this set of variables and constructs  
 318 distinguishes reliably between HSCT recipients who express low and high SIIV intent.  
 319 There was a moderately strong relationship with 74.7% (Nagelkerke R<sup>2</sup>) of variation  
 320 in vaccination intention explained by the overall model. GP and HSCT Team cues to

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3 321 vaccination, self-efficacy and anticipated regret constructs did not significantly  
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5 322 improve predictive value and so were not included in the final model. Age and pre-  
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7 323 HSCT SIV vaccination receipt remained independent predictors of SIV intention,  
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9 324 with those aged >65 and those who had not received SIV before HSCT more likely to  
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11 325 be in the low intent group. A greater perceived benefit of vaccination was the  
12  
13 326 strongest predictor of being in the high intent group. Although the constructs  
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15 327 susceptibility to influenza, likelihood of contracting influenza, severity of influenza  
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17 328 infection, barriers to vaccination and worry about catching influenza improved the  
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19 329 predictive value of the overall multivariate model, they did not independently  
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21 330 predict vaccination intention.  
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342 *Table 4 Multivariate logistic regression model predicting odds of high SIV intent.*343 *Overall model was statistically significant compared with a constant only model*344 *( $p < 0.001$ ). \*Statistically significant independent predictor ( $p < 0.05$ )*



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Variable	Odds Ratio of high SIIV Intent (95% CI)	P
Age >65	0.02 (0.01-0.57)	0.02*
No SIIV before HSCT	0.04 (0.02-0.56)	0.02*
Benefits of vaccination	2.96 (1.29-6.81)	0.01*
Susceptibility to seasonal Influenza	0.96 (0.33-2.78)	0.64
Likelihood of catching seasonal influenza	1.68 (0.86-3.26)	0.13
Severity of seasonal influenza infection	0.69 (0.39-1.21)	0.20
Barriers to vaccination	0.69 (0.57-0.99)	0.05
Worry less about catching seasonal influenza if vaccinated	4.99 (1.01-24.77)	0.05

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349 *Cues to Vaccination and Preferred Vaccination Location*

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351 Considering their HSCT team and GPs, both high and low intent groups agreed more  
 352 strongly with statements that their HSCT team understands their condition enough  
 353 to know if the influenza vaccine is right for them. Patients were also asked how  
 354 much they agreed with the statement that they would definitely have the vaccine if  
 355 their GP or HSCT team recommended it. Agreement scores were dichotomized to  
 356 low agreement ( $\leq$  neutral value) and high agreement ( $>$ neutral value). Of those 22  
 357 patients with low intent, 90% agreed that they would receive the vaccine if their  
 358 HSCT Team recommended it, and only 22.7% if their GP recommended it, compared  
 359 with 98.6% and 90.0% respectively in the high intent group.

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3 361 Participant responses to the statement *I would prefer to have the seasonal influenza*  
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5 362 *vaccine next winter at my transplant centre instead of my GP surgery* were  
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7 363 categorized into prefers HSCT centre, prefers GP surgery or no preference. Of the  
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9 364 low intent group, over half (54.5%) favoured vaccination at their HSCT centre, with  
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11 365 only a minority (4.5%) favouring vaccination at their GP surgery. Of those with high  
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13 366 intent 43.7% favoured vaccination at their HSCT programme, compared with 29.6%  
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15 367 at their GP surgery although these findings did not reach statistical significance  
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17 368 (p=0.05).  
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## 23 370 Discussion

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28 372 This is the first study to explore sociodemographic factors and psychological  
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30 373 determinants of SIIV intention amongst HSCT recipients Approximately a quarter of  
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32 374 participants expressed low SIIV intent which is in keeping with previously reported  
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34 375 SIIV uptake rates of 60-70% [10,11] Participants' SIIV uptake during the 2016-2017  
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36 376 UK influenza season was not evaluated, and uptake in this cohort may not be  
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38 377 equivalent to intent rates reported here.  
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44 379 Constructs of a mHBM were significant determinants of SIIV intention. Strategies  
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46 380 tailored to a population and their specific concerns are the most effective at  
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48 381 improving knowledge and changing attitudes towards vaccination, and increasing  
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50 382 vaccine uptake[22]. Based on our findings, the mHBM may provide a useful  
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52 383 framework for structuring strategies to address low SIIV intent in the HSCT  
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54 384 population. Exploring HSCT recipients increased risk of influenza, both in terms of  
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3 385 susceptibility and severity, discussing the potential benefits of vaccination, and  
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5 386 exploring concerns around side effects may help to promote vaccine intent and  
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7 387 uptake.  
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11 389 A strong association between past vaccination behaviours and future vaccination  
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13 390 intent has been reported[23]. Previous influenza vaccination has been associated  
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15 391 with high intent or uptake in all at risk groups [24,25] and cancer patients[26] and  
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17 392 our findings accord with this. It may therefore be helpful to explore recipients pre-  
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19 393 HSCT SIV behaviour and discussion rationale for refusal where appropriate.  
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23 395 It was reassuring to find that none of gender, ethnicity, educational background,  
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25 396 living circumstances or relationship status were associated with vaccine hesitancy in  
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27 397 this study. However, vaccination intention did vary with age. High intent was  
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29 398 greatest at 91.7% in the 35-53 age bracket, but of concern, fell in those over 65 to  
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31 399 53.5%, which is below the 2015-2016 uptake rate of 71% in the equivalent UK  
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33 400 general population age-group[27]. Older age has been reported as a barrier to  
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35 401 vaccination in a cohort of oncology patients, including some with haematological  
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37 402 malignancy [26]. However, a French study of patients with secondary  
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39 403 immunodeficiency, including haematological disorders, reported higher vaccination  
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41 404 rates in those aged over 65 compared with younger patients[28]. In a UK study, older  
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43 405 age was found to be a predictor of uptake of the 2009 pandemic influenza A vaccine  
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45 406 amongst high-risk adults[29]. A meta-analysis of international studies found  
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47 407 inconsistent association between age and vaccination intent and uptake in the  
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49 408 general public, older patients, and those with chronic disease [23]. It is not apparent  
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3 409 from these studies why age impacts on intent, and there are likely to be a range of  
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5 410 social, psychological, financial and healthcare access issues specific to each study  
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7 411 population. Our findings highlight a specific age group in whom intent is low and  
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9 412 may benefit from targeted intervention. Further evaluation of this finding and  
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11 413 exploration of underlying determinants is warranted.  
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16 415 High SIIV intent was greatest in those recipients within the first 0-6 months' post-  
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18 416 HSCT (81.3%) and lowest at more than 12 months (55.6%) although this finding was  
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20 417 not statistically significant. Longer time from HSCT may be associated with a change  
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22 418 in perceived risk of infection, or concern about vaccine side effects or efficacy;  
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24 419 however, we did not detect any statistically significant difference in health beliefs at  
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26 420 0-6, 6-12 and > 12 months from HSCT. This finding suggests there is a need for  
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28 421 reinforcement of SIIV intent from healthcare professionals throughout and beyond  
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30 422 the first-year post HSCT.  
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37 424 In both vaccine intention groups, patients expressed greater confidence in their  
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39 425 HSCT team than their GP, with respect to understanding of whether the influenza  
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41 426 vaccine is right for them. Fewer patients felt that a recommendation from their GP  
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43 427 would prompt them to receive the SIIV compared with if their HSCT Team made the  
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45 428 recommendation. This was most marked in the low intent group. These findings  
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47 429 suggest that cues from the HSCT team are important in promoting vaccination  
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49 430 amongst HSCT recipients, and particularly for those with low intent. Cues from  
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51 431 healthcare providers are considered a key factor in promoting vaccination[23] and a  
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53 432 study of Israeli cancer patients identified recommendation from an oncologist as a  
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3 433 significant predictor of vaccine uptake [26]. Our findings accord with this, and  
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5 434 suggest that HSCT recipients value the advice of their specialist team. This highlights  
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7 435 the importance of HSCT specialists engaging in discussion with patients about  
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9 436 influenza vaccination. Preference for vaccination at HSCT centre rather than GP  
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11 437 surgery was similar at 43.7% and 54.5% in low and high intent groups respectively. In  
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13 438 the high intent group, more patients expressed a preference for vaccination at their  
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15 439 GP surgery than in the low intent group. For approximately 50% of those HSCT  
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17 440 recipients with both low and high intent, access to an SIIV service at HSCT centres  
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19 441 may facilitate vaccination uptake  
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21 442  
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23 443 None of the transplant variables assessed were associated with SIIV intention.  
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25 444 Current influenza vaccination guidelines are standardized for all HSCT recipients as  
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27 445 evidence is insufficient to recommend modification according to donor type, stem  
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29 446 cell source or conditioning[7,30]. Influenza infections are reported to occur with  
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31 447 higher frequency in allogeneic compared with autologous HSCT recipients [31,32]  
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33 448 and may have a higher associated morbidity and mortality[33] although this latter  
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35 449 finding has not been consistently reported[4]. There was no difference in  
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37 450 vaccination intention between autologous and allogeneic HSCT recipients. This  
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39 451 suggests the unique aspects of allogeneic HSCT, principally GvHD and the need for  
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41 452 immunosuppressive therapy, do not contribute to increased influenza vaccination  
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43 453 intention in this group compared with autoHSCT recipients.  
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53 455 Strength and Weaknesses of the Study  
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3 457 Our study was developed from an established theoretical framework for exploring  
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5 458 health beliefs. Think-aloud sessions and a pilot exercise ensured that the  
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7 459 questionnaire was easy to understand and acceptable to participants. By  
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9 460 completing the questionnaire anonymously, participants were encouraged to  
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11 461 respond according to their own beliefs without influence by their healthcare team.  
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14 462 By recruiting from 3 study sites we sought to capture the beliefs of participants with  
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16 463 different experiences of post HSCT care, reduce the impact of geographical bias and  
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18 464 render our results more generalizable to the UK HSCT population. The study did not  
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20 465 include a qualitative component and there may be additional determinants of  
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22 466 influenza vaccine intention not captured here. Data on non-responders was not  
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24 467 captured and therefore we cannot exclude a participation bias. The small absolute  
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26 468 number of participants expressing low SIIV intent in our study may bias our data.  
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## 35 471 Conclusion

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39 473 Our data indicate that the constructs of a mHBM are important determinants of SIIV  
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41 474 intention in the HSCT recipient population. These constructs may be used to  
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43 475 develop interventions addressing low SIIV intent, for example, SIIV uptake amongst  
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45 476 HSCT recipients may be promoted by public health authorities and patient support  
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47 477 groups with messages adapted from our findings. Future prospective studies to  
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49 478 investigate the efficacy of such intervention are warranted. HSCT recipients strongly  
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51 479 value the expertise and recommendation of their transplant team, and we would  
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53 480 encourage practitioners to discuss SIIV intention with all patients as a routine and  
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3 481 important aspect of post-transplant care. Furthermore, those aged over 65, and  
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5 482 those who had not received the SIIV prior to HSCT were particularly likely to have  
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7 483 low intent and may be target groups. Local provision of vaccination services at HSCT  
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9 484 centres may serve as an additional promoter for a proportion of patients and this  
10  
11 485 would require allocation of resources from health commissioners.  
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#### 27 492 Authorship Statement

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32 494 Paul D E Miller, Alice S Forster, Thushan I de Silva, Karl Peggs, Alejandro Madrigal and  
33  
34 495 John A Snowden all contributed substantially to the design, analysis, and  
35  
36 496 interpretation of data. Hayley Leonard, Chloe Anthias, Michaela Mayhew, Matthias  
37  
38 497 Klammer, Erin Hurst and Susan Paskar all contributed substantially to the acquisition  
39  
40 498 of data. All authors contributed to drafting the work and/or revising it critically for  
41  
42 499 intellectual content. All authors gave final approval of the version to be published.  
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#### 47 501 Data sharing statement

48 502 No additional data available

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STROBE Statement—Checklist of items that should be included in reports of *cross-sectional studies*

	Item No	Recommendation
<b>Title and abstract</b>	1	(a) Indicate the study's design with a commonly used term in the title or the abstract <a href="#">Abstract line 41-43</a> (b) Provide in the abstract an informative and balanced summary of what was done and what was found <a href="#">Abstract line 36-71</a>
<b>Introduction</b>		
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported <a href="#">Introduction Line 103-141</a>
Objectives	3	State specific objectives, including any prespecified hypotheses <a href="#">Introduction line 143-146</a>
<b>Methods</b>		
Study design	4	Present key elements of study design early in the paper <a href="#">Method Section</a>
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection <a href="#">line 155-162</a>
Participants	6	(a) Give the eligibility criteria, and the sources and methods of selection of participants <a href="#">line 157-160</a>
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable <a href="#">Line 169-188</a>
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group <a href="#">Line 169-188</a>
Bias	9	Describe any efforts to address potential sources of bias <a href="#">lines 157-158 and 168-170</a>
Study size	10	Explain how the study size was arrived at <a href="#">N/A</a>
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why. <a href="#">Lines 197-199, 213-216</a>
Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding <a href="#">lines 218-229</a> (b) Describe any methods used to examine subgroups and interactions <a href="#">N/A</a> (c) Explain how missing data were addressed <a href="#">Lines 237-240</a> (d) If applicable, describe analytical methods taking account of sampling strategy <a href="#">N/A</a> (e) Describe any sensitivity analyses <a href="#">N/A</a>
<b>Results</b>		
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed. <a href="#">Line 264</a> (b) Give reasons for non-participation at each stage <a href="#">N/A</a> (c) Consider use of a flow diagram <a href="#">N/A</a>
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders <a href="#">Table 2</a> (b) Indicate number of participants with missing data for each variable of interest <a href="#">Table 3</a>
Outcome data	15*	Report numbers of outcome events or summary measures <a href="#">line 273-274</a>
Main results	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were

		adjusted for and why they were included <a href="#">Table 3 and Table 4</a>
		(b) Report category boundaries when continuous variables were categorized <a href="#">Table 2</a>
		(c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period <a href="#">N/A</a>
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses <a href="#">N/A</a>
<b>Discussion</b>		
Key results	18	Summarise key results with reference to study objectives <a href="#">Line 380-382</a>
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias. <a href="#">Lines 385-393</a>
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence . <a href="#">Line 387-463</a>
Generalisability	21	Discuss the generalisability (external validity) of the study results <a href="#">Line 486-489</a>
<b>Other information</b>		
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based – <a href="#">line 30-32</a>

\*Give information separately for exposed and unexposed groups.

**Note:** An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at <http://www.plosmedicine.org/>, Annals of Internal Medicine at <http://www.annals.org/>, and Epidemiology at <http://www.epidem.com/>). Information on the STROBE Initiative is available at [www.strobe-statement.org](http://www.strobe-statement.org).