



AUTHOR(S):

TITLE:

YEAR:

Publisher citation:

OpenAIR citation:

Publisher copyright statement:

This is the _____ version of an article originally published by _____
in _____
(ISSN _____; eISSN _____).

OpenAIR takedown statement:

Section 6 of the "Repository policy for OpenAIR @ RGU" (available from <http://www.rgu.ac.uk/staff-and-current-students/library/library-policies/repository-policies>) provides guidance on the criteria under which RGU will consider withdrawing material from OpenAIR. If you believe that this item is subject to any of these criteria, or for any other reason should not be held on OpenAIR, then please contact openair-help@rgu.ac.uk with the details of the item and the nature of your complaint.

This publication is distributed under a CC _____ license.

1 **Antimicrobial stewardship activities in hospitals in Ireland and the United Kingdom:**
2 **a comparison of two national surveys.**

3 Aoife Fleming, Antonella Tonna, Si'le O'Connor, Stephen Byrne, Derek Stewart

4 Int J Clin Pharm (2015) 37:776–781

5 **Abstract**

6 Background Best practice guidelines recommend that a multidisciplinary Antimicrobial
7 Management Team (AMT) conduct antimicrobial stewardship (AMS) activities in hospitals. In
8 order to continuously improve AMS activities in Irish hospitals it is important to benchmark
9 performance by comparison with other countries.

10 Objective To compare the membership of AMTs and AMS activities conducted in Irish and
11 United Kingdom (UK) hospitals. Methods A postal questionnaire to determine the
12 membership and activities of AMTs was issued to the specialist antimicrobial pharmacist or
13 pharmacist in charge at all Irish Hospitals and all UK National Health Service Hospitals. The
14 membership of AMTs and the extent of AMS activities conducted were compared between
15 the countries.

16 Results The response rates to the surveys were 73 % (n = 51) in Ireland and 33 % in the UK (n
17 = 273). 57 % of Irish respondents reported having an AMT compared to 82 % in the UK
18 ($p < 0.001$). Significantly more AMTs in the UK had a specialist antimicrobial pharmacist on
19 the team (95 % UK, 69 % Ireland, $p < 0.001$). A higher proportion of Irish respondents
20 reported measuring the overall volume of antimicrobial prescribing (Ireland 85 %, UK 72 %, $p = 0.057$). A higher proportion of UK respondents reported measuring the appropriateness
21 of antimicrobial prescribing (76 % UK, 58 % Ireland, $p = 0.019$) and the appropriateness of
22 restricted antimicrobial prescribing (64 % UK, 52 % Ireland, $p = 0.140$).

24 Conclusion Irish and UK AMTs need to be supported to recruit and retain specialist
25 antimicrobial pharmacists and to achieve higher rates of audit, prescription appropriateness
26 review and feedback activities.

27 Introduction

28 The Strategy for Antimicrobial Resistance in Ireland (SARI) Hospital Antimicrobial Stewardship
29 working group set out clear recommendations to promote rational antimicrobial prescribing
30 in Irish hospitals (1). These included details of the personnel and surveillance activities which
31 should be in place. The role of the specialist antimicrobial pharmacist to optimise
32 antimicrobial prescribing in the hospital setting has been identified, and the recommendation
33 that they need to continue working as an integral member of the Antimicrobial Management
34 Team (AMT) has been well supported by recent studies (2). International research has
35 identified the key role of the specialist antimicrobial pharmacist in the development and
36 implementation of antimicrobial stewardship (AMS) (3). The increasing contribution of
37 specialist antimicrobial pharmacists to obtaining AMS goals in English hospitals has been
38 identified (4). With the recent publication of a five year United Kingdom (UK) antimicrobial
39 resistance strategy, it is ever more important to ensure that the necessary structures
40 (presence of an AMT) are in place to achieve the goals of AMS (5). In order to attain such
41 national strategies, efforts to standardise the AMS strategies in individual settings must be
42 made. The Society for Healthcare Epidemiology of America (SHEA), and the British Society for
43 Antimicrobial Chemotherapy (BSAC), recommend that antimicrobial usage rates between
44 institutions is conducted, or 'bench-marking' as it is commonly known (6). While this primarily
45 addresses the quantifiable consumption of antimicrobials, the importance of comparing the
46 AMT structure and personnel cannot be overlooked and these elements of hospital AMS
47 should also be compared or 'bench-marked'. Irish AMS policy-makers can learn much from
48 the experience of the UK. An important first step is the comparison of Irish hospital AMS
49 structures with those of the UK.

50 In 2011-2012 a questionnaire to determine the profile and activity of AMTs in Ireland and the
51 UK was mailed to hospital specialist antimicrobial pharmacists. The findings of both
52 questionnaires have been previously published (7) (8). The need for a comparative study was
53 identified in order to benchmark AMS activities in Ireland against those in the UK.

54

55

56 Aim

57 The aim of this study was to compare the results of the antimicrobial stewardship in hospitals
58 survey between the UK and Ireland in order to identify any differences in practice that could
59 be addressed in either jurisdiction.

60

61 **Ethical approval**

62 Ethical approval was granted by the Clinical Research Ethics Committee of the Cork Teaching
63 Hospitals, Ireland and the Ethical Review Panel of the School of Pharmacy and Life Sciences,
64 Robert Gordon University, Aberdeen, UK.

65 **Methods**

66 A postal questionnaire was issued to the specialist antimicrobial pharmacist or pharmacist in
67 charge in all Irish Hospitals (n= 70, March – April 2012) and all UK National Health Service
68 (NHS) Hospitals (n=836, November 2011 - January 2012). Two reminders were issued at two-
69 weekly intervals. The Irish questionnaire was sent out after the UK questionnaire as ethical
70 approval was received slightly later, in March 2012. The questionnaires had key questions in
71 common and findings from these questions formed the basis for this comparative study.
72 Details on the development of this questionnaire have already been published (8). The
73 questionnaire was reviewed for face and content validity by one consultant physician
74 specialising in infectious diseases and seven specialist antimicrobial pharmacists (8). The
75 questionnaire was piloted by sending it to 30 hospitals in the UK and minor modifications
76 were made post piloting. Further minor modifications were made to the questionnaire for
77 use in the Irish context, including changing the references to Irish policy and guideline sources
78 (7). The first section of the questionnaire had questions relating to the AMT and AMS
79 strategies. The second section collected details regarding hospital demographics. There were
80 also some open questions to collect feedback from respondents and to gather their views on
81 key emerging issues around hospital AMS.

82 The results of both surveys were compared using Chi-squared tests to test categorical
83 variables and the association between proportions using StataCorp. 2011 *Stata Statistical*
84 *Software: Release 12*. College Station, TX: StataCorp LP. *P* values of ≤ 0.05 are considered
85 statistically significant. Responses to the open questions were analysed to extract the main

86 issues or themes emerging and to identify different perspectives between Irish and UK
87 respondents.

88 **Results**

89 The responses from 226 completed questionnaires in the UK study (32.7% response) and from
90 51 questionnaires in the Irish study (73% response rate) were included in this analysis. In the
91 Irish survey, 15 private and 36 public hospitals responded. The hospital bed size ranged from
92 <100 bed (24%), 100-249 (36%), 250-499 (30%) and >500 bed (10%). In the UK survey, all
93 surveys were sent to NHS hospitals and bed size ranged from <500 (47.3%), 501-999 (31.4%),
94 1000-1499 (13.7%) and >1500 (4.4%). The presence of an AMT and the membership profile is
95 outlined in Table 1. Significantly more UK hospitals had an AMT and had a specialist
96 antimicrobial pharmacist as a member of the AMT.

97 In some cases respondents did not, or were unable to answer certain questions, hence leading
98 to a varying total response for these questions.

99 Hospital antimicrobial prescribing policy:

100 Irish hospitals were less likely to have an antimicrobial prescribing policy in place ($p = 0.001$)
101 than UK hospitals, (Ireland 88% (45/51), UK 98% (222/226)). Respondents in the UK and
102 Ireland reported no significant difference in the overall aims of the policy; the majority of
103 AMTs promoted the appropriate prescribing of antimicrobials, promoted the use of narrow
104 spectrum rather than broad spectrum antimicrobials, and encouraged microbiological
105 investigation and rationalisation, as well as reducing multi-drug resistant infections ($p > 0.05$
106 for all). In terms of the content of the policy, the top three areas included were the same (1.
107 Empirical treatment of common infections, 2. Surgical prophylaxis 3. Gentamicin protocol).
108 Responses indicated that significantly more Irish policies contained Surgical prophylaxis ($p =$
109 0.014) and significantly more UK policies (UK 32% (70/222), Ireland 4% (2/45)) contained an
110 automatic 'Stop Order' for certain antimicrobials ($p < 0.001$). Table 2 outlines the methods of
111 dissemination of the antimicrobial prescribing policy, with more Irish hospitals using mobile
112 phone technology and more UK hospitals using the hospital intranet.

114 Monitoring adherence to the antimicrobial prescribing policy:

115 Approximately the same proportion of respondents in both countries reported that the
116 volume of antimicrobials prescribed was monitored (Table 3). The appropriateness of
117 antimicrobial use against the local policy was monitored by more UK hospitals (76%) than Irish
118 hospitals (58%) ($p < 0.001$). The main method for monitoring antimicrobial prescribing was
119 different between the two countries with a higher proportion of Irish hospitals monitoring
120 the volume of prescribing and a higher proportion of UK hospitals reporting that audits
121 measuring appropriateness to the policy are conducted. A difference was found between
122 Ireland and UK in the reported auditing of restricted antimicrobials, with the UK respondents
123 reporting more activity, but this was not statistically significant.

124

125 Feedback on antimicrobial resistance patterns was provided to prescribers in 29% (66/226)
126 of UK hospitals and 33% (17/51) of Irish hospitals ($p = 0.56$). Only 29% (15/51) of Irish
127 respondents reported providing feedback to ward teams about antimicrobial prescribing
128 compared to 62% (138/222) UK hospitals ($p < 0.001$). Feedback to individual doctors on their
129 antimicrobial prescribing was not conducted extensively by either group of respondents (UK
130 33% 74/222, Ireland 25% 13/51, $p = 0.278$). Feedback comparing aspects of antimicrobial
131 prescribing with similar institutions was reported as being conducted in 24% of both UK
132 (53/222) and Irish (12/51) hospitals.

133

134 Key strategic issues:

135 There was one open question for respondents to add their opinions about the key strategic
136 issues. This question was not answered by all participants but some interesting and pertinent
137 points regarding the future of AMS in both jurisdictions were raised. It was very evident in the
138 UK comments that AMS varied between hospitals with different strategies and different levels
139 of progress in place.

140 *“Locally we need to finalise guidelines and then begin to develop our audit and feedback*
141 *processes.” (UK)*

142 *“I think we have a comprehensive antimicrobial stewardship which was identified by the*
143 *SHA as a role model in the South East and I can see the main key strategy is to make*
144 *sure all the trusts know how to implement DoH Guidelines...”(UK)*

145 (SHA = Strategic Healthcare Authority, DoH = Department of Health)

146 In the UK, one very common point raised was the belief that the introduction of e-prescribing
147 would improve antimicrobial surveillance and auditing, and therefore may improve the
148 appropriate prescribing of antimicrobials.

149 *“Electronic prescribing would make monitoring much easier and feedback immediate*
150 *and effective in changing prescribing patterns” (UK)*

151 In the Irish survey responses some of the key issues raised were in relation to a lack of
152 resources and personnel to conduct AMS.

153 *“Despite repeated attempts to put an Antimicrobial Stewardship team in place it has not*
154 *happened. We need a Microbiologist to push things forward.” (Ireland)*

155 *“It will be difficult to progress programs without ring-fencing of resources needed to*
156 *implement and develop antibiotic programmes.” (Ireland)*

157

158 The other main issue raised by respondents from the UK and Ireland was the threat and
159 challenge of antimicrobial resistance. Several respondents noted that AMS strategies need to
160 focus on the management of serious infections such as Extended Spectrum Beta-lactamase
161 infections, Carbapenem Resistant and Vancomycin Resistant infections.

162 *“Meeting the challenge posed by emergent multidrug resistant organisms e.g.*
163 *carbapenem resistant enterococci, in the face of the paucity of new classes of*
164 *antimicrobial agents.” (Ireland)*

165 *“Targeting and interventions to reduce carbapenemase producing organisms e.g.*
166 *carbapenem review rounds to rationalise empiric use of carbapenems”* (UK)

167 *“Monitoring ESBL and VRE organisms.”* (UK).

168

169 Discussion

170 This comparison of the results of two nationwide surveys of AMS in UK and Irish hospitals has
171 provided very important information regarding the differences between AMS in both
172 jurisdictions. A key difference noted was the significantly lower number of Irish hospitals with
173 an AMT at the time of the questionnaire, and the lower number of Irish AMTs with a specialist
174 antimicrobial pharmacist. Fewer Irish hospitals had an antimicrobial prescribing policy, but
175 the content of the policies between Ireland and the UK were similar. It was encouraging to
176 see that most hospitals in the UK and Ireland measured the volume of antimicrobials
177 prescribed. However, a lower proportion of Irish hospitals reported auditing activities with a
178 higher proportion of UK hospitals conducting audits of adherence to the antimicrobial
179 prescribing policy. This may be attributed to a higher presence of AMT in the hospitals
180 included or the higher proportion of AMT with a specialist antimicrobial pharmacist on board.
181 Areas for improvement in both countries were also identified with hospitals not reporting on
182 antimicrobial resistance to hospital doctors extensively. Irish hospitals were less likely to
183 provide feedback to ward teams on their prescribing patterns.

184 The lack of financial resources to support optimum AMS development in Irish hospitals was
185 raised by many respondents. This is at odds with recent recommendations by SARI and the
186 Health Information and Quality Authority who have recommended that multidisciplinary
187 teams should be in place in hospitals, along with antimicrobial pharmacy services, to
188 implement AMS activities (1, 9). Recent economic circumstances in Ireland have resulted in
189 financial restrictions in many areas of healthcare and one area affected has been recruitment
190 of staff in the Health Service Executive. Pharmacists have played a key role internationally in
191 driving AMS activities in the hospital setting (4). Support for the role of specialist antimicrobial
192 pharmacists was influenced largely by the provision of funds in the years around 2003 to 2006
193 from the Departments of Health in the UK and Ireland to support these roles (1, 4). At this
194 basic level of policy implementation it is unfortunate to find that the results of this

195 comparative study indicate that Irish hospitals had fewer goals achieved than UK hospitals.
196 Advances in policy have moved beyond the basic recommendations for AMTs to such
197 strategies as the implementation of care bundles such as the *“Start Smart – then Focus”*
198 bundle (10). Irish hospitals must ensure that they meet the basic requirements in order to
199 stay abreast of new developments and opportunities to improve patient safety through AMS.
200 But the nature of AMS activities requires much time and effort on the part of the AMT
201 members to extract, analyse and feedback antimicrobial consumption data (11). A key
202 difference noted by this study was that more UK hospitals conducted audits of antimicrobial
203 prescribing than Irish hospitals. Antimicrobial prescribing analysis can monitor antimicrobial
204 consumption (volume of prescribing) and antimicrobial prescribing appropriateness (by
205 comparing actual prescribing trends with the locally antimicrobial prescribing policy) (1). The
206 SARI guidelines for AMS in hospitals in Ireland recommend audit activities such as reviewing
207 surgical antibiotic prophylaxis, audits of therapeutic drug monitoring for the likes of
208 vancomycin/gentamicin and audits investigating parenteral to oral antibiotic conversion (1).
209 Antimicrobial prescribing audits are necessary to obtain local information regarding the
210 quality of antimicrobial prescribing (e.g. audit of surgical antibiotic prophylaxis). Hospital
211 AMTs and specialist antimicrobial pharmacists are vital to ensure the continued
212 implementation and development of these antimicrobial prescribing audits.

213 The consumption of hospital antimicrobial usage in Ireland is monitored by the Health
214 Protection Surveillance Centre and recent reports of public hospital consumption indicated
215 an increase from 2007 (77.2 Defined Daily Doses per 100 Bed Days) to 2013 (84.4 Defined
216 Daily Doses per 100 Bed Days) (12). In England, the recent ESPAUR report 2014 highlighted
217 that antimicrobial consumption in the hospital sector increased by 11% between 2010 and
218 2013 (DDD per 100 admissions) (13). This data indicates increasing trends in antimicrobial
219 prescribing in UK and Irish hospitals. These trends must be investigated, and in order to target
220 the increase in consumption, antimicrobial prescribing audits are required.

221 In an effort to improve and standardise AMS initiatives it is first necessary to achieve a more
222 uniform playing field, with more Irish hospitals needing AMT and dedicated specialist
223 antimicrobial pharmacists to conduct AMS audit activities. With recent advances in the area
224 of information technology (e.g. smartphone availability and antimicrobial prescribing

225 applications), auditing and access to policies is improving all the time. Several applications
226 have been developed and implemented in Ireland to support the dissemination and use of
227 antimicrobial prescribing guidelines. The MicroGuide® application is used in many NHS trusts
228 in the UK (14). The development of such AMS initiatives will no doubt improve access to
229 antimicrobial prescribing guidelines and future surveys investigating AMT activities should
230 investigate the impact of these developments on improving the appropriateness of
231 antimicrobial prescribing.

232 A limitation of this study is that it relies on respondents' self-reported data and knowledge
233 which may lead to response bias and reduced generalisability. While there was an incomplete
234 response rate, the results are important as responses were received from a representative
235 sample of the overall hospital population. Hospitals of varying size, and varying funding
236 category in Ireland, responded. While the questionnaires were sent out in the UK and Ireland
237 at different time points, they were sent within four months of each other and this is unlikely
238 to impact on the findings. The lower response rate in the UK may have an effect on the
239 representativeness of the findings. A comparison of publicly versus privately funded hospitals
240 was not possible as the UK sample included NHS hospitals only. Some questions were not
241 answered by all respondents or else they were unable to answer, this reduced the
242 completeness of the responses to the overall response rate. The open question asking
243 respondents about key strategic issues was not answered by all participants.

244 This investigation has provided valuable information for Irish hospitals by comparing their
245 AMS activities to UK hospitals. While the results from the UK are quite encouraging, the
246 implementation of AMS in Irish hospitals needs to be prioritised. The recommendations from
247 the SARI Guidelines in Ireland need to be readdressed as the fundamental requirements for
248 AMS, the presence of a team with a specialist antimicrobial pharmacist and auditing of
249 antimicrobial prescribing appropriateness, are not yet widespread in Irish hospitals. Support
250 for AMTs to conduct audits of antimicrobial prescribing, and commitment from the highest
251 levels of hospital administration, must be secured to facilitate this activity in all hospitals (11).
252 If the outputs of antimicrobial prescribing are not being measured, there is little evidence
253 with which to motivate prescribers to change their antimicrobial prescribing practices.
254 Important lessons for AMS can be learned in Ireland by bench-marking against UK AMS

255 strategies. The future collection and analysis of hospital AMT and AMS activities, if conducted
256 centrally by the respective departments of health or national AMS task force groups, is
257 recommended. This questionnaire should be repeated in the future to capture further
258 information on the development and comparison of AMS over the coming years, especially
259 examining the impact of advances in information technology.

260 **Conclusion**

261 This comparative study has identified significant differences in AMS strategies between Irish
262 and UK hospitals. UK hospitals are more likely to have a specialist antimicrobial pharmacist
263 on the AMT and are more likely to conduct audits of the appropriateness of antimicrobials
264 and restricted antimicrobials. The absence of specialist antimicrobial pharmacists on the Irish
265 AMTs may be leading to reduced AMS activities. In order to promote antimicrobial
266 stewardship in Irish hospitals, Irish AMTs need to be supported to recruit and retain specialist
267 antimicrobial pharmacists and to achieve higher rates of audit and feedback activities.

268 **Acknowledgements**

269 The authoring team would like to acknowledge the participation of all respondents to the
270 survey.

271 **Funding**

272 The first author is funded by the Health Research Board in Ireland under the Scholars
273 Programme in Health Services Research Grant No. PHD/2007/16.

274 **Conflicts of interest**

275 There are no conflicts of interest to declare.

276

277 **Table 1. Presence and membership profile of the Antimicrobial Management Team.**

	Ireland	UK	
Presence of an AMT	57% (29/51)	82% (186/226)	p ≤ 0.001*
Specialist antimicrobial pharmacist on the AMT	69% (20/29)	95% (177/186)	p < 0.001*
Consultant in infectious diseases [‡] on the AMT	24% (7/29)	67% (97/145)	p < 0.001*
Infection control manager on the AMT	55% (16/29)	60.2% (112/186)	p = 0.007*

Consultant surgeon on the AMT	24% (7/39)	45% (59/130)	p = 0.002*
Consultant microbiologist on the AMT	93% (27/29)	97% (180/186)	p = 0.331
AMT & microbiology department in the hospital	47% (24/51)	71% (159/224)	p = 0.001*

278 ‡Consultant in infectious diseases: a doctor who specialises in the diagnosis and treatment of
 279 infectious diseases. (*= statistical significance)

280 Table 2. Dissemination of the antimicrobial prescribing policy.

Activity	Ireland	UK	
Dissemination of the antimicrobial prescribing policy by mobile phone	20% (9/45)	7% (16/229)	p = 0.006*
Antimicrobial prescribing policy updates communicated via the intranet	64% (29/45)	92% (205/229)	p < 0.001*
Antimicrobial prescribing policy updates communicated by contact with other healthcare professionals (e.g. pharmacists)	60% (27/45)	71% (158/222)	p = 0.139

281 (*= statistical significance)

282 Table 3. Comparison of audit activities to monitor antimicrobial prescribing.

Activity	Ireland	UK	
Monitor volume of antimicrobial prescribing	86% (36/42)	73% (162/222)	p = 0.080
Audit all antimicrobial prescribing against policy	58% (24/41)	76% (169/222)	p = 0.019
Audit restricted antimicrobial prescribing	52% (22/42)	65% (143/222)	p = 0.140

283

284

285 References:

- 286 1. SARI Hospital antimicrobial stewardship working group. Guidelines for antimicrobial
 287 stewardship in hospitals in Ireland. Health Service Executive, Health protection surveillance
 288 centre, 2009. Report No.978-0-9551236-7-2.
- 289 2. American Society of Health System Pharmacists. ASHP statement on the pharmacist's
 290 role in antimicrobial stewardship and infection prevention and control. American journal of

- 291 health-system pharmacy : AJHP : official journal of the American Society of Health-System
292 Pharmacists. 2010;67(7):575-7.
- 293 3. Drew RH. Antimicrobial stewardship programs: how to start and steer a successful
294 program. Journal of managed care pharmacy : JMCP. 2009;15(2 Suppl):S18-23.
- 295 4. Wickens HJ, Farrell S, Ashiru-Oredope DA, Jacklin A, Holmes A. The increasing role of
296 pharmacists in antimicrobial stewardship in English hospitals. The Journal of antimicrobial
297 chemotherapy. 2013;68(11):2675-81.
- 298 5. Department of Health. UK Five year Antimicrobial Resistance Strategy 2013 to 2018.
299 London.2013 [9 October 2014]; Available from:
300 [https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/238872/2](https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/238872/20130902_UK_5_year_AMR_strategy_FINAL.pdf)
301 [0130902_UK_5_year_AMR_strategy_FINAL.pdf](https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/238872/20130902_UK_5_year_AMR_strategy_FINAL.pdf).
- 302 6. Society for Healthcare Epidemiology of America (SHEA), the Infectious Diseases
303 Society of America (IDSA), and the Pediatric Infectious Diseases Society (PIDS). Policy
304 statement on antimicrobial stewardship. Infect Control Hosp Epidemiol. 2012;33(4):322-7.
- 305 7. Fleming A, Tonna A, O'Connor S, Byrne S, Stewart D. A cross-sectional survey of the
306 profile and activities of Antimicrobial Management Teams in Irish Hospitals. International
307 journal of clinical pharmacy. 2014;36(2):377-83.
- 308 8. Tonna AP, Gould IM, Stewart D. A cross-sectional survey of antimicrobial stewardship
309 strategies in UK hospitals. Journal of clinical pharmacy and therapeutics. 2014;39(5):516-20.
- 310 9. Health Information and Quality Authority. National Standards for the Prevention and
311 Control of Healthcare Associated Infection. 2009 [9 October 2014]; Available from:
312 http://www.hiqa.ie/system/files/National_Standards_Prevention_Control_Infections.pdf.
- 313 10. Department of Health's Advisory Committee on Antimicrobial Resistance and
314 Healthcare Associated Infection (ARHAI). Antimicrobial Stewardship: "Start Smart - then
315 Focus". 2011 [9 October 2014]; Available from:
316 [https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/215308/d](https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/215308/dh_131181.pdf)
317 [h_131181.pdf](https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/215308/dh_131181.pdf).
- 318 11. MacDougall C, Polk RE. Antimicrobial stewardship programs in health care systems.
319 Clin Microbiol Rev. 2005;18(4):638-56.
- 320 12. Health Protection Surveillance Centre. Hospital Antimicrobial Consumption
321 Surveillance. Ireland: HPSC; 2014 [3 December 2014]; Available from: [http://www.hpsc.ie/A-](http://www.hpsc.ie/A-Z/MicrobiologyAntimicrobialResistance/EuropeanSurveillanceofAntimicrobialConsumptionESAC/PublicMicroB/SACHC/Report1.html)
322 [Z/MicrobiologyAntimicrobialResistance/EuropeanSurveillanceofAntimicrobialConsumptionE](http://www.hpsc.ie/A-Z/MicrobiologyAntimicrobialResistance/EuropeanSurveillanceofAntimicrobialConsumptionESAC/PublicMicroB/SACHC/Report1.html)
323 [SAC/PublicMicroB/SACHC/Report1.html](http://www.hpsc.ie/A-Z/MicrobiologyAntimicrobialResistance/EuropeanSurveillanceofAntimicrobialConsumptionESAC/PublicMicroB/SACHC/Report1.html).
- 324 13. Public Health England. English surveillance programme for antimicrobial utilisation
325 and resistance (ESPAUR). London 2014 [9 October 2014]; Available from:
326 [https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/362374/E](https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/362374/ESPAUR_Report_2014_3.pdf)
327 [SPAUR_Report_2014_3.pdf](https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/362374/ESPAUR_Report_2014_3.pdf).
- 328 14. Patient First UK. MicroGuide No.1 Healthcare app in the UK. United Kingdom: Patient
329 First.; 2014 [3 December 2014]; Available from:
330 <http://www.patientfirstuk.com/Press/MicroGuide-No1-Mobile-Healthcare-App-in-the-UK>.

