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1 **An Investigation of antifungal stewardship programmes in England**

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4 Pebody⁷, Rakhee Patel⁸, Phil Howard⁹, Susan Hopkins⁷ on behalf of the English
5 Surveillance Programme for antimicrobial utilisation and resistance (ESPAUR),
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26

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- 28 antifungal management

29 **Abstract**

30 Objectives: To explore the current status of antifungal stewardship (AFS) initiatives
31 across National Health Service (NHS) Trusts within England, the challenges and
32 barriers as well as ways to improve current AFS programmes.

33 Methods: An electronic survey was sent to all 155 acute NHS acute Trusts in
34 England.

35 Results: Forty seven Trusts, corresponding to 30% of English acute Trusts, returned
36 a survey; 46 trusts (98%) had an antimicrobial stewardship (AMS) programme but
37 only 5 (11%) had a dedicated AFS programme. Twenty (43%) Trusts said they
38 included AFS as part of their AMS programmes. From those conducting AFS
39 programmes, 7 (28%) have an AFS/management team, 16 (64%) monitor and report
40 on antifungal usage, 5 (20%) have dedicated AFS ward rounds and 12 (48%) are
41 directly involved in the management of invasive fungal infections.

42 Thirteen acute Trusts (52%) started their AFS programme to manage costs, whilst
43 12 (48%) commenced the programme due to clinical need; 27 (73%) declared that
44 they would increase their AFS initiatives if they could. Of those without an AFS
45 programme, 14 (67%) responded that this was due to lack of resources / staff time.
46 Twelve Trusts (57%) responded that the availability of rapid diagnostics and clinical
47 support would enable them to conduct AFS activities.

48 Conclusions: Although a minority of Trusts conduct AFS programmes, nearly half
49 include AFS as part of routine AMS activities. Cost issues are the main driver for
50 AFS, followed by clinical need. The availability of rapid diagnostics and clinical
51 support could help increase AFS initiatives.

52

53 **Introduction**

54 Antimicrobial stewardship (AMS) initiatives have until recently largely focussed on
55 antibacterial agents. However, a number of recent studies have highlighted the
56 importance of antifungal stewardship (AFS), outlining significant patient benefits, as
57 well as cost-savings. (Standiford et al 2012, Lopez-Medrano 2013, Mondain et al
58 2013, Valerio et al 2014, Micallef et al 2015) Issues addressed in AFS include
59 selection of the most appropriate agent in terms of intrinsic antifungal activity
60 (Parkins et al), whether additional diagnostic or biomarker tests are required, dose
61 (especially with major organ dysfunction, drug interactions (Bartholomew et al)
62 (which are a major issue with the azole antifungals), underlying therapy plan
63 (increased or reduced immunosuppression, renal support etc.), addressing current or
64 future adverse events and advising on therapeutic drug monitoring (TDM; Ashbee et
65 al), potential for antifungal resistance and oral switch possibilities. | Resistance to
66 antifungal agents has emerged as an area of major concern, both acquisition of
67 intrinsically resistant fungi (*Candida krusei*, *Candida auris* (Schelenz et al),
68 Mucorales and *Fusarium* spp. being good examples) and isolates with acquired
69 resistance, notably *Candida glabrata* and *Aspergillus fumigatus*. Dual fungal infection
70 is an increasing problem (Salehi et al). Better antifungal choices improve outcomes
71 and reduce cost (Parkins et al; Micallef et al). Better availability and usage of non-
72 culture based fungal disease diagnostics should also reduce unnecessary anti-
73 bacterial use (Denning et al). We sought to explore the current status of AFS
74 initiatives across National Health Service (NHS) acute Trusts within England.

75

76

77 **Methods**

78 A web-based survey containing 50 closed questions was developed and deployed by
79 Public Health England's select survey programme as previously described (Ashiru-
80 Oredope et al 2015), in order to explore the status of AFS in England. There was
81 also the opportunity to provide comments (i.e. free text). The final draft was piloted
82 for face validity (Supplementary Information Figure S1) and disseminated to all 155
83 NHS acute hospital trusts across England via the following networks: Lead Public
84 Health Microbiologists (Public Health England) network, British Infection Association
85 (BIA), UK Clinical Pharmacy Association (UKCPA) and the East of England
86 antimicrobial pharmacist group. The survey was open for 6 weeks and reminders
87 were issued at three weeks and again at five weeks. All NHS hospitals in England
88 were included. NHS hospitals in Wales, Northern Ireland and Scotland and all UK
89 private hospitals were excluded. The responses were first de-duplicated to remove
90 multiple responses from individuals but multiple responses from the same trusts
91 were retained if they were from different healthcare professionals (i.e. pharmacists,
92 microbiologists etc.). Responses from non-English Trusts were also excluded from
93 the analysis. Results were analysed using Microsoft Excel.

94

95 **Results**

96 In total, 47 hospital Trusts in England responded to the questionnaire, representing
97 30% of all acute Trusts. The majority (53%; 25) were district general hospitals (small,
98 medium and large acute Trusts), followed by teaching (36%; 17) and specialist
99 Trusts (11%; 5)(table 1). Most respondents were microbiologists (37; 69%), followed
100 by antimicrobial pharmacists and infectious disease physicians. A wide range of
101 specialities was covered by participating hospitals.

102

103 Only one English NHS acute Trust reported that it had no AMS programme in place
104 (a specialist hospital). This contrasts with only five Trusts (11%) reporting having a
105 dedicated AFS programme. Four of these were in teaching Trusts and one was in a
106 specialist Trust. However, most Trusts had some form of informal AFS programme
107 or monitoring ability, with 76% of Trusts having guidelines for the treatment and / or
108 prophylaxis of invasive fungal infections.

109

110 Perceived potential benefits of AFS included improvements in safety (23), outcome
111 (19), costs (24), reduced side-effects (20) and obtaining surveillance data (18).

112

113 Most hospital Trusts had access to a number of available laboratory tests (e.g.
114 galactomannan, cryptococcal antigen, β -D-glucan; table 1). Interestingly, availability
115 of laboratory testing was not related to the type of hospital (e.g. DGH, teaching
116 hospital; data not shown). Of concern is the slow turnaround time reported in the
117 questionnaire; most results were unavailable for at least 48 hours.

118

119 Most AFS activities were performed by a microbiologist, followed by an antimicrobial
120 pharmacist, infectious disease physician or other pharmacist. A variety of models
121 were suggested. Seven Trusts reported having an AFS / management team, while
122 five reported performing dedicated AFS ward rounds. Twelve Trusts said they
123 offered advice on patients with invasive fungal infections. Several Trusts said they
124 saw fungaemic patients on their general daily ward rounds. A number of respondents
125 identified that they perform ward rounds on haematology wards and intensive care
126 units within their hospitals. Some Trusts with no dedicated AFS programme
127 nevertheless included patients on antifungal agents as part of their AMS work. One

128 respondent suggested they reviewed patients on a list of 'restricted drugs' as part of
129 their AMS round, which included high-cost antifungal agents. Most suggested they
130 performed their AFS programme weekly, but some respondents did it more
131 frequently. Other Trusts did it as required on an ad-hoc basis.

132

133 One respondent suggested they approached AFS using an analogy from infection
134 prevention: *"there is a role for the infection prevention team but daily infection*
135 *prevention activities are in everybody's job description. Our AFS team does not do*
136 *specific AFS ward rounds – we have empowered the specialists in various clinical*
137 *teams (champions) to look after this when they do their normal ward rounds. We*
138 *support them and help them with audits but optimal antifungal prescribing is their*
139 *responsibility."*

140

141 There were a variety of different reasons for commencing an AFS programme
142 including: financial concerns (13; 52%), clinical need (12; 48%), attempts to improve
143 patient management (40%) and interested individuals. Interestingly, only two
144 respondents suggested concerns about antifungal resistance as a reason for starting
145 their programme. A variety of resources were used for commencing AFS. The most
146 frequent resource cited was discussions (with colleagues or experts), teaching
147 events / meetings, and literature searches. One hospital Trust recruited two medical
148 mycologists specifically to set up an AFS programme, whilst another AFS
149 programme resulted from an audit of antifungal prescribing.

150

151 Patients were identified by a variety of different mechanisms. Pharmacy records
152 were used to detect patients receiving antifungal agents (18), via microbiology

153 results (13) and queries from clinicians (15). Six respondents performed specialty-
154 specific ward rounds.

155

156 Many centres have an antimicrobial pharmacist (19; across all hospital types), a
157 microbiologist or Infectious Disease physician, a database and access to TDM. A
158 small majority of trusts performed TDM (57%).

159

160 Most respondents reported that as part of their AFS programme, they assessed
161 clinical response (19), highlighted drug-drug interactions (15), addressed side-effects
162 (14) and ensured appropriate use of TDM / fungal biomarkers (17 each). Other
163 comments included checking compliance to guidelines / evidence-based use.
164 Measures used to assess effectiveness included monitoring the likelihood of
165 obtaining adequate therapeutic drug levels (17), costs of antifungal agents (13),
166 resistance profile (10) and mortality data (5). Other Trusts obtained surveillance data
167 as part of their AFS programme. Most respondents thought their advice was 'usually'
168 followed, though some suggested it was 'sometimes' followed.

169

170 The majority (79%) of respondents would ideally perform more AFS duties. One
171 respondent reported they'd needed to suspend their AMS service (and hence AFS
172 service) due to staffing issues.

173

174 A number of reasons were suggested by the 21 respondents who did not perform
175 AFS. These included lack of time, competing priorities, perceived lack of importance
176 and lack of expertise. Three respondents suggested that funding by NHS England
177 for high cost antifungal drugs was a reason for not performing AFS (so any financial

178 savings didn't benefit the Trust). Other reasons for not performing AFS included
179 'lower numbers' / 'antifungal use is relatively less' and lack of interest / engagement
180 from other specialties (e.g. haematology).

181

182 Availability of rapid diagnostics, clinical support (57% each) and more resources
183 (52%) could help persuade some clinicians to start an AFS service, but CPD events
184 (43%) and E-learning programmes (29%) were not considered to be beneficial.

185

186

187 **Discussion**

188 The clinical and financial benefits of AFS are well described (Standiford et al 2012,
189 Lopez-Medrano 2013, Mondain et al 2013, Valerio et al 2014, Micallef et al 2015).

190 Most studies up until now have suggested financial benefits as the principal reason
191 for performing it. However, even small studies targeting the management of patients
192 with candidaemia have shown improvements in mortality (Gouliouris et al 2016).

193 There are important differences between AMS and AFS (table 2). Clinicians are less
194 familiar with fungal infections, in terms of diagnostics and therapy and some drugs
195 can be toxic and the azole antifungal agents have multiple interactions. Some
196 antifungals are expensive. Patients with fungal infections (or suspected fungal
197 infection) also typically have multiple co-morbidities and / or are extremely unwell.

198

199 We provide data on an important and emerging area from a national survey. Most
200 respondents recognised the potential benefits of an AFS program. Not surprisingly,
201 most NHS acute Trusts in England responded to say they had an AMS programme
202 in place. We found that microbiologists and antimicrobial pharmacists are the

203 clinicians most involved in AFS. However, only 76% of acute Trusts had guidelines
204 for the treatment and or prophylaxis of fungal infections and only 57% of Trusts
205 performed TDM on some azoles, despite national guidelines suggesting its
206 importance (Ashbee et al 2015).

207

208 A variety of methods for performing AFS are described, from dedicated ward rounds
209 (at least weekly) to ad-hoc arrangements as and when required. This varied
210 according to institution. Some hospitals perform it as part of their AMS programme
211 (currently suspended due to lack of resources in at least one hospital) whilst one
212 hospital had appointed two mycologists to help with AFS. Patients were typically
213 identified by either laboratory results or pharmacy records in most cases.

214

215 Most Trusts had access to a range of fungal biomarkers, although not necessarily in
216 their own hospital. However, the turnaround times were typically prolonged (>48
217 hours), which limits their clinical impact and utility for clinicians. This was highlighted
218 in comments from several respondents. Fungal diagnostics is an area of difficulty for
219 many clinicians and hugely important if antifungal agents are to be used
220 appropriately and there is some evidence from this survey that some clinicians are
221 unfamiliar and not confident with their interpretation. One laboratory expressed
222 dissatisfaction in the funding of diagnostic tests (funded for certain patients but not
223 others).

224

225 Most respondents thought their advice was 'usually' followed. However, the
226 comments section suggests some areas (e.g. haematology / respiratory medicine)
227 are less engaged or reluctant to follow advice from an AFS team of microbiologist

228 and antimicrobial pharmacist. One way, suggested by Manchester, circumvented the
229 issue by giving ownership back to the clinical team, who ultimately are responsible
230 for the patient.

231

232 Most respondents who perform AFS would do more if they had the available
233 resources. One hospital had reduced its AFS programme as a clinician had left and
234 no-one had replaced them. Standiford reported the situation where costs fell when
235 an AFS programme was instituted and then rose when it was withdrawn (Standiford
236 et al).

237

238 The funding mechanism in England is different from other countries in the United
239 Kingdom. Most systemic antifungals, excluding fluconazole, itraconazole,
240 ketoconazole and flucytosine are classified as high cost drugs, and are funded
241 separately outside of the payment by results (PBR) or tariff system
242 (<https://www.england.nhs.uk/resources/pay-syst/drugs-and-devices/high-cost-drugs/>)
243 . Hospitals are required to provide patient level information to receive direct payment
244 for the antifungals they use. A national Quality, Innovation, Productivity and
245 Prevention (QIPP) incentive scheme has slightly reduced consumption on high-cost
246 antifungals as defined daily doses (DDD), but the use of antifungals with expired or
247 soon to expire patents (i.e. voriconazole and caspofungin) where cheaper costs will
248 be seen has actually fallen. Most of the savings seen from the use of generic
249 voriconazole has funded more expensive antifungals with years to run on their
250 patents (data from www.RX-info.com). Future NHS England incentive schemes are
251 focusing on paying the lowest cost for “off-patent” antifungals
252 (<https://www.england.nhs.uk/wp-content/uploads/2016/11/ge3-hospital-medicines->

253 [optimisation.pdf](#))), but unless all high cost antifungals are removed from the tariff
254 exclusion list, there will only be limited improvements in antifungal stewardship.

255

256 Our study, in common with a number of questionnaire studies, has a number of
257 limitations. The return rate was only 30% which compares to other similar studies
258 (Burns 2009). Nevertheless, we present data from a range of hospital Trusts of
259 different types and involving different types of patients. Bias is inherent in any
260 questionnaire; clinicians with an interest in AFS may have been more likely to
261 respond than others.

262

263 AFS has been shown to have significant benefits to patients. We suggest that AFS is
264 being performed in most hospitals in a variety of different ways in England which in
265 part reflects different patient populations. Most hospitals would do more if they had
266 the resources to do it, suggesting improvements can still be made.

267

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274 Denning, Samir Agrawal, Rohini Manuel, Silke Schelenz, Rakhee Patel, Phil
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276 Vaudrey, Elizabeth Johnson, David Enoch, Berit Muller-Pebody.

277

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280

281 **Transparency declarations**

282 CM has received travel grants to attend scientific conferences from Astellas, Gilead,
283 Pfizer and Novartis, educational grants from Pfizer and Novartis, attended a Pfizer
284 Advisory Board Meeting and consulted for Astellas.

285 DWD holds Founder shares in F2G Ltd, a University of Manchester spin-out
286 antifungal discovery company, in Novacyt which markets the Myconostica real-time
287 molecular assays. He acts or has recently acted as a consultant to Astellas, Sigma
288 Tau, Basilea, Scynexis, Cidara, Biosergen, Quintiles, Pulmatrix and Pulmocide. In
289 the last 3 years, he has been paid for talks on behalf of Astellas, Dynamiker, Gilead,
290 Merck and Pfizer. He is a longstanding member of the Infectious Disease Society of
291 America Aspergillosis Guidelines group, the European Society for Clinical

292 Microbiology and Infectious Diseases Aspergillosis Guidelines group and the British
293 Society for Medical Mycology Standards of Care committee.

294 SA has had educational grants and paid lectures from Astellas, Gilead, Merck and
295 Pfizer and is a member of the ECIL group (European Conference for Infections in
296 Leukaemia).

297 RJM has been paid for talks by Merck in the past year.

298 SS received educational grants from Astellas and has acted as advisor for Basilea,
299 Pfizer, Astellas and Gilead.

300 DAE has received funding to attend conferences from MSD, Gilead and Astellas and
301 consulted for Astellas.

302

303 All other authors: nothing to declare.

304

305 **Disclaimer**

306 The views expressed are those of the author(s) and not necessarily those of the
307 NHS, the NIHR, the Department of Health or Public Health England.

308

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356

Table 1: Results of Antifungal stewardship questionnaire

1. Background data		
Total number of responses (de-duplicated, excluding non-English Trusts)	54	
Total number of acute Trusts with identified names	47 (30% of English Trusts)	
Number of Trusts with multiple replies (2 or 3)	6	
Number of Trusts outside England that responded (not included in analysis)	3	
Type of Hospital Trust	Total Responding Trusts (n = 47)	%
District General	25	53
Teaching	17	36
Specialist	5	11
Job Title of Respondents	Total Respondents (n = 54)	%
Microbiologists	37	69
Antimicrobial Pharmacist	8	15
Director of Infection Prevention & Control	2	4
Infectious Diseases Physician	3	6
Mycologist	1	2
Others (Clinical Pharmacy Technician, Microbiology Manager & Microbiology Registrar)	3	6
Specialties provided at the hospital	Total Responding Trusts (n = 47)	%
Burns	10	21
Haematology-Oncology	40	85
Infectious Diseases and Immunity	16	34
Intensive Care Unit (ICU)	45	96
Paediatric ICU / Neonatal PICU/NICU	36	77

Respiratory Diseases	45	96
Cardiology	44	94
Solid Organ Transplant (State)	13	28
Stem Cell Transplant: Allograft	12	26
Stem Cell Transplant: Autograft	17	36
Care of the Elderly	43	91
Others:		
<ul style="list-style-type: none"> • kidney, liver, pancreas, small bowel; renal and pancreas transplant • Neurosurgery • Maxillo-facial surgery • Ear, Nose & Throat (ENT) surgery • Cardiothoracic surgery • Cystic fibrosis • Bone tumour and bone / joint infection • Spinal cord injury rehabilitation • Intestinal failure 		
Does the Trust have an AMS Programme?	Total Responding Trusts (n = 47)	%
Yes	46	98
No	1	2
Does the Trust have a dedicated AFS Programme?	Total Responding Trusts (n = 47)	%
Yes - we have a dedicated antifungal stewardship programme	5	11
Sort of - we include antifungal stewardship as part of our antimicrobial stewardship programme	20	43
Not really, but we do monitor antifungal usage	12	26
No	9	19
Benefits of AFS	Total Responding Trusts (n =47)	%

Improved safety	23		
Improved outcome	19		
Save money	24		
Reduced side-effects	20		
Obtain surveillance data to devise antifungal treatment guidelines	18		
Do you have the following fungal guidelines?	Trusts Responding to Section (n = 36)	%	
Trusts who had fungal guidelines (either prophylaxis, treatment or both)	25		76
Do you perform triazole therapeutic drug monitoring?	Trusts Responding to Section (n = 46)	%	
Yes	26		57
No	17		37
Don't know	3		6
Available Fungal biomarker tests	Trusts Responding to section (n = 47)	%	
Galactomannan	44		94
Beta-D-glucan	36		77
PCR: PCP	41		87
PCR: Candida	22		47
PCR: Aspergillus	26		55
PCR: Pan-fungal	31		66
Mannan Ag/Ab	14		30
Cryptococcal Ag	43		91
Fungal biomarker tests turnaround times	<48 hours	48 - 96 hours	>96 hours
Galactomannan	5	17	14
β -D-glucan	4	15	11
PCR: PCP	8	16	8

PCR: Candida	1	8	8
PCR: Aspergillus	3	8	10
PCR: Pan-fungal	0	9	16
Mannan Ag/Ab	0	5	3
Cryptococcal Ag	19	11	7
2. In hospitals with an AFS programme in place, the majority of AFS ward rounds were performed by:		Trusts Responding to Section (n = 25)	%
Microbiologist		21	84
Antimicrobial pharmacist		13	52
Infectious disease physician		5	25
ICU pharmacist		2	8
Haematology pharmacist		1	4
ICU physician		1	4
Which of these form part of your AFS programme?		Trusts Responding to Section (n = 25)	%
Have an AFS / management team		7	28
Monitor and report on antifungal use		16	64
Dedicated AFS ward rounds		5	20
AFS team have direct involvement in management of invasive fungal infections (e.g. candidaemia and aspergillosis)		12	48
How often are AFS ward rounds performed in a typical week?		Trusts Responding to Section (n = 25)	%
Daily		3	
2 - 3 times per week		1	
Weekly		10	
Fortnightly		0	
Monthly		0	
Why was your AFS programme started?		Trusts Responding	%

	to Section (n = 25)	
Clinical need	12	48
Improve antifungal management	10	40
Manage antifungal costs	13	52
Manage antifungal resistance	2	8
Concerns over worsening outcomes of patients with fungal infections	3	12
Request from clinicians	0	0
Other, please specify		
<ul style="list-style-type: none"> • Special interest in clinical mycology • We don't have a separate AFS, but it is part of our AMS • As part of Antibiotic stewardship Programme • Part of antimicrobial stewardship rounds • Current antimicrobial stewardship started Aug 2014-no dedicated AFS programme; but as (relatively small) part of general antimicrobial stewardship • Started as an audit and re-audit 		
What resources did you use to develop your AFS programme?	Trusts Responding to Section (n = 25)	%
CPD event	6	24
Discussions with colleagues	14	56
Discussions with experts	6	24
Literature search	11	44
Peer meetings where AFS has been tried and tested	7	28
Not known	3	12
Other, please specify:		
<ul style="list-style-type: none"> • Recruitment of 2 medical mycologists to set up AFS • In house audit of AF prescribing • Involvement with the ESCMID antifungal guideline writing groups 		
How do you target patients?	Trusts Responding to Section (n = 25)	%

Drug prescriptions (pharmacy records)	18	72
Laboratory results / organisms	13	52
Queries from clinicians	15	60
Specialty	6	24
What resources do you have available?	Trusts Responding to Section (n = 25)	%
IT database for collecting data	9	36
Therapeutic drug monitoring	17	68
Antimicrobial pharmacist	20	80
Dedicated microbiologist	11	44
Infectious disease physician	5	20
Other:		
<ul style="list-style-type: none"> • Electronic prescribing - we can see who is on antifungals • Unsure about adults. Paediatrics have a motivated oncologist • The Microbiologist is often involved in starting antifungals 		
How do you monitor therapy?	Trusts Responding to Section (n = 25)	%
Efficacy (i.e. clinical response)	19	76
Highlighting drug-drug interactions	15	60
Highlighting/preventing side-effects	14	56
Appropriate use of therapeutic drug monitoring	17	68
Appropriate use of fungal biomarkers	17	68
Other		
<ul style="list-style-type: none"> • Compliance to guidelines/evidence-based use • Compliance with antimicrobial prescribing guidelines • Confirming diagnosis 		
How do you monitor effectiveness?	Trusts Responding to Section (n = 25)	%
Efficacy (i.e. clinical response)	21	84
Clinical parameters (e.g. respiratory function, normalisation of inflammatory markers, imaging etc.)	18	72

Highlighting / preventing side effects	15	60
Obtaining adequate therapeutic drug levels	17	68
Highlighting and reducing drug-drug interactions	18	72
Cost of antifungal drug budget	13	52
Resistance profile	10	40
Mortality data	5	25
Other <ul style="list-style-type: none"> Surveillance of candidaemia and other serious fungal diseases 		
Do you provide advice?	Trusts Responding to Section (n = 25)	%
Yes: Verbal advice	21	84
Yes: Written advice	16	64
No	0	0
Do clinicians follow your advice?	Trusts Responding to Section (n = 25)	%
Always	2	8
Usually	16	64
Sometimes	4	16
Rarely	0	0
Never	0	0
Don't know	0	0
Would you do more AFS if you could?	Trusts Responding to Section (n = 34)	%
Yes	27	79
No	4	12
Don't know	3	9
3. Please specify the reasons for not performing AFS	Trusts Responding to Section (n = 21)	%
Competing priorities	10	48

Funding by NHS England for high cost antifungal drugs	3	14
Lack of interest	2	10
Lack of resources: staff time	14	67
Lack of resources: expertise	3	14
Perceived lack of importance	5	24
Other, please specify		
<ul style="list-style-type: none"> • Antifungal use is relatively less • Lower numbers • Lack of interest from haematology side 		
If these barriers were addressed, would you do AFS?	Trusts Responding to Section (n = 18)	%
Yes	16	89
No	2	11
What would convince you to do AFS?	Trusts Responding to Section (n = 21)	%
Availability of rapid diagnostics (i.e. within 48h)	12	57
Clinical support	12	57
CPD Events	9	43
E-learning programmes	6	29
More resources	11	52
Comments		
<p><i>"Huge impact on appropriate prescribing by implementing a systemic antifungal guideline"</i></p> <p><i>"Rapid in house testing for candida isolates so we can de-escalate to azoles quickly"</i></p> <p><i>"Rapid availability of HRCT"</i></p>		
<p><i>"We used to do weekly antifungal WR's which were excellent. We haven't resumed these since a colleague left and none of the other microbiologists have the expertise."</i></p> <p><i>"We also struggle to fit everything in, so lack of time is a major factor. Also the fact that other things have become more 'important'...e.g. CQUIN for antibiotic reduction so time and effort are currently being directed elsewhere"</i></p> <p><i>"Antifungals are also hugely complicated so training would be greatly received....."</i></p>		

“Anti-fungal stewardship is challenging in transplant and respiratory patients: the transplant team is usually set in their ways as to how they manage their patients and also fear of clinical failure if antifungals are stopped”.

“The respiratory team (bronchiectasis and CF) usually rely on radiology findings rather than on biomarkers.”

“Although GM is available the TAT is not satisfactory for stewardship”

“We have problems with funding of this test”

“The Trust does not invest enough in pharmacy/microbiology”

“The number of prescriptions for antifungals in the trust is very small”

“There is little or no microbiological oversight of antifungal use in haematology-oncology or respiratory, otherwise most antifungals are used on the basis of advice from a consultant microbiologist”

“The Wythenshawe antifungal stewardship (AFS) team consists of two members of the Infectious Diseases (ID) team (a Consultant Medical Mycologist & a Consultant in ID) and an antimicrobial Pharmacist in addition to a group of Champions and it is led by ID.”

“The key targets of the programme are to improve patient outcomes by updating and clarifying antifungal guidelines, involving and educating champions, implementing better diagnostics (β -D-glucan, therapeutic drug monitoring, resistance monitoring) and by stopping unnecessary courses of antifungals.”

*“Mortality to fungal infections, antifungal resistance and cost of IV antifungals were chosen as outcome measures. The UHSM AFS programme has been successful in decreasing mortality to candidaemia, in stopping the increase of azole resistance in *Aspergillus fumigatus* and in decreasing the cost of echinocandins antifungal drugs used.”*

“By integrating AFS into the team members' job plans this has achieved minimal additional staff costs. Savings in antifungal consumption has covered the increase in diagnostic costs.”

“Staff engagement has been one of the areas where we believe we have had the most success, and is showing the programme to be sustainable.”

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360 **Table 2: Comparison between antimicrobial stewardship (AMS) versus antifungal**
 361 **stewardship (AFS)**

	Antimicrobial stewardship	Antifungal stewardship
Source of infection	Patient to patient transmission	Patient to patient transmission is rare but can occur by endogenous infection with some fungi. Infection is often acquired from the environment e.g. via inhalation, inhalation, patient's own flora or devices such as catheters
Clinical data	A lot of supporting clinical data	Relative lack of clinical data
Toxicity and drug-drug interactions	Less common	More common
Diagnostic and monitoring tests	More tools available for interpretation	Fewer tools available that can also be difficult to interpret
Therapeutic drug monitoring	Therapeutic drug monitoring regularly used	Therapeutic drug monitoring developing
Staff familiarity	Greater familiarity	Less confidence and familiarity

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