

1
2
3 **IMPROVING CHILDREN'S AND THEIR VISITORS' HAND**
4 **HYGIENE COMPLIANCE**
5

6
7 **Lary, D.¹, A. Calvert¹, B. Nerlich³, J. Segal⁴, N. Vaughan⁵, J.**
8 **Randle², K. R. Hardie^{1*}**
9

- 10
11 **1. School of Life Sciences, Centre for Biomolecular Sciences, University of**
12 **Nottingham, University Park, Nottingham, NG7 2RD**
13 **2. School of Nursing, Physiotherapy, and Midwifery, University of**
14 **Nottingham, Queen's Medical Centre, NG7 2UH. Currently freelance**
15 **medical report writer.**
16 **3. School of Sociology and Social Policy, University of Nottingham,**
17 **University Park, Nottingham, NG7 2RD**
18 **4. School of Engineering, University of Nottingham, Coates Building,**
19 **University Park, Nottingham, NG7 2RD**
20 **5. Department of Infection Prevention and Control, Nottingham University**
21 **Hospitals NHS Trust, Queen's Medical Centre, NG7 2UH**
22

23 ***Corresponding author: Dr Kim Hardie, School of Life Sciences, University of**
24 **Nottingham, University Park, Nottingham, NG7 2RD.**

25 **Tel: 0115 8467958**

26 **Fax: 0115 8467951**

27 **Email: kim.hardie@nottingham.ac.uk**
28
29
30

31 **Running title: IMPROVE CHILDREN/VISITOR HAND HYGIENE**
32

33 **Word count: 2597**
34

35 **Sources of funding:** This work was supported by the University of Nottingham [grant number
36 KT86]; East Midlands Development Agency [grant number HIRF 502]; and Saudi Arabian
37 Government [grant number DLary1].
38
39

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30

Abstract

Background: Numerous interventions have tried to improve healthcare workers' hand hygiene compliance, however little attention has been paid to children's and their visitors' compliance.

Aim: To increase children's and visitors' compliance using interactive educational interventions.

Methods: This was an observational study of hand hygiene compliance before and after the introduction of educational interventions. Qualitative data in the form of Questionnaires and interviews was obtained.

Findings: Hand hygiene compliance increased by 21.4% ($P < 0.001$) following the educational interventions, with children's compliance reaching 40.8% and visitors' being 50.8%. Compliance varied depending on which of the five moments of hygiene was observed ($P < 0.001$), with the highest compliance after body fluid exposure (96%). Responses from questionnaires showed educational interventions raised awareness of the importance of hand hygiene (69%, 57%) compared to those who had not experienced the educational intervention (50%).

Conclusion: Educational interventions may result in a significant increase in children's and visitors' hand hygiene ($P < 0.001$).

Keywords: Hand hygiene compliance, children, visitors, educational intervention, behavioural change, infection prevention

31

32 **Background**

33 Children are vulnerable to infectious diseases (Willmott et al., 2016) and NICE 2017 (NICE,
34 2017) calls for education providers and parents to do more to promote good hand hygiene
35 practices. This is especially relevant when considering children's vulnerability in healthcare
36 settings where not only are children treated by a plethora of healthcare workers who travel
37 in and out of different clinical settings, but they are typically surrounded by ill people.
38 Consequently the healthcare environment has been emphasised as a potential source of
39 harm for patients in the last few years and the reduction of healthcare associated infections
40 (HCAI) is now part of the everyday delivery of healthcare treatment.

41 To prevent and reduce HCAI transmission, it is important to determine if the main routes of
42 exposure to infection are direct, indirect, or due to repeated person-to-person contact. In
43 children, the transmission of infections is likely to correlate with their natural behaviour (e.g.
44 regular exploration of their mouths). The resultant spread of respiratory secretions coupled
45 with an immature immune system combine to increase children's risk of infections (Snow et
46 al., 2008) and they are especially at high risk of respiratory infections and gastrointestinal
47 diseases (Stein et al., 2007).

48 Hand hygiene (HH) is the single most important measure for reducing HCAI, and
49 interventions can improve compliance (Randle et al., 2010) with the most effective being
50 multimodal.(Naikoba and Hayward, 2001; Gould et al., 2017)

51 Unsurprisingly studies have focused on Healthcare workers' compliance and patients' and
52 visitors' has been overlooked, even though their Hand Hygiene Compliance (HHC) is
53 important, especially if they augment the care provided by the HCWs as a parent would.
54 Patients and visitors pose a high risk because of their potential to (i) transmit virulent
55 pathogens from the community to the healthcare setting and/or (ii) transfer pathogens within

56 clinical areas to the patient (directly or indirectly).(Gould et al., 2017; Randle et al., 2010;
57 Munoz-Price et al., 2012)

58 This study monitored children's and their visitors HHC before and after the introduction of
59 an educational intervention (Supplementary Figure A) The educational intervention was
60 either the Glo-yo (Supplementary Figure B, Supplementary Figure C, Supplementary Table
61 A) ; or a video.

62
63

64 **Methods**

65 ***Ethical and Regulatory Aspects***

66 The Research Ethical Committee (REC) Committee East Midlands Research NHS and the
67 Research & Innovation department, NHS, approved this study.

68 ***Study design***

69 This observational study was conducted on six paediatric wards in a teaching Hospital in
70 the East Midlands. Random sampling (slips of paper in a hat) allocated two paediatric wards
71 for each educational intervention (the Glo-yo or the video) and the control group which
72 received no intervention (see Supplementary Table A). The baseline phase included HHC
73 rates using the WHO 5 moments of hand hygiene (2009). The intervention phase included
74 Hand HHC rates and the educational interventions. After the interventions, a qualitative
75 questionnaire was given to the parents/carers of the children (3-15 years) or children (≥ 16).
76 Questions asked about HH behaviours, beliefs and attitudes about infection, hygiene and
77 cleanliness that may influence or prevent effective HH, and views about different HH
78 approaches, including the use of the Glo-yo or Video.

79 ***Statistical analysis***

80 The data were analysed using SPSS statistic software (IBM SPSS statistic v. 21) and
81 GraphPad Prism6. HHC rates composed of simple frequency counts and Chi-square
82 tests. The questionnaire responses were collated in categories inherent in the questions
83 themselves, compared using simple frequency counts and grouped into themes.

84

85 **Results**

86 **Baseline**

87 A total of 525 HH opportunities of patients and visitors were monitored, and the overall
88 compliance rate was 157/525 (30%, Table IA: proportion complied). HHC was low,
89 particularly for children (10%). This rate was significantly different from that of their visitors
90 (26%: $P < 0.05$). There was also a significant difference in HHC dependent on the moment
91 of HH, irrespective of whether they were children or visitors ($P < 0.001$). The lowest level of
92 compliance was observed after contact with patient surroundings (13%), and the highest
93 was after exposure to body fluid (100%). Similarly, HHC of patients and visitors depended
94 on the ward that they were on ($P = 0.31$) and were significantly different dependent on the
95 time of day ($P < 0.001$).

96 ***Post intervention phase***

97 1437 HH opportunities were observed. HHC increased by 24.4% compared to the baseline
98 phase, and was significantly different between (i) children and visitors ($P < 0.01$), (ii) the
99 moments of contact providing the opportunity, (iii) the type of paediatric ward observed, and
100 (iv) the intervention used ($P < 0.001$) (Table IB). The higher HHC in the afternoon shift was
101 not significantly different from the morning shift ($P = 0.29$). HHC of patients and visitors in
102 both intervention groups (but not the control group) was significantly different to the baseline
103 phase HHC ($P < 0.001$). The control group had similar HHC during the intervention phase
104 (30.1%) compared to the baseline (32.3%). Interestingly HHC improvement was greatest
105 after the intervention session using the Glo-yo, and this was a statistically significantly
106 difference ($P < 0.001$).

107

108 ***The intervention session was successful at raising awareness of the importance of***
109 ***Handwashing***

110 Of the 62 children and visitors approached, 31 agreed to participate in the educational
111 intervention. The Glo-yo group included 16/31 (51.6%) of the participants (9/16 were
112 patients). The Video group included 7/31 (22.5%) of the participants (5/7 patients). The
113 control group included 8/31 (25.8%) of the participants (1/8 patients) (who only had access
114 to HHC leaflets). All children were given a questionnaire to complete to determine their
115 perception of the intervention session.

116 Children reported that the educational interventions raised their awareness of hand hygiene,
117 with the Glo-yo intervention prompting a higher proportion of the participants to indicate that
118 they strongly agreed with this (Figure 1).

119

120 ***The intervention session helped increase children's knowledge and understanding of***
121 ***germs and handwashing***

122 The questionnaire sought participant feedback on; A. why we wash our hands, B. germs
123 and bacteria, C. when to wash hands, and D. parts of hands that are difficult to wash. The
124 answers varied between intervention and subcategory of question. The Glo-yo intervention
125 group agreed strongly with respect to all question subcategories (Figure 2).

126 Almost two thirds of participants in the Glo-yo and MLT intervention groups strongly agreed
127 that the session and both training aids focused on why we wash our hands (62.5% and
128 71.4%), but 100% of the control group merely agreed with this (Figure 2a). When asked
129 about whether the intervention increased knowledge about bacteria and germs, 33.3% of
130 the participants in the Glo-yo group highly agreed and 100% of the Video group agreed,
131 which contrasted with the control group, who were 100% neutral on this point (Figure 2a).
132 When the participants considered whether the intervention sessions dealt with when to wash

133 hands, 88% of the Glo-yo group strongly agreed, whereas 71% of the Video group and 88%
134 of control group were neutral (Figure 2c). Finally, when asked whether the intervention
135 session increased the knowledge and understanding of the parts of hands that are difficult
136 to wash, 69% of the Glo-yo group, 43% of the Video group and only 13% of the control group
137 strongly agreed. Indeed, a small proportion of the participants of the Video and controls
138 disagreed with this (Figure 2d).

139

140 ***The session improved children's handwashing even for one day***

141 Due to the limited time that patients spend in hospital, and because the session was only
142 performed once with each participant, the final part of the questionnaire aimed to determine
143 whether a single intervention session could improve handwashing even for one day. More
144 than half of the Glo-yo group strongly agreed 56% whilst the participants of the other
145 intervention groups were less convinced (Figure 3).

146

147 **Discussion**

148 Studies focusing on the HHC of patients and visitors in healthcare settings are limited (Buet
149 et al., 2013). However, previous studies have reported an increase in HHC after educational
150 intervention (McGuckin et al., 1999; Chen and Chiang, 2007; Fishbein et al., 2011).

151 Children and visitors had the highest level of compliance 'after exposure to their own body
152 fluids which has previously been identified (Randle et al., 2010) This may be as a result of
153 self-protection, or due to emotional sensations including feelings of unpleasantness,
154 discomfort and/or disgust (Whitby et al., 2007). The lowest compliance was found for the
155 moment 'after contact with patient surroundings'. This increased after intervention by 45%
156 to reach 58.3%. Although this is considered a low compliance rate, it is significantly higher

157 than recent data (Randle et al., 2013), and it is important as near touch sites pose the highest
158 risk to patients, especially those in close and direct contact with patients (Dancer, 2009).
159 Another high increase in HHC was observed 'after contact with patients'. This was mainly
160 observed in visitors, increasing from 23.7% to 70.8%, to reach a level >20% higher than
161 previous observational studies (Randle et al., 2010). No study was found that looked at HHC
162 of patients before a meal, in this study it was observed that compliance at this opportunity
163 at the intervention phase was as high as 65 %.

164 This study indicates that HHC is better than previously reported, and provides evidence of
165 a significant increase in HHC during intervention ($P < 0.001$). The Glo-yo session proved
166 the most successful intervention and was able to raise awareness of the importance of HH,
167 with parents strongly agreeing that the Glo-yo session will improve their child's hand
168 washing. This aligns with previous research indicating educational and psychological
169 programmes integrating tangible materials and images of the subject to be learnt can
170 improve motivation and learning with the added benefit of long term behavioural change
171 (Bairaktarova et al., 2011; Worthington et al., 2001; Ho et al., 2009).

172

173 **Acknowledgements**

174 Thanks to: ward managers and the clinical lead for children's services at Nottingham
175 University Hospitals Trust, healthcare workers, children and their families.

176 The Authors declares that there is no conflict of interest.

177

178 **References**

179 Bairaktarova D, Evangelou D, Bagiati A, et al. (2011) Early Engineering in Young Children's
180 Exploratory Play with Tangible Materials. *Children, Youth and Environments* 21: 212-235.

- 181 Buet A, Cohen B, Marine M, et al. (2013) Hand Hygiene Opportunities in Pediatric Extended Care
182 Facilities. *Journal of Pediatric Nursing-Nursing Care of Children & Families* 28: 72-76.
- 183 Chen YC and Chiang LC. (2007) Effectiveness of hand-washing teaching programs for families of
184 children in paediatric intensive care units. *Journal of Clinical Nursing* 16: 1173-1179.
- 185 Dancer SJ. (2009) The role of environmental cleaning in the control of hospital-acquired infection.
186 *Journal of Hospital Infection* 73: 378-385.
- 187 Fishbein AB, Tellez I, Lin H, et al. (2011) Glow Gel Hand Washing in the Waiting Room: A Novel
188 Approach to Improving Hand Hygiene Education. *Infection Control and Hospital
189 Epidemiology* 32: 661-666.
- 190 Gould DJ, Moralejo D, Drey N, et al. (2017) Interventions to improve hand hygiene compliance in
191 patient care. *Cochrane Database of Systematic Reviews*.
- 192 Ho JH, Zhou SZ, Wei D, et al. (2009) Investigating the Effects of Educational Game with Wii Remote
193 on Outcomes of Learning. In: Pan Z, Cheok AD, Muller W, et al. (eds) *Transactions on
194 Edutainment Iii*. 240-252.
- 195 McGuckin M, Waterman R, Porten L, et al. (1999) Patient education model for increasing
196 handwashing compliance. *American Journal of Infection Control* 27: 309-314.
- 197 Munoz-Price LS, Birnbach DJ, Lubarsky DA, et al. (2012) Decreasing Operating Room
198 Environmental Pathogen Contamination through Improved Cleaning Practice. *Infection
199 Control and Hospital Epidemiology* 33: 897-904.
- 200 Naikoba S and Hayward A. (2001) The effectiveness of interventions aimed at increasing
201 handwashing in healthcare workers - a systematic review. *Journal of Hospital Infection* 47:
202 173-180.
- 203 NICE. (2017) Healthcare-associated infections: prevention and control in primary and community
204 care. NICE Guidance.
- 205 Randle J, Arthur A and Vaughan N. (2010) Twenty-four-hour observational study of hospital hand
206 hygiene compliance. *Journal of Hospital Infection* 76: 252-255.
- 207 Randle J, Firth J and Vaughan N. (2013) An observational study of hand hygiene compliance in
208 paediatric wards. *Journal of Clinical Nursing* 22: 2586-2592.
- 209 Snow M, White GL and Kim HS. (2008) Inexpensive and time-efficient hand hygiene interventions
210 increase elementary school children's hand hygiene rates. *Journal of School Health* 78: 230-
211 233.
- 212 Stein C, Kuchenmuller T, Hendrickx S, et al. (2007) The Global Burden of Disease Assessments -
213 WHO Is Responsible? *Plos Neglected Tropical Diseases* 1.
- 214 Whitby M, Pessoa-Silva CL, McLaws M, et al. (2007) Behavioural considerations for hand hygiene
215 practices: the basic building blocks. *Journal of Hospital Infection* 65: 1-8.
- 216 Willmott M, Nicholson A, Busse H, et al. (2016) Effectiveness of hand hygiene interventions in
217 reducing illness absence among children in educational settings: a systematic review and
218 meta-analysis. *Archives of Disease in Childhood* 101: 42-50.
- 219 Worthington HV, Hill KB, Mooney J, et al. (2001) A cluster randomized controlled trial of a dental
220 health education program for 10-year-old children. *Journal of Public Health Dentistry* 61: 22-
221 27.
- 222

224 **Figure legends**

225 **Figure 1. Participant feedback indicated that interactive sessions raised their**
226 **awareness of the importance of Handwashing.**
227

228 **Figure 2. Participants agreed that the intervention sessions helped increase**
229 **children's knowledge and understanding of germs and handwashing.** The responses
230 to the second question on the questionnaire are shown ('The session helped increase your
231 child's knowledge/understanding of the following:').

232

233 **Figure 3. Participants agreed that the intervention sessions would be effective in**
234 **improving children's handwashing even for one day, with the strongest positive**
235 **response being for the Glo-yo intervention.**

236

237 **Table 1. A χ^2 -Test of difference in proportions of opportunities adhered to, across**
238 **levels of variable. Left Column (A) shows the baseline data and right Column (B) the**
239 **intervention (intermidate phase data)**

240 *significant)P < 0.05)

241 **highly significant (P < 0.001)

242

243 **Table 2. Participant comments in response to two of the questions on the**
244 **questionnaire.**

245

246 **Supplementary Material:**

247 **Supplementary Figure A. An outline of the study**

248 **Supplementary Figure B. Glo-yo interactive educational toy.**

249 **Supplementary Figure C. The leaflet distributed in the control group**

250 **Supplementary Table A. Comparative description of the training aids used in the**
251 **intervention phase of the trial.**

252

Q1. The Session was successful at raising awareness of the importance of Handwashing

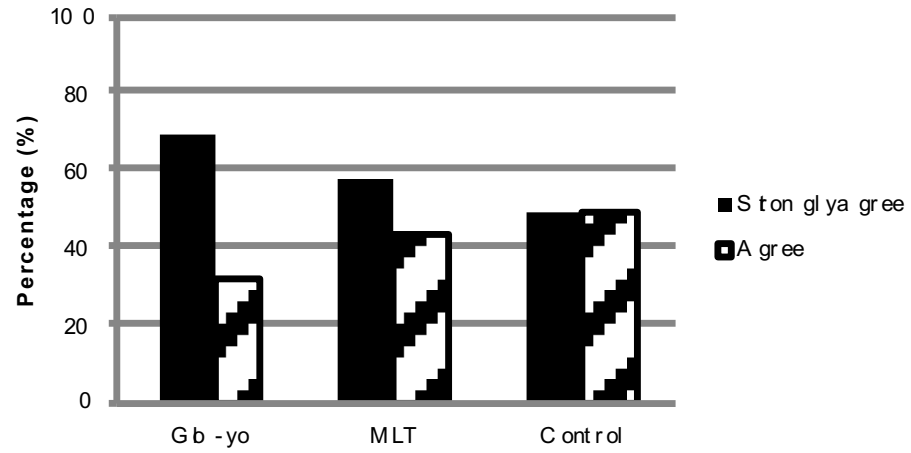


Figure 1

Q2. The session helped increase your child's knowledge/understanding of the following:

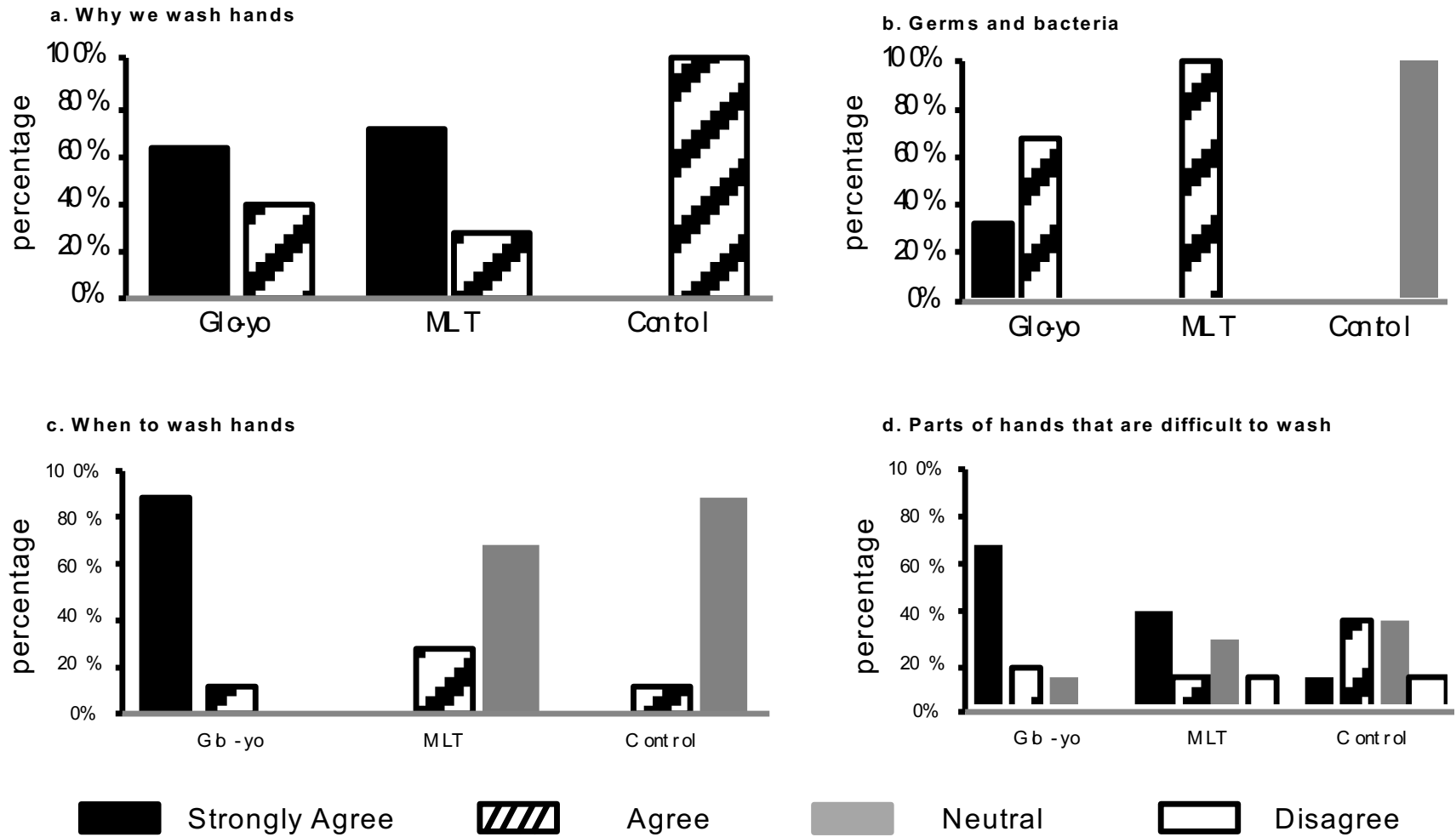


Figure 2

Q3. Do you think the session will improve children's handwashing even if for one day?

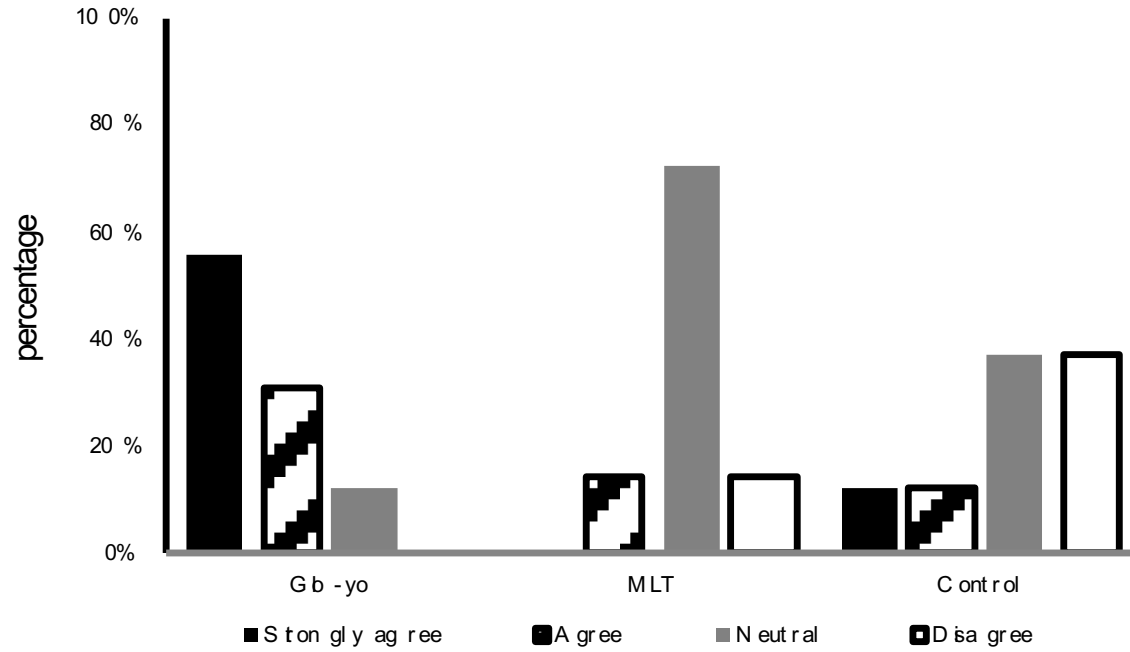


Figure 3

Variable	A. Baseline					B. Intervention				
	No. (%)	Proportion	Proportion		<i>P</i> -value ^a	No. (%)	Proportion	Proportion		<i>P</i> -value ^a
	A. Patients and visitors (N= 525)					B. Patients and Visitors (N= 1437)				
Patients	33	(6.3)	3/33	(9.9)	<0.05*	228	(15.9)	93/228	(40.8)	<0.5
Visitors	492	(93.7)	127/492	(25.8)		1209	(84.1)	614/1209	(50.8)	
Ward										
General paediatric	129	(24.6)	25/129	(19.3)	0.31	340	(24.6)	156/340	(45.9)	<0.001**
Surgical ward	96	(18.3)	27/96	(28.1)		319	(20.6)	190/319	(59.6)	
Dialysis and urology	33	(6.3)	5/33	(15.1)		147	(11.6)	85/147	(57.8)	
Oncology	97	(18.5)	29/97	(29.8)		198	(13.5)	95/198	(48.8)	
Neuroscience	119	(22.7)	32/119	(26.8)		198	(15.1)	96/198	(48.5)	
Children's assessment	51	(9.7)	12/51	(23.5)		231	(14.6)	85/231	(36.8)	
Time										
Morning	270	(51.4)	49/270	(18.1)	<0.001**	689	(47.9)	349/689	(60.6)	0.29
Afternoon	255	(48.6)	81/255	(31.7)		748	(52.1)	358/748	(62.3)	
Type of opportunity										
Before patient contact	188	(35.8)	76/188	(40.4)	<0.001**	1943	(47.5)	1136/1943	(58.4)	<0.001**
After body fluid exposure risk	31	(5.9)	31/31	(100)		25	(<1)	24/25	(96)	
After patient contact	122	(23.2)	29/122	(23.7)		1026	(25.1)	726/1026	(70.8)	
After contact with patient surroundings	184	(35)	24/184	(13)		1051	(25.7)	696/1051	(58.3)	
Before meal						43	(1)	28/43	(65.1)	
Intervention Group										
Control	170	(32.3)	44/170	(25.8)	<0.001**	433	(30.1)	181/433	(25.6)	<0.001**
Glo-yo	129	(24.5)	32/129	(24.8)		466	(32.4)	275/466	(59)	
MLT	226	(43)	54/226	(23.8)		538	(37.4)	251/538	(46.7)	

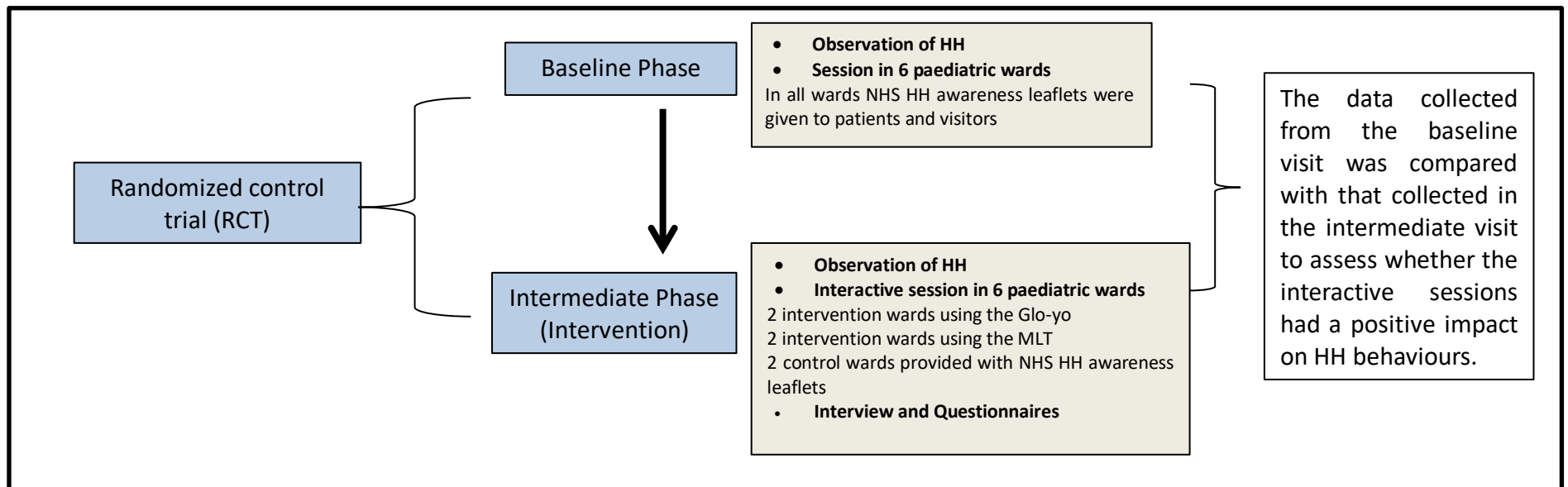
Table 1. A χ^2 -Test of difference in proportions of opportunities adhered to, across levels of variable. Left Column (A) shows the baseline data and right Column (B) the intervention (intermediate phase data)

*significant ($P < 0.05$)

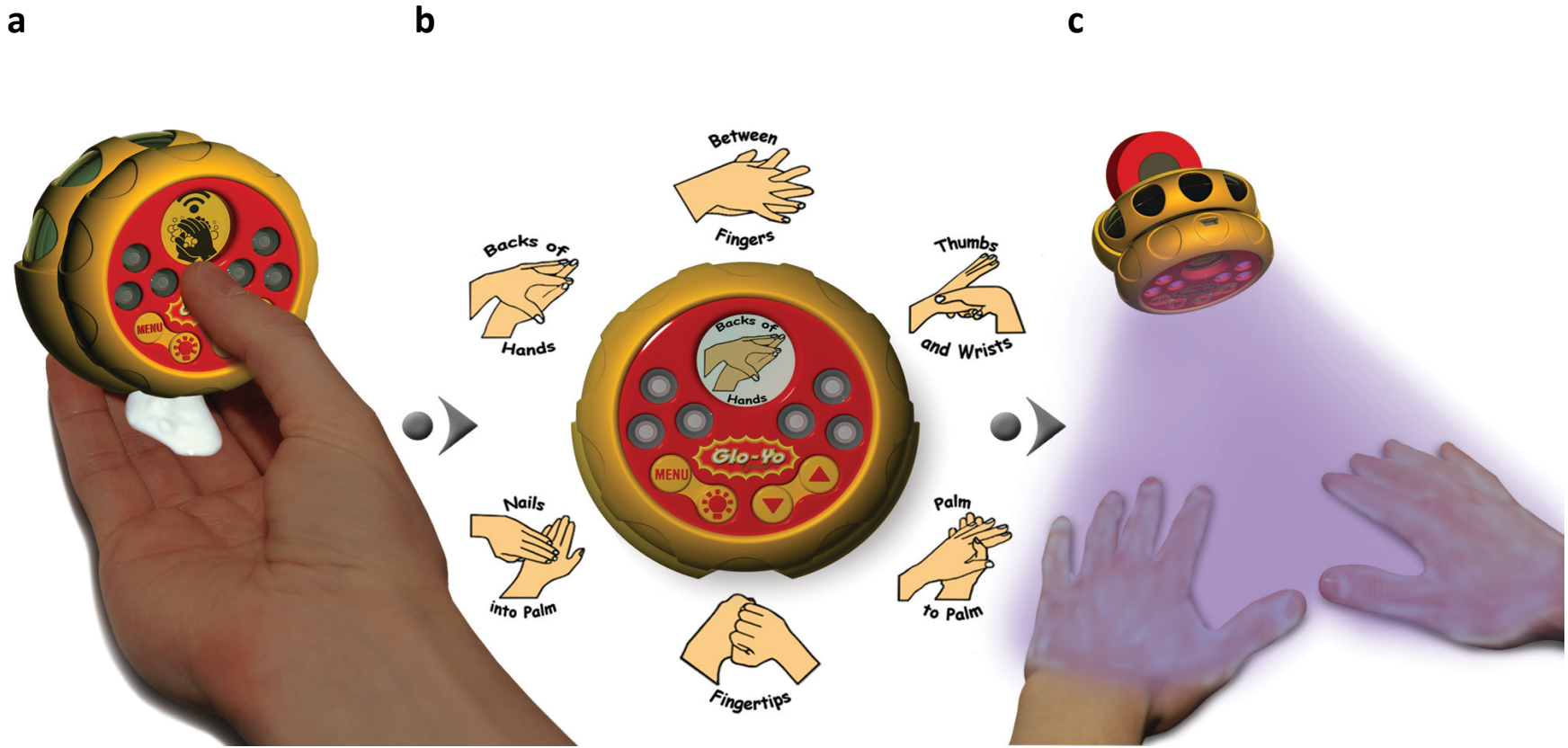
**highly significant ($P < 0.001$)

Intervention group	Comments on the question 'How would they describe the session and the activities carried out by the facilitator?'	Comments on the question 'Would you recommend the sessions to children in schools?'
Glo-yo	<i>'The session is very effective though the time is not enough to explore the new toy (Glo-yo).'</i>	<i>'Strongly agree, schools will be much better to learn about hand washing'</i>
	<i>'I found the session very interesting and very encouraging and very easy task to do.'</i>	<i>'Very interesting would like to have same session in schools'</i>
	<i>'Very helpful, the toy was interesting to use and good way to teach kids hand washing.'</i>	<i>'Mum found it interesting and very worthwhile. I would recommend it to school children. My daughter found it interesting'</i>
		<i>'I would recommend the hand wash in schools it will encourage children more to wash hands and be germ free than hospital.'</i>
MLT	<i>'The session in general is encouraging for children to learn about hand washing and germs. The use of phone is not easy for my child to understand'</i>	<i>'For my child was too much information, i enjoyed the video as a parent'</i>
	<i>'The video is too long and not easy to follow by child'</i>	<i>'The session was encouraging!'</i>
	<i>'The video is very complicated for a child to understand. I enjoyed the video as it's easier to follow and understand'</i>	<i>'The session with the facilitator was fun hand washing session was useful. However the phone video is not easy for child to understand'</i>
Control		<i>'Session was helpful in understanding when to wash hands, and how, will recommend for school children'</i>
		<i>'Helpful session should be more practical to apply in schools'</i>

Table 2. Participant comments in response to two of the questions on the questionnaire.



Supplementary Figure A.



Supplementary Figure B. Glo-yo interactive educational toy. (a) handheld Glo-yo, (b) 6 images of the HHC steps displayed on the screen during 20 seconds, (c) UV lights illuminate the iridescent cream on hands as a way to assess the effectiveness of HHC [14].

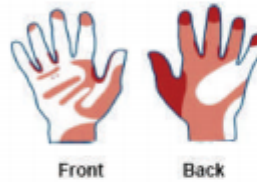
Hand Hygiene

“Hand Washing is the single most important method of preventing and controlling infection.”

Health Protection Agency

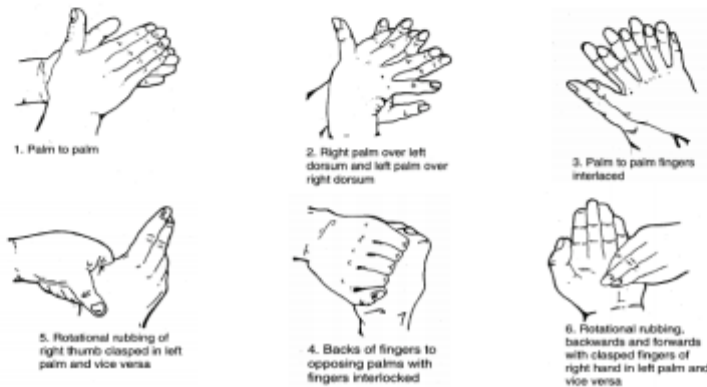
To try to minimise the impact of infections in hospitals it is important that all staff, visitors and patients wash their hands on a regular basis.

Studies have shown that when people wash their hands there are areas that are regularly missed, these are shown by the red areas on the picture opposite. To try to prevent this it is recommended, that, when washing your hands you use the six step process outlined below.



Whilst hand washing is the most effective method of preventing hospital acquired infections it is recognised that access to a hand wash basin is not always easy, in these cases use of alcohol hand sanitiser may be used instead. Again it is recommended that the same six step process should be used.

If you see others not washing their hands, politely ask them to do so!



	Description	Reference/Link
Glo-yo	The Glo-yo is an interactive toy that helps children learn how to wash their hands better. The toy was designed by an undergraduate engineering student, with the help of school children. The device has a UV light and LDS screen which presents the optimal handwashing regime, timed over 20 seconds as the WHO recommendation for HHC.	http://glo-yo.co.uk/ [14]
MLT	A video aimed to patients, visitors and HCWs presents the importance of hand hygiene, and the appropriate steps that can reduce the spread of HCAI between patients, visitors and HCWs. The video covers the following: Preventing the spread of germs, when you should clean your hands and hand washing techniques. It was shown to the people on a mobile phone.	The video was produced for the use in hospital and healthcare centres in Nottingham University NHS Trust. Content authors Jacqueline Randle, Heather Wharrad and Richard Windle of the University of Nottingham and Natalie Vaughn of the NHS. Technical development was by Peter Cook (Video) and Fred (Web). http://www.nottingham.ac.uk/nmp/sonet/rlos/placs/cleanyourhands/
HH Leaflet	A patient care leaflet that presents the important steps of HH to prevent and control infection.	Supplementary Figure B

Supplementary Table A. Description of the Glo-yo, MLT and leaflet used for the RCT.