Opportunities to enhance diagnostic testing and antimicrobial stewardship: a qualitative multinational survey of healthcare professionals

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Supplementary Material:

TABLE S1: Characteristics of survey participants, by (a) country and (b) specialty

	(a) Country						(b) Specialty			
	Brazil	**China**	**Germany**	**India**	**Italy**	**United States**	**Clinicians with ID experience**	**ICU clinicians/ hospitalists**	**Lab managers/ supervisors**	**Pharmacists**
How many beds are there in your hospital? n(%)										
Less than 100	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
100-250	20 (40.0%)	0 (0.0%)	17 (34.0%)	25 (50.0%)	7 (14.0%)	12 (24.0%)	9 (11.7%)	17 (21.8%)	32 (44.4%)	23 (31.5%)
251-500	20 (40.0%)	0 (0.0%)	5 (10.0%)	19 (38.0%)	11 (22.0%)	23 (46.0%)	31 (40.3%)	23 (29.5%)	11 (15.3%)	13 (17.8%)
501-750	8 (16.0%)	2 (4.0%)	14 (28.0%)	4 (8.0%)	18 (36.0%)	11 (22.0%)	9 (11.7%)	21 (26.9%)	11 (15.3%)	16 (21.9%)
751-999	2 (4.0%)	4 (8.0%)	5 (10.0%)	2 (4.0%)	6 (12.0%)	2 (4.0%)	7 (9.1%)	7 (9.0%)	3 (4.2%)	4 (5.5%)
≥1000	0 (0.0%)	44 (88.0%)	9 (18.0%)	0 (0.0%)	8 (16.0%)	2 (4.0%)	21 (27.3%)	10 (12.8%)	15 (20.8%)	17 (23.3%)
Which of these roles best describes your primary role? n(%)										
Physician	4 (8.0%)	8 (16.0%)	10 (20.0%)	3 (6.0%)	4 (8.0%)	11 (22.0%)	40 (51.9%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
ID physician	8 (16.0%)	5 (10.0%)	3 (6.0%)	10 (20.0%)	9 (18.0%)	2 (4.0%)	37 (48.1%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
Hospitalist/ICU physician	13 (26.0%)	13 (26.0%)	13 (26.0%)	13 (26.0%)	13 (26.0%)	13 (26.0%)	0 (0.0%)	78 (100%)	0 (0.0%)	0 (0.0%)
Pharmacist	13 (26.0%)	12 (24.0%)	12 (24.0%)	12 (24.0%)	12 (24.0%)	12 (24.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	73 (100%)
Lab manager/supervisor	12 (24.0%)	12 (24.0%)	12 (24.0%)	12 (24.0%)	12 (24.0%)	12 (24.0%)	0 (0.0%)	0 (0.0%%)	72 (100%)	0 (0.0%)
Are you or do you have experience as an infection control officer? n(%)										
Yes (current)	26 (52.0%)	24 (48.0%)	3 (6.0%)	19 (38.0%)	35 (70.0%)	13 (26.0%)	35 (45.5%)	22 (28.2%)	26 (36.1%)	37 (50.7%)
Yes (former)	13 (26.0%)	2 (4.0%)	6 (12.0%)	7 (14.0%)	5 (10.0%)	12 (24.0%)	16 (20.8%)	11 (14.1%)	9 (12.5%)	9 (12.3%)
No	11 (22.0%)	24 (48.0%)	41 (82.0%)	24 (48.0%)	10 (20.0%)	25 (50.0%)	26 (33.8%)	45 (57.7%)	37 (51.4%)	27 (37.0%)
How would you describe your hospital? n(%)										
Rural	50 (100.0%)	50 (100.0%)	40 (80.0%)	45 (90.0%)	50 (100.0%)	42 (84.0%)	1 (1.3%)	5 (6.4%)	11 (15.3%)	6 (8.2%)
Urban	0 (0.0%)	0 (0.0%)	10 (20.0%)	5 (10.0%)	0 (0.0%)	8 (16.0%)	76 (98.7%)	73 (93.6%)	61 (84.7%)	67 (91.8%)
How would you describe your hospital? n(%)										
Private	31 (62.0%)	5 (10.0%)	17 (34.0%)	34 (68.0%)	2 (4.0%)	22 (44.0%)	23 (29.9%)	33 (42.3%)	33 (45.8%)	22 (30.1%)
Public	19 (38.0%)	45 (90.0%)	33 (66.0%)	16 (32.0%)	48 (96.0%)	28 (56.0%)	54 (70.1%)	45 (57.7%)	39 (54.2%)	51 (69.9%)
How would you describe your hospital? n(%)										
Academic	23 (46.0%)	25 (50.0%)	26 (52.0%)	22 (44.0%)	22 (44.0%)	31 (62.0%)	41 (53.2%)	42 (53.8%)	26 (36.1%)	40 (54.8%)

	(a) Country						(b) Specialty			
	Brazil	**China**	**Germany**	**India**	**Italy**	**United States**	**Clinicians with ID experience**	**ICU clinicians/ hospitalists**	**Lab managers/ supervisors**	**Pharmacists**
Non-academic	27 (54.0%)	25 (50.0%)	24 (48.0%)	28 (56.0%)	28 (56.0%)	19 (38.0%)	36 (46.8%)	36 (46.2%)	46 (63.9%)	33 (45.2%)
Does your hospital have an on-site microbiology lab?										
Yes	44 (88.0%)	50 (100.0%)	45 (90.0%)	49 (98.0%)	47 (94.0%)	46 (92.0%)	71 (92.2%)	75 (96.2%)	69 (95.8%)	66 (90.4%)
No	6 (12.0%)	0 (0.0%)	5 (10.0%)	1 (2.0%)	3 (6.0%)	3 (6.0%)	5 (6.5%)	3 (3.8%)	3 (4.2%)	7 (9.6%)
Don't know	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	1 (2.0%)	1 (1.3%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
How many years of experience do you have since you completed your training/ primary qualifications? n(%)										
1-2 years	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	2 (4.0%)	1 (1.3%)	1 (1.3%)	0 (0.0%)	0 (0.0%)
3-5 years	0 (0.0%)	0 (0.0%)	0 (0.0%)	6 (12.0%)	1 (2.0%)	3 (6.0%)	4 (5.2%)	4 (5.1%)	0 (0.0%)	2 (2.7%)
6-9 years	19 (38.0%)	3 (6.0%)	13 (26.0%)	21 (42.0%)	3 (6.0%)	6 (12.0%)	14 (18.2%)	13 (16.7%)	18 (25.0%)	20 (27.4%)
10+ years	31 (62.0%)	47 (94.0%)	37 (74.0%)	23 (46.0%)	46 (92.0%)	39 (78.0%)	58 (75.3%)	60 (76.9%)	54 (75.0%)	51 (69.9%)
Are you part of an antimicrobial stewardship team/ committee within your institution? n(%)										
Yes	31 (62.0%)	24 (48.0%)	22 (44.0%)	28 (56.0%)	29 (58.0%)	28 (56.0%)	48 (62.3%)	33 (42.3%)	37 (51.4%)	44 (60.3%)
No	19 (38.0%)	26 (52.0%)	28 (56.0%)	22 (44.0%)	21 (42.0%)	22 (44.0%)	29 (37.7%)	45 (57.7%)	35 (48.6%)	29 (39.7%)

Abbreviations: ICU, intensive care unit; ID, infectious diseases.

TABLE S2: Frequency of use of each diagnostic technology.

	n (%)
Traditional, culture-based tests (blood, urine, sputum, other)	
Routinely used for all patients with symptoms of infection, where appropriate	248 (82.7%)
Used on a case-by-case basis only for selected patients, where appropriate	40 (13.3%)
Used on a case-by-case basis only for severely ill patients and/or immunocompromised patients, where appropriate	11 (3.7%)
Available, but not used for patients at my hospital (i.e., present within a research lab)	1 (0.3%)
Not available for use at my hospital	0 (0.0%)
Unable to comment	0 (0.0%)
PCR (such as open PCR, closed PCR, multiplex PCR, GeneXpert)	
Routinely used for all patients with symptoms of infection, where appropriate	105 (35.0%)
Used on a case-by-case basis only for selected patients, where appropriate	164 (54.7%)
Used on a case-by-case basis only for severely ill patients and/or immunocompromised patients, where appropriate	23 (7.7%)
Available, but not used for patients at my hospital (i.e., present within a research lab)	3 (1.0%)
Not available for use at my hospital	5 (1.7%)
Unable to comment	0 (0.0%)
Immunoassays (such as ELISA)	
Routinely used for all patients with symptoms of infection, where appropriate	65 (21.7%)
Used on a case-by-case basis only for selected patients, where appropriate	153 (51.0%)
Used on a case-by-case basis only for severely ill patients and/or immunocompromised patients, where appropriate	57 (19.0%)
Available, but not used for patients at my hospital (i.e., present within a research lab)	7 (2.3%)
Not available for use at my hospital	11 (3.7%)
Unable to comment	0 (0.0%)
Imaging (such as FISH)	
Routinely used for all patients with symptoms of infection, where appropriate	42 (14.0%)
Used on a case-by-case basis only for selected patients, where appropriate	123 (41.0%)
Used on a case-by-case basis only for severely ill patients and/or immunocompromised patients, where appropriate	66 (22.0%)
Available, but not used for patients at my hospital (i.e., present within a research lab)	21 (7.0%)
Not available for use at my hospital	42 (14.0%)
Unable to comment	6 (2.0%)
Rapid sequencing (such as NGS/ Next-Generation Sequencing)	
Routinely used for all patients with symptoms of infection, where appropriate	21 (7.0%)
Used on a case-by-case basis only for selected patients, where appropriate	87 (29.0%)
Used on a case-by-case basis only for severely ill patients and/or immunocompromised patients, where appropriate	72 (24.0%)
Available, but not used for patients at my hospital (i.e., present within a research lab)	36 (12.0%)
Not available for use at my hospital	74 (24.7%)
Unable to comment	10 (3.3%)
Mass spectrometry for pathogen identification (such as MALDI-TOF GC-MS)	
Routinely used for all patients with symptoms of infection, where appropriate	31 (10.3%)
Used on a case-by-case basis only for selected patients, where appropriate	81 (27.0%)
Used on a case-by-case basis only for severely ill patients and/or immunocompromised patients, where appropriate	62 (20.7%)
Available, but not used for patients at my hospital (i.e., present within a research lab)	21 (7.0%)

	n (%)
Not available for use at my hospital	86 (28.7%)
Unable to comment	19 (6.3%)
Rapid ID/AST (phenotypic)	
Routinely used for all patients with symptoms of infection, where appropriate	60 (20.0%)
Used on a case-by-case basis only for selected patients, where appropriate	102 (34.0%)
Used on a case-by-case basis only for severely ill patients and/or immunocompromised patients, where appropriate	57 (19.0%)
Available, but not used for patients at my hospital (i.e., present within a research lab)	18 (6.0%)
Not available for use at my hospital	45 (15.0%)
Unable to comment	18 (6.0%)
Rapid ID/ AST (molecular)	
Routinely used for all patients with symptoms of infection, where appropriate	52 (17.3%)
Used on a case-by-case basis only for selected patients, where appropriate	105 (35.0%)
Used on a case-by-case basis only for severely ill patients and/or immunocompromised patients, where appropriate	65 (21.7%)
Available, but not used for patients at my hospital (i.e., present within a research lab)	17 (5.7%)
Not available for use at my hospital	47 (15.7%)
Unable to comment	14 (4.7%)
Point-of-care (such as COVID lateral flow, urinary antigen, rapid strep A)	
Routinely used for all patients with symptoms of infection, where appropriate	115 (38.3%)
Used on a case-by-case basis only for selected patients, where appropriate	99 (33.0%)
Used on a case-by-case basis only for severely ill patients and/or immunocompromised patients, where appropriate	29 (9.7%)
Available, but not used for patients at my hospital (i.e., present within a research lab)	10 (3.3%)
Not available for use at my hospital	38 (12.7%)
Unable to comment	9 (3.0%)
Biomarker (such as PCT and CRP)	
Routinely used for all patients with symptoms of infection, where appropriate	129 (43.0%)
Used on a case-by-case basis only for selected patients, where appropriate	93 (31.0%)
Used on a case-by-case basis only for severely ill patients and/or immunocompromised patients, where appropriate	46 (15.3%)
Available, but not used for patients at my hospital (i.e., present within a research lab)	8 (2.7%)
Not available for use at my hospital	16 (5.3%)
Unable to comment	8 (2.7%)

Abbreviations: AST, antimicrobial susceptibility testing; CRP, C-reactive protein; ELISA, enzyme-linked immunosorbent assay; FISH, fluorescent in-situ hybridisation; GC-MS, Gas Chromatography Mass Spectrometry; MALDI-TOF, Matrix Assisted Laser Desorption/ Ionization- Time of Flight; NGS, next-generation sequencing; PCR, polymerase chain reaction; PCT, procalcitonin.

TABLE S3. Survey participants' views on (a) turnaround time for viral, bacterial, and fungal infections per diagnostic step and (b) whether turnaround time for diagnostic testing is "quick enough" per diagnostic step.

(a) What is the turnaround time for viral, bacterial, and fungal infections per diagnostic step[1] (n=297)?				
	Identification	**Initial AST**	**Comprehensive AST**	**Resistance gene identification**
Hours	**n (%)**			
≤2	47 (15.8)	19 (6.4)	9 (3.0)	9 (3.0)
3-8	76 (25.6)	81 (27.3)	32 (10.8)	30 (10.1)
9-12	38 (12.8)	59 (19.9)	75 (25.3)	23 (7.7)
13-24	50 (16.8)	33 (11.1)	43 (14.5)	69 (23.2)
25-48	58 (19.5)	59 (19.9)	39 (13.1)	62 (20.9)
49-71	10 (3.4)	10 (3.4)	33 (11.1)	21 (7.1)
>72	13 (4.4)	14 (4.7)	37 (12.5)	57 (19.2)
Unable to comment	5 (1.7)	22 (7.4)	29 (9.8)	26 (8.8)
(b) Is the turnaround time for diagnostic testing "quick enough" per diagnostic step[1] (n=292)?				
Response	**n (%)**			
Yes	153 (52.4)	139 (47.6)	97 (33.2)	94 (32.2)
Sometimes	96 (32.9)	98 (33.6)	109 (37.3)	108 (37.0)
No	41 (14.0)	42 (14.4)	69 (23.6)	77 (26.4)
Unable to answer	2 (0.7)	13 (4.5)	17 (5.8)	13 (4.5)

[1]Survey participants were asked to consider turnaround time as time from sample collection to the results being returned to the prescribing clinician.

Abbreviations: AST, antimicrobial susceptibility testing; HCP, healthcare professional; ID, infectious diseases.

TABLE S4: Country-level responses for which factors lead to diagnostic testing and/or return of results being too slow to impact patient care

	Brazil, n (%)	China, n (%)	Germany, n (%)	India, n (%)	Italy, n (%)	United States, n (%)
Ranking 1	**n=33**	**n=36**	**n=47**	**n=43**	**n=42**	**n=44**
Lack of 24-7 microbiology lab	8 (24.2%)	4 (11.1%)	14 (29.8%)	17 (39.5%)	14 (33.3%)	4 (9.1%)
Shortage of laboratory staff	4 (12.1%)	5 (13.9%)	15 (31.9%)	6 (14.0%)	10 (23.8%)	13 (29.5%)
Lack of rapid diagnostic testing for patients that would benefit from a rapid turnaround time	15 (45.5%)	3 (8.3%)	1 (2.1%)	7 (16.3%)	7 (16.7%)	13 (29.5%)
Lack of protocols for efficient diagnostic testing (diagnostic stewardship)	0 (0.0%)	8 (22.2%)	2 (4.3%)	3 (7.0%)	3 (7.1%)	4 (9.1%)
Lack of internal processes to report diagnostic test results to HCP	1 (3.0%)	5 (13.9%)	5 (10.6%)	4 (9.3%)	1 (2.4%)	0 (0.0%)
Lack of system to alert HCP of available diagnostic test result	0 (0.0%)	2 (5.6%)	5 (10.6%)	1 (2.3%)	0 (0.0%)	1 (2.3%)
Restriction of diagnostic test use to certain HCPs (i.e., ID clinicians, AMS team members)	3 (9.1%)	3 (8.3%)	0 (0.0%)	2 (4.7%)	2 (4.8%)	2 (4.5%)
HCP workload preventing results being acted on in real-time	1 (3.0%)	6 (16.7%)	1 (2.1%)	0 (0.0%)	2 (4.8%)	5 (11.4%)
Diagnostic test outsourcing (sending to off-site labs)	1 (3.0%)	0 (0.0%)	3 (6.4%)	2 (4.7%)	3 (7.1%)	0 (0.0%)
Unable to comment	0 (0.0%)	0 (0.0%)	1 (2.1%)	1 (2.3%)	0 (0.0%)	2 (4.5%)

Abbreviations: ID, infectious disease; HCP, healthcare professional.

TABLE S5: Survey participants views on (a) how frequently guidelines are consulted; (b) the usefulness of guidelines; and (c) how up to date antimicrobial and diagnostic guidelines are.

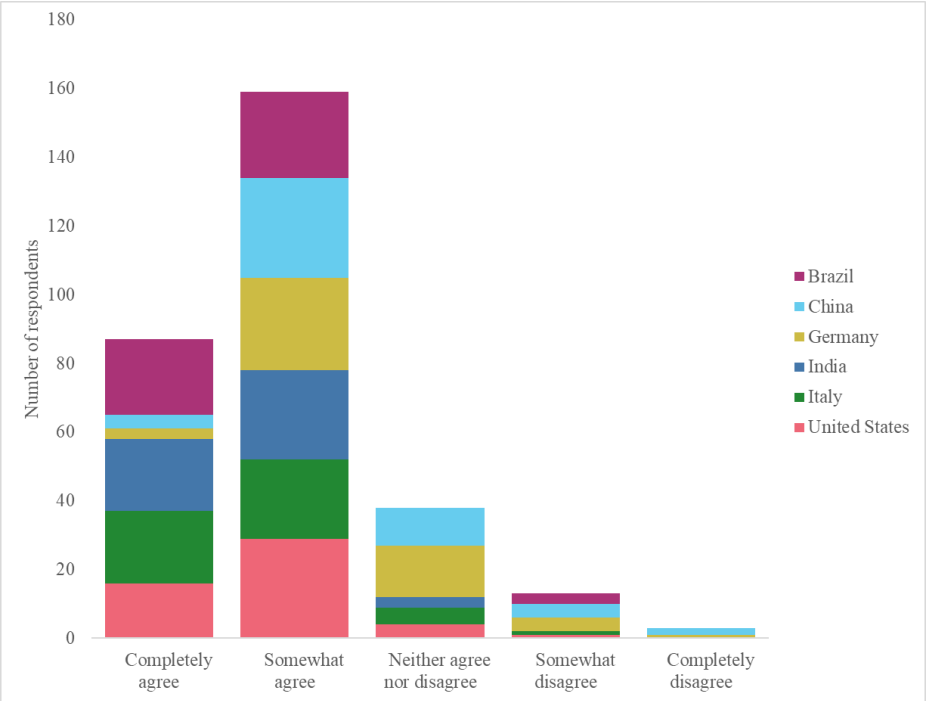
(a) Which of the following guidelines do you consult during clinical practice? (n=299)				
	International guidelines or professional society guidelines (such as WHO, PAHO, EUCAST, Surviving Sepsis)	**National guidelines (such as national AST breakpoint committees like CLSI, BrCAST, ChiCAST, PEG)**	**Regional guidelines (such as regional AST breakpoint committees and local government guidelines)**	**Local guidelines (such as hospital SOPs)**
Response	**n (%)**			
Always	111 (37.1)	150 (50.2)	116 (38.8)	181 (60.5)
Sometimes	165 (55.2)	130 (43.5)	145 (48.5)	93 (31.1)
Never	14 (4.7)	8 (2.7)	16 (5.4)	18 (6.0)
Not aware of this	9 (3.0)	10 (3.3)	18 (6.0)	5 (1.7)
Guidelines not available in my country	0 (0.0)	1 (0.3)	4 (1.3)	2 (0.7)
(b) How useful are current guidelines for healthcare professionals? (n=300)				
Response	**n (%)**			
Very useful	129 (43.0)	155 (51.7)	130 (43.3)	174 (58.0)
Somewhat useful	130 (43.3)	116 (38.7)	114 (38.0)	92 (30.7)
Minimally useful	25 (8.3)	18 (6.0)	38 (12.7)	24 (8.0)
Not at all useful	7 (2.3)	3 (1.0)	5 (1.7)	3 (1.0)
Unable to comment	9 (3.0)	7 (2.3)	8 (2.7)	6 (2.0)
Guidelines not available in my country	0 (0.0)	1 (0.3)	5 (1.7)	1 (0.3)

(c) How up to date are antimicrobial and diagnostic guidelines?	
Response	n (%)
Very recent and up to date	54 (18.0%)
Somewhat up to date	212 (70.7%)
Somewhat out of date	23 (7.7%)
Very out of date	1 (0.3%)
Unable to comment	10 (3.3%)

Abbreviations: AST, antimicrobial susceptibility testing; BrCAST, Brazilian Committee on Antimicrobial Susceptibility Testing; ChiCAST, Chinese Committee on Antimicrobial Susceptibility Testing; CLSI, Clinical and Laboratory Standards Institute; EUCAST, European Committee on Antimicrobial Susceptibility Testing; PAHO, Pan-American Health Organization; PEG, Paul Erlich Society; SOPs, Standard Operating Procedures; WHO, World Health Organization.

FIGURE S1. Survey participant agreement with the following statements (a) "Appropriate use of newly released antimicrobials may depend on suitable diagnostic tests being available"; (b) "Currently, the lack of diagnostic test availability is a barrier to the appropriate use of new antimicrobials in your facility or institution."

(a) n = 50 respondents per country. Unable to comment had 0 respondents.



(b) n = 50 respondents per country.

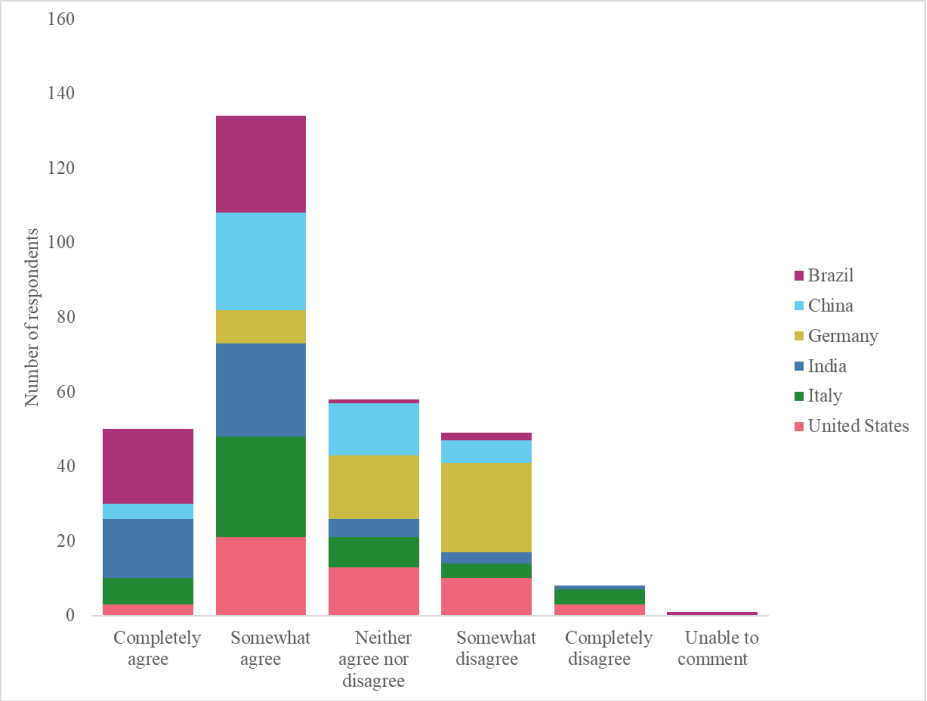
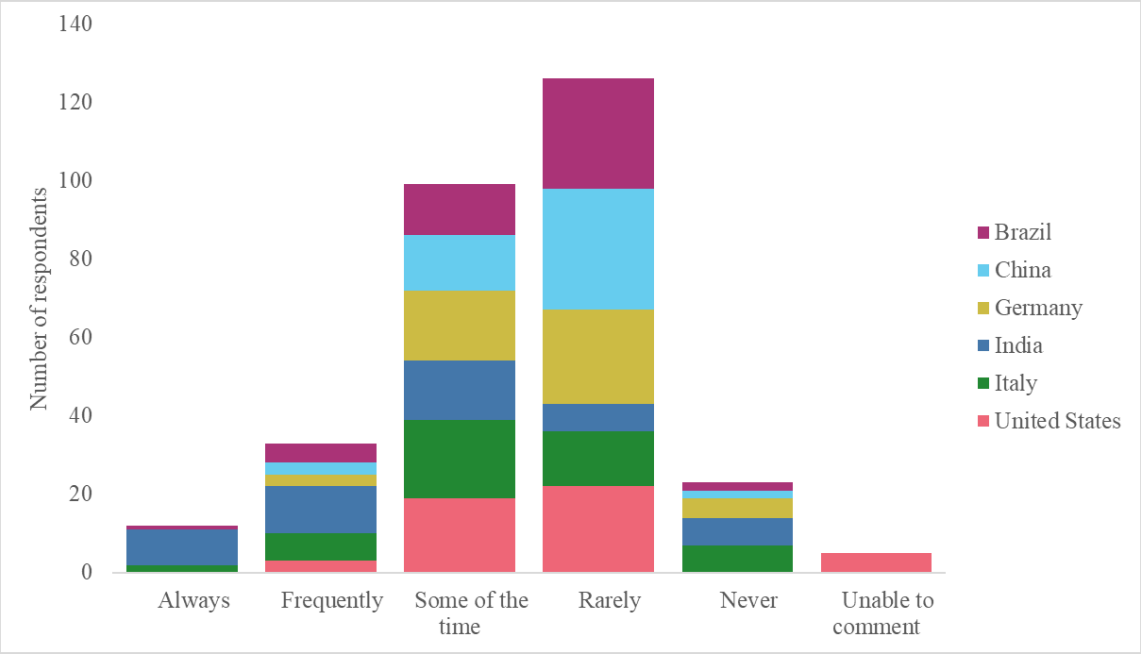
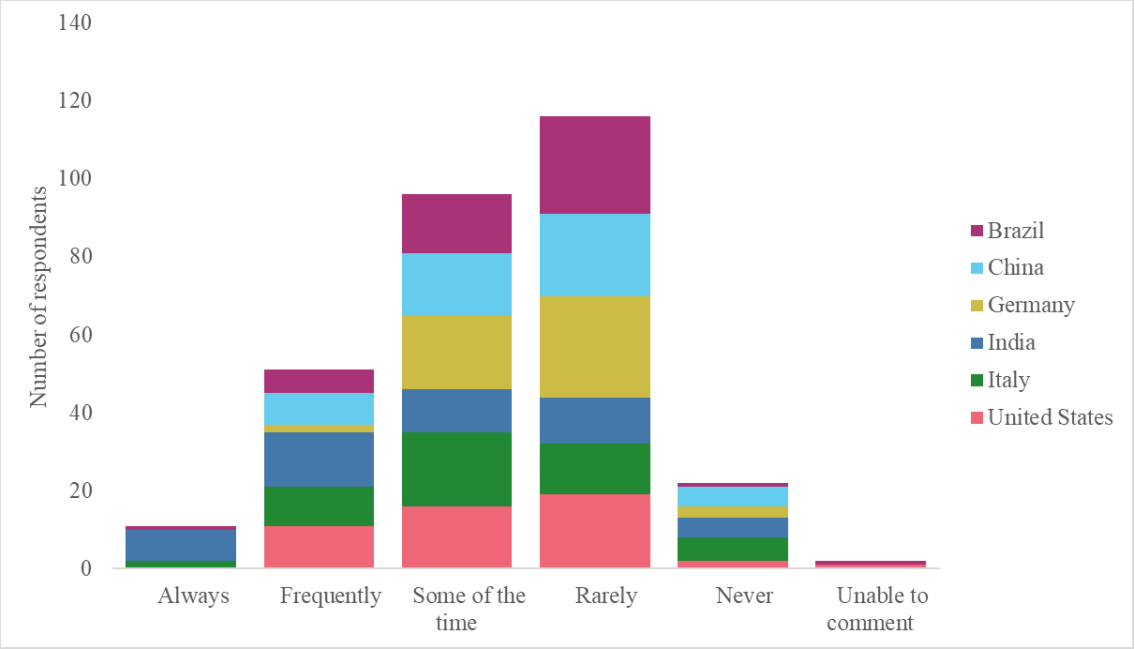


FIGURE S2: Survey participant views on (a) the frequency of guidelines not being followed due to a lack of diagnostic test availability; (b) the frequency of guidelines not being followed due to a lack of antibiotic availability (e.g. stock out, backorder, budget constraints); and (c) the frequency of guidelines not being followed due a specific antibiotic not being available due to access restrictions.

(a) n = 49 for Brazil and United States and n = 50 for China, Germany, India, and Italy.



(b) n = 49 for Brazil and United States and n = 50 for China, Germany, India, and Italy.



(c) n = 49 for Brazil and United States and n = 50 for China, Germany, India, and Italy.

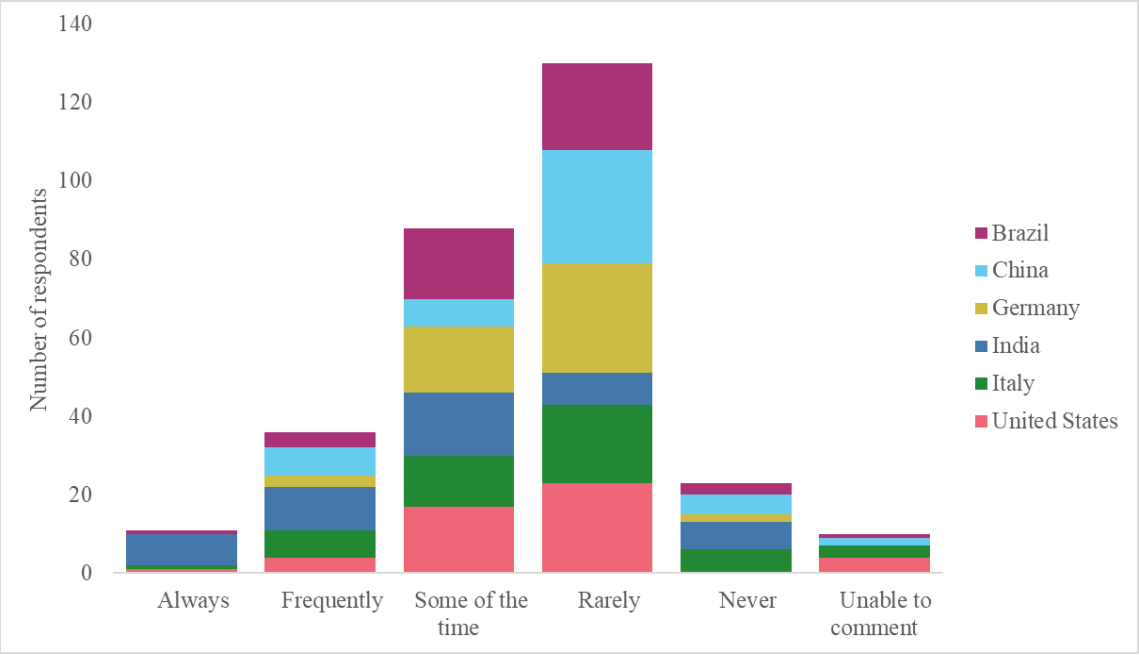
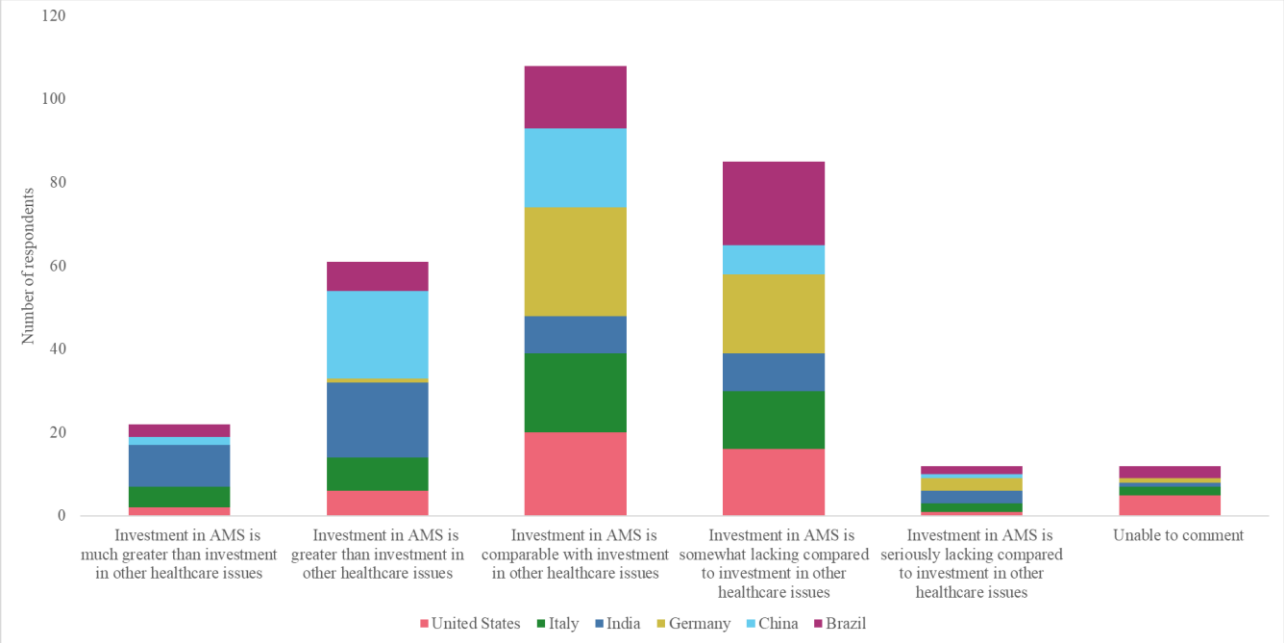
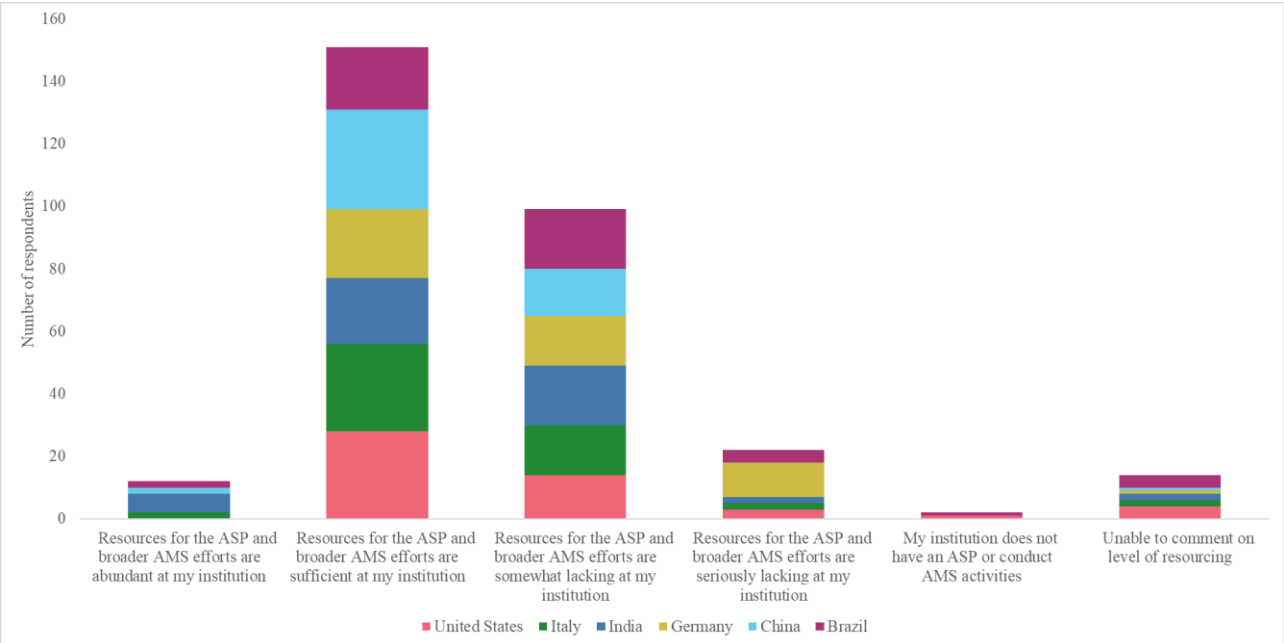


FIGURE S3: Survey participants' views on (a) the level of investment into improving AMS at an institutional level; (b) the level of resourcing of the antimicrobial stewardship program at an institutional level; and (c) resources considered to be lacking by survey participants at their facility/institution.

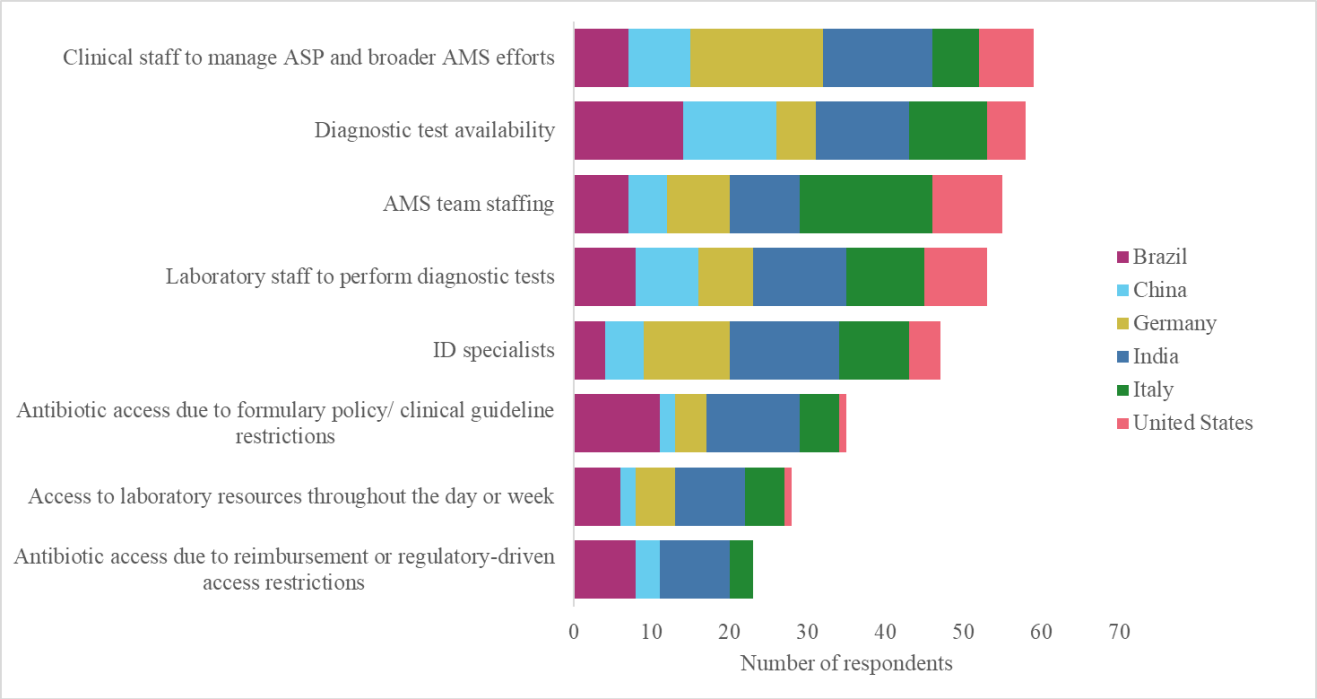
(a) n = 50 respondents per country.



(b) n = 50 respondents per country.



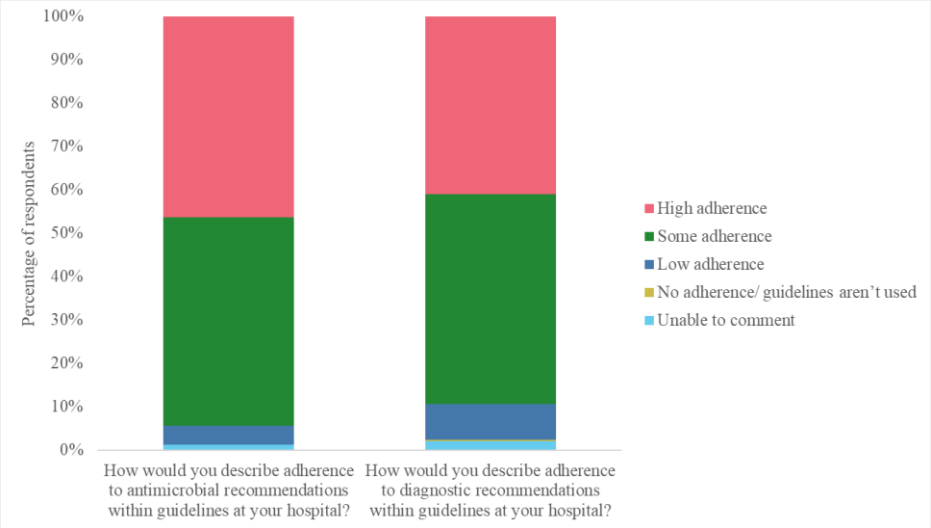
(c) n = 121, respondents could select multiple answers. Unable to comment had 0 respondents.



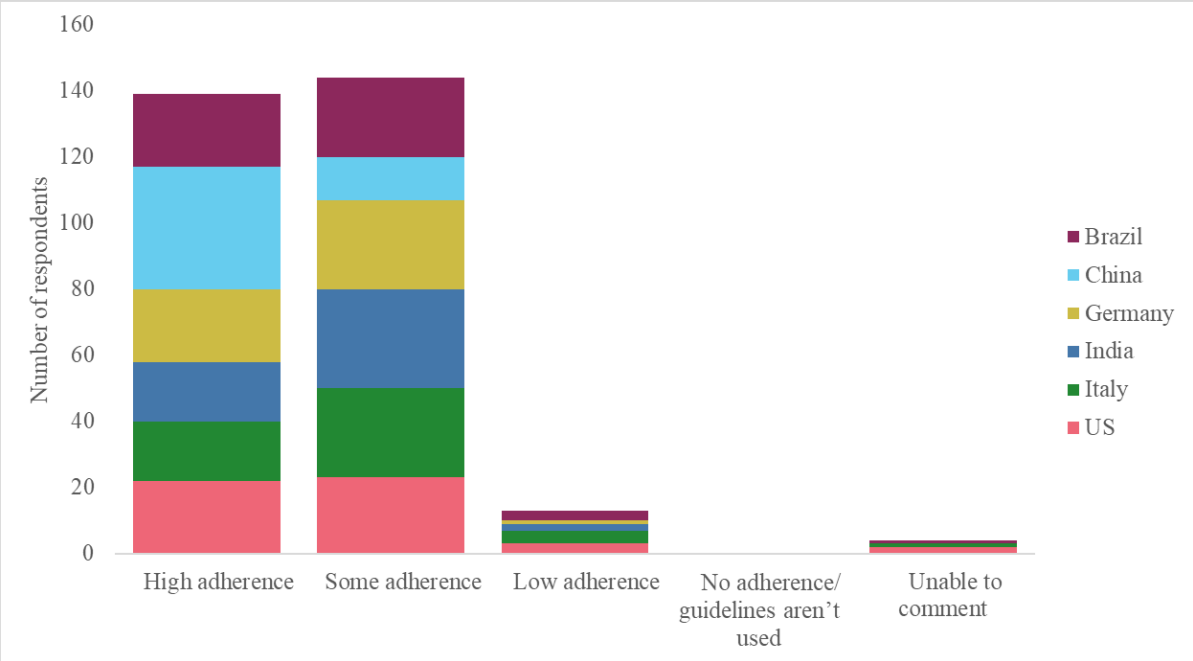
Abbreviations: AMS, antimicrobial stewardship; ASP, antimicrobial stewardship program; ID, infectious diseases.

FIGURE S4. Survey participants' reported adherence to antimicrobial and diagnostic recommendations within guidelines at an institutional level (a) overall, (b) by country for antimicrobial recommendations, and (c) by country for diagnostic recommendations.

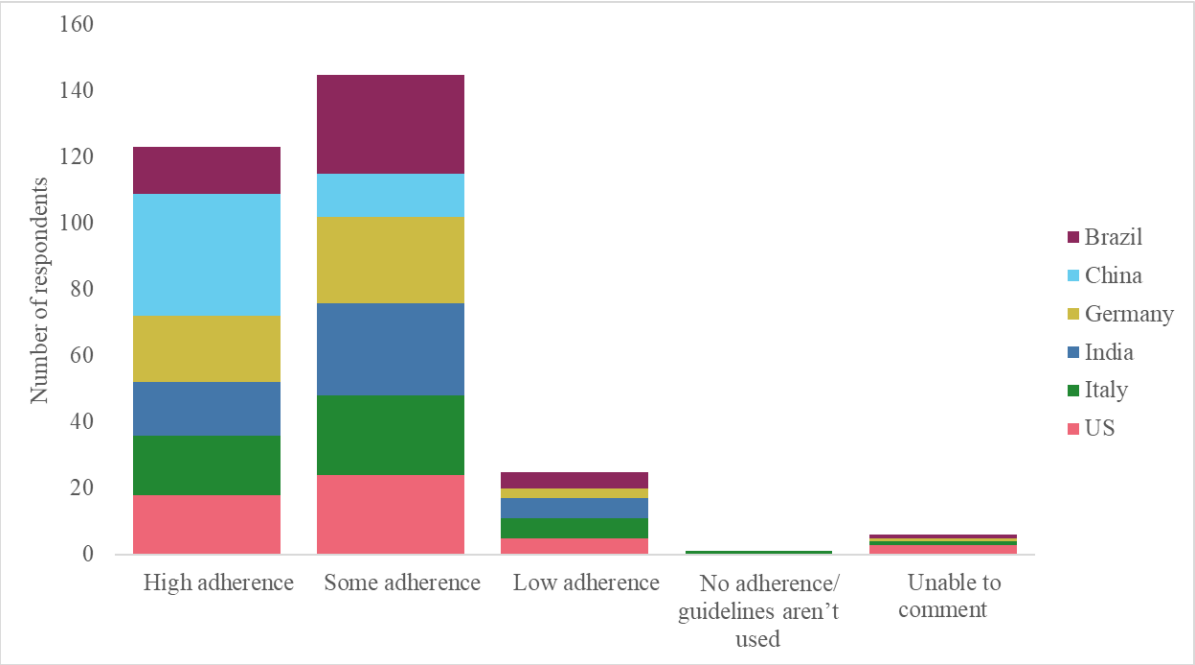
(a) n = 300 respondents per guideline type.



(b) n = 50 respondents per country.



(c) n = 50 respondents per country.



Appendix

25 Survey Questions

Thank you for taking part in the survey, which will inform antimicrobial stewardship and diagnostic practices around the world. The project consists of a targeted literature review, key opinion leader interviews, and survey of over 50 healthcare professionals in each of six countries, with an aim to publish a manuscript in a peer reviewed journal, reporting on aspects within the following four themes:

1) Current state of diagnostics,
2) Impact of diagnostics,
3) Diagnostics and product use,
4) Barriers to using diagnostics.

Data collected as part of this survey will be deidentified and aggregated for use with the manuscript.

This survey should take you approximately 30 minutes to complete. You will be asked questions related to four key themes:

1) Technology for Infectious Disease management
2) Role of diagnostics in antimicrobial stewardship
3) Challenges of diagnostic uptake
4) Guidelines

When completing the survey, please consider your experience of **inpatient clinical settings**. This research focuses on inpatient care, rather than outpatient and community settings.

1. Please describe the clinical setting you work in by answering the multiple-choice questions below.

Please select one option per question.

1.1 Does your hospital have an on-site microbiology lab?

a) Yes
b) No
c) Don’t know

1.2 Does your hospital have, or have access to, a microbiology lab that is staffed 24 hours a day, 7 days a week?

a) Yes
b) No
c) Don’t know

1.3 Does your hospital provide access to a dedicated infectious disease consultancy team who support decisions around antimicrobial use and diagnostic testing?

a) Yes
b) No
c) Don’t know

1.4 Does your hospital have an antimicrobial stewardship team/ committee?

a) Yes
b) No
c) Don’t know

2. Hospitals have many tools at their disposal to support antimicrobial stewardship efforts. To understand the role these technologies play in your facility or institution, please indicate how each of the following diagnostic technologies are used at your hospital within the inpatient setting.

Please select one option per row

Diagnostic technology	Routinely used for all patients with symptoms of infection, where appropriate	Used on a case-by-case basis only for selected patients, where appropriate	Used on a case-by-case basis only for severely ill patients and/or immunocompromised patients, where appropriate	Available, but not used for patients at my hospital (i.e., present within a research lab)	Not available for use at my hospital	Unable to comment
Traditional culture-based testing (blood, urine, sputum, other)						
PCR (such as open PCR, closed PCR, multiplex PCR, GeneXpert)						
Immunoassays (such as ELISA)						
Imaging (such as FISH)						
Rapid sequencing (such as NGS/ Next-Generation Sequencing)						
Mass Spectrometry for pathogen identification (such as MALDI-TOF, GC-MS)						
Rapid ID/ AST phenotypic (such as VITEK, MicroScan WalkAway, BD Phoenix)						

Rapid ID/ AST molecular (such as BioFire FilmArray, Nanosphere)						
Point-of-care tests (bedside tests such as COVID lateral flow, urinary antigen, rapid strep A)						
Biomarker tests (such as PCT and CRP)						

Abbreviations: AST, antimicrobial susceptibility testing; CRP, C-reactive protein; ELISA, enzyme-linked immunosorbent assay; FISH, fluorescent in-situ hybridization; GC-MS, Gas Chromatography Mass Spectrometry; MALDI-TOF, Matrix Assisted Laser Desorption/ Ionization- Time of Flight; NGS, next-generation sequencing; PCR, polymerase chain reaction; PCT, procalcitonin.

3. Considering tests that are available at your hospital, please describe your overall satisfaction levels with the diagnostic technologies (or tools) within your hospital?

You may wish to consider turnaround time, sensitivity, specificity, or availability of the diagnostic tests when describing satisfaction.

Please select one option per row

	Completely satisfied	Satisfied	Neutral	Unsatisfied	Not at all satisfied	Not available	Unable to comment
Traditional, culture-based tests (blood, urine, sputum, other)							
PCR (such as open PCR, closed PCR, multiplex PCR, GeneXpert)							
Immunoassays (such as ELISA)							
Imaging (such as FISH)							
Rapid sequencing (such as NGS/ Next Generation Sequencing)							
Mass spectrometry for pathogen identification (such as MALDI-TOF GC-MS)							
Rapid ID/AST (phenotypic) (such as BioFire FilmArray, Nanosphere)							
Rapid ID/ AST (molecular) (such as VITEK, MicroScan WalkAway, BD Phoenix)							
Point-of-care (such as							

COVID lateral flow, urinary antigen, rapid strep A)							
Biomarker (such as PCT and CRP)							

Abbreviations: AST, antimicrobial susceptibility testing; CRP, C-reactive protein; ELISA, enzyme-linked immunosorbent assay; FISH, fluorescent in-situ hybridization; GC-MS, Gas Chromatography Mass Spectrometry; MALDI-TOF, Matrix Assisted Laser Desorption/ Ionization- Time of Flight; NGS, next-generation sequencing; PCR, polymerase chain reaction; PCT, procalcitonin.

4. Antimicrobial stewardship calls for interventions at multiple stages of a patient's treatment pathway. Please indicate the criteria or factors used to influence prescribing decisions at different stages of a patient's treatment pathway:

Please select as many options as apply per timepoint (per column)

	Empiric treatment decisions	Treatment adjustments if a patient's clinical presentation is worsening	Treatment adjustments for antimicrobial de-escalation	Treatment adjustment for intravenous to oral conversions	Treatment adjustment of patient transfers from ICU to medical/ surgical beds	Not considered within the treatment pathway	Unable to comment
Clinical presentation							
Local, hospital-specific guidelines							
National/ international guidelines							
Clinical risk factors (i.e., age, comorbidities, immunocompromised status)							
Hospital antibiogram							

Traditional, culture-based diagnostic test results							
Rapid/ POC diagnostic test results (such as PCR or next-generation sequencing)							
Imaging							
Availability of antibiotics							
Local resistance patterns/ prevalence of MDROs							
Patient medical history (including recent antibiotics, hospital visits, and toxicity)							

AMS team consultancy involvement in antibiotic prescribing/ infection treatment management							

ICU, Intensive Care Unit; IV, Intravenous; MDRO, Multi-Drug Resistant Organisms; POC, point-of-care

5.1 There are multiple stages when identifying and treating an unknown bacterial, fungal and/or viral infection. Which technologies do you use at your hospital for the different steps of the treatment pathway?

Please select at least one option per diagnostic testing group

	Identification of pathogen	Initial AST	Comprehensive AST	Resistance gene identification	Not used within the treatment pathway	Not available at my hospital	Unable to comment
Traditional, culture-based testing (blood, urine, sputum, other)							
Rapid or molecular testing (such as PCR, rapid sequencing or mass spectrometry)							
Automated phenotypic testing (such as VITEK, MicroScan WalkAway, BD Phoenix)							

Automated molecular testing (such as BioFire FilmArray, Nanosphere)							
Point-of-care testing (bedside tests such as COVID lateral flow, urinary antigen, rapid strep A)							
Biomarkers (such as PCT and CRP)							

Abbreviations: AST, antimicrobial susceptibility testing; CRP, C-reactive protein; ELISA, enzyme-linked immunosorbent assay; FISH, fluorescent in-situ hybridization; GC-MS, Gas Chromatography Mass Spectrometry; MALDI-TOF, Matrix Assisted Laser Desorption/ Ionization- Time of Flight; NGS, next-generation sequencing; PCR, polymerase chain reaction; PCT, procalcitonin.

5.2 Considering a suspected bacterial, fungal and/or viral infection, what is the average time between sample collection to results being returned to the prescribing clinician per diagnostic step at your hospital?

Please select one option per row

	≤2h	3-8 h	9-12h	13-24h	25-48 h	49-71h	>72h	Unable to comment
Identification								
Initial AST								
Comprehensive AST								
Resistance gene identification								

AST, antimicrobial susceptibility testing.

5.3 At your hospital, do you consider this turnaround time (time from sample collection to the results being returned to the prescribing clinician) to be quick enough to inform antimicrobial prescribing decisions?

Please select one option per row

	Yes	Sometimes	No	Unable to answer
Identification				
Initial AST				
Comprehensive AST				
Resistance gene identification				

AST, antimicrobial susceptibility testing.

5.4 What factors lead to diagnostic testing and/or return of results to the appropriate HCP being too slow to impact patient care and improve stewardship at your hospital?

Please select up to three key factors and rank them, with 1 being the most influential factor. If none of the factors below are key factors, please select 'unable to comment.'

a) Lack of 24-7 microbiology lab
b) Shortage of laboratory staff
c) Lack of rapid diagnostic testing for patients that would benefit from a rapid turnaround time
d) Lack of protocols for efficient diagnostic testing (diagnostic stewardship)
e) Lack of internal processes to report diagnostic test results to HCP
f) Lack of system to alert HCP of available diagnostic test result
g) Restriction of diagnostic test use to certain HCPs (i.e., ID clinicians, AMS team members)
h) HCP workload preventing results being acted on in real-time
i) Diagnostic test outsourcing (sending to off-site labs)
j) Unable to comment

6. Where does your knowledge of new diagnostic technologies come from?

Please select one option per row

	Primary source of knowledge	Additional source of knowledge	Not used to help my knowledge
Guidelines			
Literature			
Seminars/ conferences			
Internal hospital procedures			
Knowledge exchange with colleagues			
Company promotional materials			

7. How would you describe the level of knowledge of new and emerging diagnostic tests?

Please select one option per row

	Excellent knowledge	Good knowledge	Some knowledge	Little knowledge	No knowledge	Unable to comment
Your knowledge of new and emerging diagnostic tests						
Your colleagues' knowledge of new and emerging diagnostic tests						

8. What evidence sources are most important to support the purchase/ implementation of a new diagnostic test in your hospital?

Please select up to three key resources and rank them, with 1 being the most influential evidence source.

a) Peer-reviewed research on the accuracy (i.e., sensitivity and specificity) of the new diagnostic test

b) Peer-reviewed research on the speed of a new diagnostic test

c) Peer-reviewed research on the ability of the new diagnostic test to improve patient outcomes (clinical outcomes, including survival rates)

d) Peer-reviewed research on the ability of a new diagnostic test to improve antimicrobial stewardship (including antibiotic use, de-escalation)

e) Peer-reviewed studies on cost-effectiveness of a new diagnostic technology

f) Additional non-peer reviewed research, such as internal research or conference data

g) Clinical trials studying the wide-scale implementation of a new diagnostic technology

h) Inclusion within a national/ international guideline

i) Company materials to educate on the aims/ purpose of a new technology or that demonstrate effectiveness

j) Communication with medical company representatives

k) Unable to comment

9. Many factors influence improved patient, economic and antimicrobial stewardship outcomes. Considering only the current diagnostic testing landscape/ practices in your hospital, please select the most appropriate option for each outcome listed in the table.

Please consider if your answer is data-based or opinion-based and select the most appropriate option. By data-based, please consider any internal data, published or unpublished.

Please select one option per row

	Data-based		Opinion-based		
	Yes – internal data at my hospital shows this	No – internal data at my hospital shows this is **not** the case	Yes – my personal opinion is that this occurs at my hospital	No - my personal opinion is that this **does not** occur at my hospital	Unable to comment/ not enough information to comment
Diagnostic practices at my hospital lead to treatment de-escalation					
Diagnostic practices at my hospital aid treatment adjustment					
Diagnostic practices at my hospital lead to decreased length of stay					
Diagnostic practices at my hospital lead to improved organizational economic outcomes					
Diagnostic practices at my hospital lead to improved patient outcomes, including reduced mortality and adverse events					
Diagnostic practices at my hospital lead to decreased AMR					

Diagnostic practices at my hospital lead to decreased inappropriate use of antibiotics					
Diagnostic practices at my hospital lead to early and accurate detection of pathogens					
Diagnostic practices at my hospital lead to the spectrum of antibiotics being narrowed as much as possible in appropriate cases					
Diagnostic practices at my hospital lead to the decreased need for additional lab testing					

AMR, Antimicrobial resistance.

10. Please estimate the percentages below:

10.1 Please **estimate** the percentage (%) of all patients with a suspected infection who undergo any diagnostic tests for infection in your setting:

a) Add numerical value between 0-100% _____*%*

b) Unable to comment

10.2 Please **estimate** the percentage (%) of all patients who have specimen samples taken **before initiation** of antimicrobials in your setting:

a) Add numerical value between 0-100% _____*%*

b) Unable to comment

11. In this question please consider patients who are receiving antimicrobial therapy and are at the stage of the treatment pathway where they are eligible for treatment adjustment. Please **estimate** the percentages below based on the diagnostic test results at your hospital, based on your experience:

11.1 What percentage of patients on empiric therapy do you rely on diagnostic tests for change of therapy (de-escalation or escalation)?

a) Add numerical value between 0-100%

b) Unable to answer/ comment

11.2 What percentage of patients with mild/ moderate illness do you rely on diagnostic tests for change of therapy (de-escalation or escalation)?

a) Add numerical value between 0-100%

b) Unable to answer/ comment

11.3 What percentage of patients who are severely ill (i.e., a patient with sepsis in ICU or a patient who is immunocompromised), would you rely on diagnostic tests for a change of therapy (de-escalation or escalation)?

a) Add numerical value between 0-100%

b) Unable to answer/ comment

11.4 In what percentage of all patients with no diagnostic test result, but who are clinically improving on broad-spectrum empiric therapy, are antibiotics de-escalated?

a) Add numerical value between 0-100%

b) Unable to answer/ comment

12. What are the biggest challenges to the use of diagnostic tests (including rapid tests) across the treatment pathway in your facility or institution?

Please select up to five key challenges

a) Cost of individual tests (i.e., out-of-pocket expenses for patients)
b) Cost of set-up/ initial outlay to purchase equipment
c) Reimbursement challenges
d) Lack of clinical data
e) Lack of economic data
f) Lack of awareness/ education of new technology
g) Lack of HCP willingness to adopt new technology and change practices
h) Concerns around accuracy and sensitivity/ specificity of the diagnostic test (detection of additional pathogens or missing a pathogen)
i) Access to diagnostic tests
j) Need for a specialist or an antimicrobial stewardship team to interpret the results
k) Lack of AMS team at my hospital
l) Lack of 24/7 microbiology lab
m) Lack of guidelines
n) Lack of investment/ funding for diagnostic use and updating guidelines
o) Insufficient laboratory staff, or specialized, proficient staff to perform diagnostic tests
p) Restriction of diagnostic test access to certain, specialist HCPs
q) Lack of real-time local/regional AMR data/ resistance patterns considered
r) Misalignment between diagnostic guidelines and antimicrobial stewardship guidelines
s) Compatibility of new diagnostic tests with pre-existing equipment and staff technical knowledge
t) Unable to comment

13.1 To what extent do you agree with this statement? "Appropriate use of newly released antimicrobials may depend on suitable diagnostic tests being available."

Please select one option only

a) Completely agree
b) Somewhat agree
c) Neither agree nor disagree
d) Somewhat disagree
e) Completely disagree
f) Unable to comment

13.2 To what extent do you agree with this statement? "Currently, the lack of diagnostic test availability is a barrier to the appropriate use of new antimicrobials in your facility or institution."

Please select one option only

a) Completely agree
b) Somewhat agree
c) Neither agree nor disagree
d) Somewhat disagree
e) Completely disagree

f) Unable to comment

14. Please select the statement that best reflects your view on investment in improving antimicrobial stewardship in your facility or institution:

When thinking about investment, please consider factors such as education, new technologies, new antimicrobials, or AMS initiatives and their level of importance.

Please select one option only

a) Investment in AMS is much greater than investment in other healthcare issues
b) Investment in AMS is greater than investment in other healthcare issues
c) Investment in AMS is comparable with investment in other healthcare issues
d) Investment in AMS is somewhat lacking compared to investment in other healthcare issues
e) Investment in AMS is seriously lacking compared to investment in other healthcare issues
f) Unable to comment

15.1 Please select the statement that best reflects your view on the resourcing (staff, funding, equipment) of the antimicrobial stewardship program (ASP) and broader AMS efforts at your facility or institution:

Please select one option only

a) Resources for the ASP and broader AMS efforts are abundant at my institution
b) Resources for the ASP and broader AMS efforts are sufficient at my institution
c) Resources for the ASP and broader AMS efforts are somewhat lacking at my institution
d) Resources for the ASP and broader AMS efforts are seriously lacking at my institution
e) My institution does not have an ASP or conduct AMS activities
f) Unable to comment on level of resourcing

15.2 Which type of resources, if any, are lacking at your facility or institution?

Please select all options that apply

a) AMS team staffing
b) ID specialists
c) Diagnostic test availability
d) Laboratory staff to perform diagnostic tests
e) Clinical staff to manage ASP and broader AMS efforts
f) Antibiotic access due to formulary policy/ clinical guideline restrictions
g) Antibiotic access due to reimbursement or regulatory-driven access restrictions
h) Access to laboratory resources throughout the day or week
i) Unable to comment

16. Below is a list of common challenges which may act as barriers to the use of narrow-spectrum antibiotics within de-escalation efforts. Please select the biggest challenges preventing the earlier use of narrow-spectrum antibiotics.

Please select up to five key challenges

a) Presence of MDROs based on local AMR data
b) High resistance rates
c) Lack of AMS efforts

d) Fear of not treating the causative organism conclusively due to sensitivity and specificity of diagnostic tests
e) Requirement for consulting AMS team/ ID team
f) Slow turnaround time to receiving AST data
g) Slow turnaround time to receiving diagnostic test results
h) Microbiology lab less able to conduct diagnostic tests at night/ at weekends (lack of 24/7 microbiology lab)
i) Rapid diagnostic tests unavailable for all patients
j) Lack of processes for receiving diagnostic test results from the lab
k) Lack of processes for highlighting patients who could have therapy changes
l) HCP reluctance to change/ de-escalate therapy
m) HCP burnout/ overwork leads to lack of follow-up for patients on broad empiric therapy
n) HCP education on appropriate use of broad vs narrow spectrum agents is insufficient
o) Hospitals and individual HCPs do not consider the societal impact of AMR
p) Insufficient recommendations from guidelines on use of narrow-spectrum agents
q) Lack of an electronic health record (EHR) system and/ or apps which alert clinicians to diagnostic test results or other stewardship interventions
r) Unable to comment

17.1 Who is responsible for making decisions about incorporating new diagnostic tests into your facility or institution?
Please select all options that apply

a) Any clinicians
b) ID clinicians
c) AMS team/ committee
d) Hospital managers or hospital administration
e) Third party insurers
f) Pharmacists
g) Hospital formulary (purchasing/ procurement department)
h) Laboratory scientists/ microbiologists
i) Lab managers
j) Unable to comment

17.2 At present, are there any factors which encourage the use of novel diagnostic technologies in your facility/ institution?
Please select one option only

a) Yes (please specify in the free-text box) _____
b) No
c) Don’t know

17.3 Would the following factors encourage the use of novel diagnostic technologies if available?
Please select as many evidence sources as apply

a) Guidelines with recommendations
b) Evidence sources demonstrating improved patient outcomes (including survival rates)

c) Evidence sources demonstrating improved economic outcomes (including length-of-stay, costs, and cost reductions)
d) Company materials to educate on new technologies
e) Discussion with colleagues
f) Hospital agreements with government/ company to subsidize costs relating to diagnostic technology
g) Reduced price of equipment due to emergence of competitors
h) Financial rewards for hitting AMS targets (such as reduced antibiotic consumption)
i) Educational tools
j) Unable to comment

18. Does your hospital have the following internal guidelines?
Please select all options that apply

a) Guidelines for collection and transport of specimens
b) Guidelines for reporting of diagnostic test results to physicians
c) Guidelines for antimicrobial changes based on diagnostic test results
d) Guidelines for surveillance of antimicrobial resistance within an institution
e) Guidelines for which diagnostic tests to order under which conditions
f) Guidelines for appropriate antimicrobials per clinical presentation (i.e., suspected Community Acquired Pneumonia, complicated urinary tract infection, etc.)
g) Unable to comment

19. Which of the following guidelines do you consult during clinical practice at your facility or institution?
Please select one option per row

	Always	Sometimes	Never	Not aware of this	Guidelines not available in my country
International guidelines or professional society guidelines (such as WHO, PAHO, EUCAST, Surviving Sepsis)					
National guidelines (such as national AST breakpoint committees like CLSI, BrCAST, ChiCAST, PEG)					

Regional guidelines (such as regional AST breakpoint committees and local government guidelines)					
Local guidelines (such as hospital SOPs)					

AST, Antimicrobial Susceptibility Testing; BrCAST, Brazilian Committee on Antimicrobial Susceptibility Testing; ChiCast, Chinese Committee on Antimicrobial Susceptibility Testing; CLSI, Clinical and Laboratory Standards Institute; EUCAST, European Committee on Antimicrobial Susceptibility Testing; PEG, Paul Erlich Society; PAHO, Pan American Health Organization; SOP, Standard Operating Procedure WHO, World Health Organization.

20. Does your institute collect AMR surveillance data?
Please select one option only

a) Yes
b) No
c) Don't know

21.1 Does AMR surveillance data feed into the hospital's antibiogram (a report which shows how susceptible pathogens are to different antibiotics in the hospital)?
Please select one option only

a) Yes
b) No
c) Don't know

21.2 How often is the hospital's antibiogram updated?
Please select one option only

a) Every 0-1 month
b) Every 2-3 months
c) Every 4-6 months
d) Every 7 months-1 year
e) Once a year
f) Greater than once a year
g) Unable to comment

21.3 Does the antibiogram influence antibiotic treatment decisions (i.e., via empiric treatment guidelines or recommendations development)?
Please select one option only

a) Yes
b) Sometimes
c) No
d) Don't know

21.4 Do HCPs actively look at and use AMR surveillance data (antibiograms) for treatment decisions/ general knowledge?
Please select one option only

a) Yes
b) Sometimes
c) No
d) Don't know

22.1 This question focuses on levels of adherence to guidelines based on your experience:
Please select one option per row

	High adherence	Some adherence	Low adherence	No adherence/ guidelines aren't used	Unable to comment
How would you describe adherence to **antimicrobial** recommendations within guidelines at your hospital?					
How would you describe adherence to **diagnostic** recommendations within guidelines at your hospital?					

Column 2-4 leads to three follow-up questions:

22.2 How often does a lack of antibiotic availability (e.g. stock out, backorder, budget constraint) result in guidelines not being followed in your facility or institution?
Please select one option only

a) Always
b) Frequently
c) Some of the time
d) Rarely
e) Never
f) Unable to comment

22.3 How often are guidelines not followed due to a **specific antibiotic** not being available due to access restrictions within your facility or institution?

Please select one option only

a) Always
b) Frequently
c) Some of the time
d) Rarely

e) Never
f) Unable to comment

22.4 How often does a lack of diagnostic test availability result in guidelines not being followed at your facility or institution?
Please select one option only

a) Always
b) Frequently
c) Some of the time
d) Rarely
e) Never
f) Unable to comment

23.1 How useful are current guidelines for healthcare professionals?
Please select one option per row

	Very useful	Somewhat useful	Minimally useful	Not at all useful	Unable to comment	Guidelines not available in my country
International guidelines or professional society guidelines (such as WHO, PAHO, EUCAST, Surviving Sepsis)						
National guidelines (such as national AST breakpoint committees like CLSI, BrCAST, ChiCAST, PEG)						
Regional guidelines (such as regional AST breakpoint committees and local government guidelines)						

Local guidelines (such as hospital SOPs)						

AST, Antimicrobial Susceptibility Testing; BrCAST, Brazilian Committee on Antimicrobial Susceptibility Testing; ChiCast, Chinese Committee on Antimicrobial Susceptibility Testing; CLSI, Clinical and Laboratory Standards Institute; EUCAST, European Committee on Antimicrobial Susceptibility Testing; PEG, Paul Erlich Society; PAHO, Pan American Health Organization; SOP, Standard Operating Procedure WHO, World Health Organization.

23.2 What would make guidelines more useful for healthcare professionals?

Please select all options that apply

a) Guideline recommendations to follow local data/ resistance patterns
b) Inclusion of evidence sources, such as peer-reviewed publications
c) More frequent guideline updates
d) Addressing country-specific challenges
e) Greater education
f) Capabilities in detecting AMR
g) Accurate global MDR burden
h) Diagnostic and antimicrobial access options
i) Guidance on efficient and appropriate use of antimicrobials
j) Preanalytical and analytical lab specimen processing guidance
k) Mechanisms to track compliance
l) Ease of use at point of care (mobile apps, searchability etc.)
m) Unable to comment

24. How would you describe most antimicrobial and diagnostic guidelines in terms of being up to date?
Please select one option only

a) Very recent and up to date
b) Somewhat up to date
c) Somewhat out of date
d) Very out of date
e) Unable to comment

25. How long does newly released guidance relating to antimicrobial stewardship take to be adopted/implemented into your clinical practice?

Please select one option per row.

	0-1 years	2-4 years	5+ years	Cannot comment	Guidelines not available within my country
International guidelines or professional society guidelines					

(such as WHO, PAHO, EUCAST, Surviving Sepsis)					
National guidelines (such as national AST breakpoint committees like CLSI, BrCAST, ChiCAST, PEG)					
Regional guidelines (such as regional AST breakpoint committees and local government guidelines)					
Local guidelines (such as hospital SOPs)					

AST, Antimicrobial Susceptibility Testing; BrCAST, Brazilian Committee on Antimicrobial Susceptibility Testing; ChiCast, Chinese Committee on Antimicrobial Susceptibility Testing; CLSI, Clinical and Laboratory Standards Institute; EUCAST, European Committee on Antimicrobial Susceptibility Testing; PEG, Paul Erlich Society; PAHO, Pan American Health Organization; SOP, Standard Operating Procedure WHO, World Health Organization.