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Knowledge, Attitudes, and Practices on Antimicrobial Stewardship among Healthcare Professionals at Juba Teaching Hospital, South Sudan

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Abstract: *Antimicrobial resistance (AMR) imposes its heaviest burden on sub-Saharan Africa, yet South Sudan lacks baseline evidence on how healthcare professionals understand and enact antimicrobial stewardship (AMS). This study assessed AMS knowledge, attitudes, and practices (KAP) and their correlates at Juba Teaching Hospital, the national referral facility. We administered a COM-B-informed cross-sectional survey to 245 stratified, randomly selected professionals (74 doctors, 26 pharmacists, 145 nurses); we analysed the data using chi-square tests, t-tests, ANOVA, and multivariable logistic regression. We prioritised item-level analysis because composite knowledge and attitude scales showed low internal consistency. The survey response rate was 100%. The mean knowledge score was 67.4% (SD = 16.0), and 33.1% had good knowledge; only 32.7% understood the WHO AWaRe Access category. Knowledge differed significantly by cadre, age, and qualification, and formal AMS training independently predicted good knowledge (AOR = 2.07, 95% CI [1.14, 3.77]). Positive attitudes were held by 45.3%; 80.0% cited inadequate laboratory support, and 44.9% acknowledged patient pressure. Appropriate practice was reported by 23.0% of doctors, compared with 73.1% of pharmacists and nurses, and 55.4% of doctors often prescribed antibiotics for viral infections. Nurses with 1–5 years' experience had higher odds of appropriate practice (AOR = 7.31, 95% CI [1.68, 31.85]). Moderate knowledge thus coexists with ambivalent attitudes and a pronounced prescriber knowledge–practice gap rooted chiefly in health-system constraints. Training-led capability building must be coupled with diagnostic, governance and AWaRe-based formulary reforms.*

Keywords: *Antimicrobial Stewardship; Antimicrobial Resistance; Aware; COM-B; Knowledge–Practice Gap; South Sudan*

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1. Introduction

Antimicrobial resistance has moved from a projected threat to a measured crisis. Bacterial AMR was directly responsible for 1.27 million deaths and associated with 4.95 million deaths in 2019, with the highest mortality rates in sub-Saharan Africa (Antimicrobial Resistance Collaborators, 2022), and forecasts suggest that attributable deaths could reach 1.91 million annually by 2050 without decisive action (Naghavi et al., 2024). The World Health Organization's most recent surveillance report shows that one in six laboratory-confirmed bacterial infections worldwide in 2023 was resistant to treatment, rising to one in five in the African Region, where resistance of key Gram-negative pathogens to third-generation cephalosporins now exceeds 70% (World Health Organization [WHO], 2025). In response, the 2024 United Nations political declaration committed member states to a 10% reduction in AMR deaths by 2030 and to sourcing at least 70% of human antibiotic use from the WHO Access group (United Nations General Assembly, 2024). Antimicrobial stewardship, the coordinated set of actions that secures the right drug, dose, duration and route for each patient, is the principal health-system lever for meeting these targets (WHO, 2019; Shuayb et al., 2026).

Across Africa, the evidence repeatedly shows that what clinicians know about antibiotics is a weak predictor of what they do. Among pharmacy workers in 28 African countries, 71.3% demonstrated good AMS knowledge but only 41.6% reported consistent stewardship practice (Agiri et al., 2025); in Ghana, 78.8% of hospital professionals held favourable attitudes, yet only 35.4% reported good practice (Sefah et al., 2023); and in Nigeria, roughly two-thirds of physicians had prescribed a Reserve antibiotic within six months (Ogoina et al., 2021). Systematic reviews attribute this "knowing–doing" gap to weak regulation, scarce diagnostics, patient demand and commercial incentives rather than to ignorance alone (Chan et al., 2024; Porter et al., 2021). These constraints are magnified in conflict-affected systems, where disrupted supply chains, absent microbiology and self-medication normalise empirical broad-spectrum therapy (Fletcher et al., 2025; Skender et al., 2024).

South Sudan exemplifies these pressures. Juba Teaching Hospital, the country's principal referral facility of approximately 500 beds, lacks routine culture and sensitivity testing, a functioning Drug and Therapeutics Committee, an antibiotic formulary, restriction policies for Watch and Reserve agents and any audit-and-feedback system. A retrospective review of 1,110 inpatient records found that 86.8% of patients received antibiotics, only 5.5% of prescriptions were supported by culture results, and just 47.6% complied with national guidelines; ceftriaxone, a Watch antibiotic, accounted for 38.4% of prescriptions (Otim et al., 2021). Although South Sudan has adopted a One Health National Action Plan on AMR for 2023–2028 (Republic of South Sudan Ministry of Health, 2023), implementation depends on evidence that does not yet exist. The problem is therefore not simply that antibiotics are overused at Juba Teaching Hospital, but that the behavioural determinants of that overuse are unknown. Existing data describe *what* is prescribed but not *why*: whether low guideline compliance reflects deficient knowledge, unfavourable attitudes, structural constraints, or a combination. No published study has assessed the KAP of doctors, pharmacists and nurses on AMS anywhere in South Sudan, leaving the National Action Plan without a behavioural baseline and leaving hospital managers to design interventions blind. This study provides the first such baseline and interrogates it through an explicit behavioural theory, so that the findings can be translated directly into targeted capability, opportunity and motivation interventions.

1.1 Objectives of the Study

1.1.1 General Objective

To assess the knowledge, attitudes and practices on antimicrobial stewardship among healthcare professionals at Juba Teaching Hospital, South Sudan.

1.1.2 Specific Objectives

1. To assess the level of knowledge on antimicrobial stewardship among healthcare professionals at Juba Teaching Hospital.
2. To determine the attitudes of healthcare professionals towards antimicrobial stewardship.
3. To evaluate self-reported antimicrobial stewardship practices of doctors, pharmacists and nurses.
4. To identify socio-demographic and professional factors associated with knowledge, attitudes and practices on antimicrobial stewardship.

1.2 Hypotheses of the Study

The following null hypotheses were tested at $\alpha = .05$:

- **H01:** Mean AMS knowledge scores do not differ significantly across professional cadres, age groups or educational qualifications.
- **H02:** Formal AMS training received in the preceding two years is not significantly associated with good AMS knowledge.
- **H03:** Attitudes towards AMS do not differ significantly by professional cadre, training status or gender.
- **H04:** Socio-demographic and professional characteristics are not significantly associated with appropriate self-reported AMS practice within any cadre.

2. Literature Review

2.1 Conceptual Review

Antimicrobial stewardship denotes an organisational and clinical programme that promotes optimal antimicrobial selection, dosing, duration and route in order to improve patient outcomes while limiting resistance, toxicity and cost (WHO, 2019). In low- and middle-income countries its core elements comprise leadership commitment, accountability, access to diagnostics, treatment guidelines, education, and monitoring with feedback (Akpan et al., 2020; Wesangula et al., 2025). A central operational tool is the WHO *AWaRe* classification, which stratifies antibiotics into Access (narrow-spectrum, first- and second-choice agents with lower resistance potential), Watch (broader-spectrum agents with higher resistance potential, prioritised for stewardship) and Reserve (last-resort agents for multidrug-resistant infections) (WHO, 2022). The classification links bedside choice to national and global consumption targets and has been embedded in South Sudan's Essential Medicines List.

Within this study, *knowledge* refers to correct understanding of AMS principles, resistance mechanisms, AWaRe categories and guideline-recommended therapy; *attitudes* to evaluative dispositions towards stewardship, including perceived

relevance, personal responsibility and perceived feasibility under contextual constraints; and *practices* to self-reported prescribing, dispensing and administration behaviours. Because each cadre occupies a distinct position in the medication-use chain, with doctors prescribing, pharmacists dispensing and nurses administering and monitoring, practices were defined in cadre-specific terms rather than as a single construct (Balliram et al., 2021; Tembo et al., 2022).

2.2 Theoretical Review

The classical KAP model assumes a linear sequence in which knowledge shapes attitudes, which in turn shape practice. Its parsimony explains its popularity in AMS surveys, but its predictive validity is weak: the persistent knowledge–practice gap documented across Africa is itself evidence that the sequence is frequently interrupted (Agiri et al., 2025; Saleem et al., 2025). Two theories offer richer explanations. The Theory of Planned Behaviour (Ajzen, 1991) holds that intention, the proximal cause of behaviour, is determined by attitudes, subjective norms and perceived behavioural control. Applied to prescribing, it explains why clinicians who endorse stewardship may still prescribe for viral illness when patient expectations (a normative pressure) or diagnostic uncertainty (low perceived control) dominate (Chan et al., 2024).

The Capability–Opportunity–Motivation–Behaviour (COM-B) model, the hub of the Behaviour Change Wheel, generalises this logic by positing that behaviour occurs only when a person has the psychological and physical *capability*, the social and physical *opportunity*, and the reflective and automatic *motivation* to act (Michie et al., 2011). COM-B is particularly suited to fragile health systems because it treats environmental opportunity, such as laboratory access, drug availability and supervisory structures, as a co-equal determinant rather than as background noise. It has recently been applied to AMS in East African outpatient settings, where it revealed that clinicians' AMR awareness was undermined by gaps in AMS-specific knowledge and institutional support (Kaniu et al., 2025). This study therefore adopts COM-B as its organising theory, operationalising capability as knowledge, motivation as attitudes and behaviour as practice, while treating opportunity factors as moderators; the Theory of Planned Behaviour is used interpretively to explain normative influences such as patient pressure.

2.3 Empirical Studies

Knowledge and its determinants. Reported levels of good AMS knowledge in Africa range widely, from 8.9% in Ghana (Sefah et al., 2023) and 19% among Ugandan interns (Nabidda et al., 2023) to 75% among Zambian staff already engaged in AMS (Mudenda et al., 2024), a spread that reflects both genuine variation and inconsistent thresholds and sampling frames. Cadre is a consistent determinant: pharmacists generally outperform nurses (Balliram et al., 2021; Tembo et al., 2022), and in Jordan being a pharmacist and familiarity with AMS independently predicted better knowledge (Jarab et al., 2024). Knowledge of AWaRe is notably weak; frontline professionals in Nigeria showed only moderate familiarity with the classification (Akpan et al., 2024), and a multi-country review found that many professionals can name the categories but cannot apply them clinically (Saleem et al., 2025). Training is the most modifiable determinant: a behavioural-science-informed programme in Ghana raised knowledge scores from 65% to 82% (Sneddon et al., 2020), and prior AMR training predicted good practice among 485 health workers in Addis Ababa (Getu et al., 2025).

Attitudes and perceived barriers. Attitudes are typically more favourable than knowledge, with 58% to 80% of respondents expressing positive views (Kimbowa et al., 2022; Sefah et al., 2023). However, favourable attitudes coexist with fatalism about feasibility: in Zimbabwe, clinicians regarded AMR as a national problem far more often than a problem in their own facility (Olaru et al., 2022), and Cameroonian physicians with a mean knowledge score of 56% were nonetheless confident that they used antibiotics appropriately (Domche Ngongang et al., 2021). Qualitative syntheses identify ineffective regulation, scarce laboratory capacity and patient demand as dominant barriers (Porter et al., 2021; Nkinda et al., 2022), while leadership commitment, functioning therapeutics committees and accessible guidelines act as facilitators (Mbugua et al., 2020; Obasanya et al., 2022).

Practices and the knowledge–practice gap. Self-reported and audited practices consistently lag knowledge. In Tanzania, 72.6% of pharmacists with excellent knowledge admitted dispensing antibiotics without prescription (Poyongo & Sangeda, 2020), and community pharmacies across sub-Saharan Africa show a median non-prescription dispensing rate of 67.5% (Orisile et al., 2024). In the Democratic Republic of Congo, moderate knowledge coexisted with broad-spectrum prescribing without microbiological confirmation in over 80% of cases (Bahinzi et al., 2025), and appropriate prescribing across West Africa averages about 50% (Donkor et al., 2025). Multifaceted interventions that pair education with guidelines, audit and restriction improve guideline adherence by around 45% (Siachalinga et al., 2022), and regional programmes have raised hospital stewardship scores substantially, although sustainability without external facilitation remains fragile (Wesangula et al., 2025). Evidence from humanitarian settings is sparse; MSF-supported hospitals, including Bentiu in South Sudan, show measurable consumption patterns but rarely undertake systematic audits (Skender et al., 2024), and Sudanese experience shows that conflict amplifies empirical broad-spectrum use (Fletcher et al., 2025).

Research gap. The literature thus converges on three propositions: knowledge is necessary but insufficient; attitudes are shaped by perceived feasibility; and system opportunity mediates whether knowledge becomes practice. Yet South Sudan is absent from this evidence

base. No study has measured AMS KAP among any cadre in the country, compared cadres, or tested determinants within a behavioural framework. The present study addresses this gap.

2.4 Conceptual Framework

Figure 1 operationalises the COM-B model for this study. Socio-demographic and professional characteristics (age, gender, cadre, qualification, experience, formal AMS training and department) are hypothesised to influence capability, measured as AMS knowledge (H01, H02), and motivation, measured as attitudes (H03). Capability and motivation are posited to shape behaviour, measured as cadre-specific practices, while individual characteristics may also act on practice directly (H04). Opportunity factors, comprising guideline availability, laboratory diagnostics, supervision, drug supply and patient expectations, are conceptualised as moderators that can block the translation of knowledge and positive attitudes into practice.

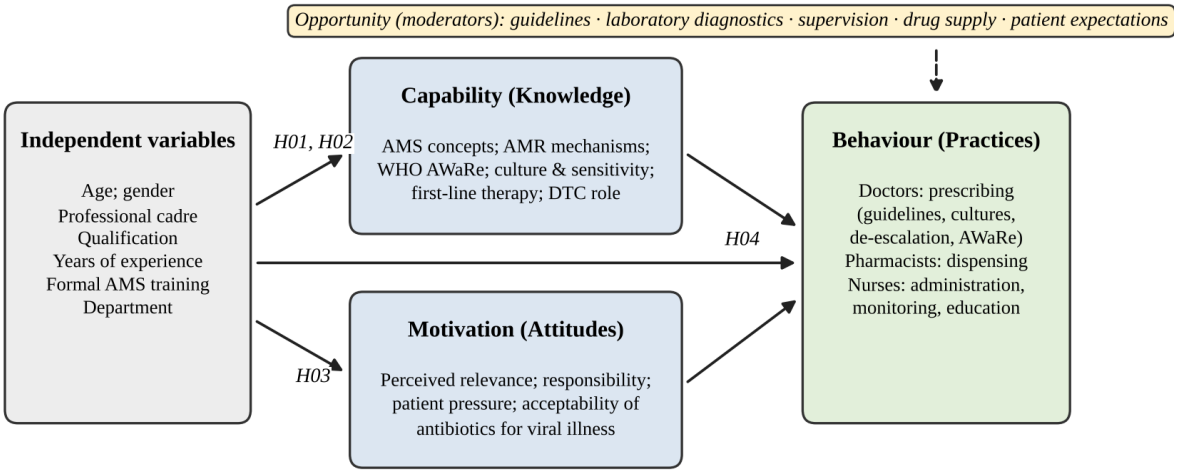


Figure 1. *COM-B-based conceptual framework of AMS knowledge, attitudes and practices.* Solid arrows denote hypothesised associations; the dashed arrow denotes moderating opportunity factors. Source: adapted from Michie et al. (2011).

3. Methodology

A quantitative, analytical cross-sectional design was employed, which is appropriate for estimating the distribution of KAP at a single point in time and for examining associations without manipulating the clinical environment (Beard, 2024). The study was conducted at Juba Teaching Hospital, South Sudan's largest tertiary referral facility, which provides internal medicine, surgery, paediatrics, obstetrics and gynaecology, outpatient and pharmacy services to patients from all ten states and three administrative areas. Its laboratory performs basic haematology and clinical chemistry, but culture and sensitivity testing is rarely available owing to shortages of reagents, equipment and trained personnel. The target population comprised all healthcare professionals who prescribe, dispense or administer antibiotics, namely doctors (medical officers, registrars and specialists), pharmacists (pharmacists and pharmacy technicians) and nurses. The sampling frame, obtained from the hospital's human resources department, listed approximately 500 eligible staff (150 doctors, 50 pharmacists and 300 nurses). Professionals with at least six months of service who were actively involved in antibiotic use and who gave written consent were eligible; trainees, staff on extended leave and those with less than six months of service were excluded.

Sample size was estimated with Cochran's formula, $n_0 = Z^2 p(1-p)/d^2$, assuming $Z = 1.96$, $p = .50$ in the absence of prior South Sudanese data, and $d = .05$, giving 385. Applying the finite population correction for $N = 500$ yielded 218, which was inflated by 10% for anticipated non-response to a target of 242. Stratified random sampling with proportional allocation was used, with cadres as strata; within each stratum participants were selected by computer-generated random numbers in SPSS, and replacements were drawn from the same stratum when a selected person was unavailable. Rounding to secure adequate representation of the smallest stratum produced a final sample of 245 (74 doctors, 26 pharmacists and 145 nurses), all of whom returned complete questionnaires.

Data were collected over four weeks in 2026 using a structured, self-administered English-language questionnaire adapted from validated African and international AMS KAP instruments (Kimbowa et al., 2022; Lister et al., 2025; Sefah et al., 2023; Zainaghi et al., 2024). Section A captured socio-demographic and professional characteristics, including formal AMS or AMR training in the previous two years. Section B contained ten multiple-choice and true/false knowledge items covering the definition of AMS, antibiotic activity against viruses, drivers of resistance, AWaRe categories, culture and sensitivity testing, first-line pneumonia therapy, premature cessation of therapy and the role of

the Drug and Therapeutics Committee. Section C contained ten five-point Likert attitude statements, with negatively worded items reverse-scored. Section D contained six cadre-specific practice items rated on a five-point frequency scale (never to always) for doctors, pharmacists and nurses, respectively. Content validity was established through expert review against the study objectives and COM-B domains, and face validity through a pilot among 21 professionals outside the sample, after which ambiguous items were reworded.

Internal consistency was assessed with Cronbach's α. The pharmacists' and nurses' practice scales showed acceptable consistency (α = .659 for each; pilot α = .850 for pharmacists), whereas the knowledge (α = .303), attitude (α = .254) and doctors' practice (α = .388) scales did not. Because these instruments span conceptually distinct domains, for example definitions, resistance mechanisms and AWaRe classification, low α was interpreted as multidimensionality rather than random error (Taborda et al., 2024; Zainaghi et al., 2024). Item-level analysis was therefore treated as primary, and composite scores were retained for comparability with the literature. Each correct knowledge response scored one point; attitude and practice responses were summed after reverse-scoring and converted to percentages. Following modified Bloom's cut-offs (Deeb et al., 2024; Juttla et al., 2024), knowledge and practice were classified as good or appropriate (≥ 80%), moderate (60–79%) or poor or inappropriate (< 60%), and attitudes as positive (≥ 80%) or negative (< 80%).

Questionnaires were checked for completeness, entered into IBM SPSS Statistics version 26, and a random 10% of entries were verified against paper forms. Descriptive statistics comprised frequencies, percentages with Wilson 95% confidence intervals, means and standard deviations. Bivariate associations were examined with Pearson's chi-square test for categorical outcomes, independent-samples *t*-tests and one-way ANOVA with least significant difference (LSD) post-hoc comparisons for continuous scores. Effect sizes (Cramér's V, Cohen's d and η^2) were derived from the test statistics to gauge practical significance. Variables with $p < .20$ at the bivariate stage were entered into multivariable binary logistic regression models for good knowledge, positive attitudes and appropriate practice (separately for doctors and nurses; pharmacists were too few for modelling). Model adequacy was assessed with the omnibus likelihood-ratio test, the Hosmer–Lemeshow statistic and Nagelkerke R^2, and multicollinearity was screened through inspection of standard errors. Adjusted odds ratios (AOR) with 95% confidence intervals are reported, and $p < .05$ denoted statistical significance. Ethical approval was granted by the University of Juba Research Ethics Committee, with administrative clearance from the Juba Teaching Hospital Institutional Review Board and the Ministry of Health. The study adhered to the Declaration of Helsinki (World Medical Association, 2025) and CIOMS (2016) guidelines; written informed consent was obtained, questionnaires were anonymous and completed privately, participants were assured that responses would never be used for disciplinary purposes, and data were stored on an encrypted, password-protected device.

4. Results and Discussions

4.1 Descriptive Statistics

All 245 sampled professionals participated (response rate 100%). As shown in Table 1, the workforce was young and early-career: 55.1% were aged 20–29 years and 75.9% had five or fewer years of experience. Nurses formed the largest cadre (59.2%), more than half of participants held a diploma (53.1%), and only 39.2% had received formal AMS training in the preceding two years.

Table 1: ***Socio-Demographic and Professional Characteristics of Participants (N = 245)***

Characteristic	n	% [95% CI]	Characteristic	n	% [95% CI]
Gender			*Years of experience*		
Male	134	54.7 [48.4, 60.8]	1–5	186	75.9 [70.2, 80.8]
Female	111	45.3 [39.2, 51.6]	6–10	32	13.1 [9.4, 17.9]
Age (years)			11 or more	27	11.0 [7.7, 15.6]
20–29	135	55.1 [48.8, 61.2]	*Formal AMS training*		
30–39	84	34.3 [28.6, 40.4]	Yes	96	39.2 [33.3, 45.4]
40–49	19	7.8 [5.0, 11.8]	No	149	60.8 [54.6, 66.7]
50 and above	7	2.9 [1.4, 5.8]	*Department*		
Professional cadre			Medical ward	75	30.6 [25.2, 36.6]
Doctor	74	30.2 [24.8, 36.2]	Surgical ward	51	20.8 [16.2, 26.3]
Pharmacist	26	10.6 [7.3, 15.1]	Obstetrics & gynaecology	47	19.2 [14.7, 24.6]
Nurse	145	59.2 [52.9, 65.2]	Outpatient department	31	12.7 [9.1, 17.4]
Highest qualification			Pharmacy	21	8.6 [5.7, 12.7]
Diploma	130	53.1 [46.8, 59.2]	Paediatric ward	8	3.3 [1.7, 6.3]
Bachelor's	99	40.4 [34.5, 46.7]	Other	12	4.9 [2.8, 8.4]
Master's / other	16	6.5 [4.1, 10.3]			

Note. CI = confidence interval (Wilson score method). Master's (n = 14) and other qualifications (n = 2) are combined. AMS = antimicrobial stewardship.

The mean knowledge score was 67.39% (*SD* = 16.01; range 20–100%). One-third of participants (33.1%, 95% CI [27.5, 39.2]) achieved good knowledge, 48.6% moderate and 18.4% poor knowledge (Table 2). Item-level analysis revealed a sharply uneven profile: procedural and institutional concepts were well understood, such as the role of the Drug and Therapeutics Committee (91.4%) and the danger of stopping antibiotics early (87.3%), whereas conceptual and diagnostic stewardship were weak. Only 32.7% correctly identified the meaning of the AWaRe Access group, 50.2% understood that resistance can emerge without direct individual exposure, 54.3% answered correctly on culture-guided prescribing, and 42.9% did not recognise that antibiotics are ineffective against viruses.

Attitudes were favourable in principle but ambivalent in application (Table 3, presented after the knowledge items in Table 2). The mean attitude score was 76.63% (*SD* = 10.24), and 45.3% (95% CI [39.2, 51.6]) met the threshold for positive attitudes. Large majorities regarded AMR as a serious problem in South Sudan (82.4%) and AMS as relevant to their daily work (78.3%), and 80.0% wanted further training. Yet 80.0% agreed that the lack of laboratory support makes good stewardship difficult, 44.9% acknowledged that patient pressure influences their decisions, and one in three (33.5%) considered antibiotics for viral infections acceptable when patients expect them.

Table 2: ***Knowledge of Antimicrobial Stewardship Concepts (N = 245)***

Knowledge item	Correct, n (%)	Incorrect, n (%)
Item-level responses (ranked by correct responses)		
Role of the Drug and Therapeutics Committee	224 (91.4)	21 (8.6)
Stopping antibiotics early contributes to resistance	214 (87.3)	31 (12.7)
Factors contributing to AMR	211 (86.1)	34 (13.9)
Definition of antimicrobial stewardship	208 (84.9)	37 (15.1)
First-line treatment of community-acquired pneumonia	170 (69.4)	75 (30.6)
Ceftriaxone as a Watch antibiotic	148 (60.4)	97 (39.6)
Antibiotics are ineffective against viruses	140 (57.1)	105 (42.9)
Culture and sensitivity-guided prescribing	133 (54.3)	112 (45.7)
Resistance can arise without individual exposure	123 (50.2)	122 (49.8)
Meaning of the AWaRe "Access" group	80 (32.7)	165 (67.3)
Overall knowledge level, n (%)		
Good (≥ 80%)	81 (33.1)	—
Moderate (60–79%)	119 (48.6)	—
Poor (< 60%)	45 (18.4)	—

Note. Mean knowledge score = 67.39% (*SD* = 16.01). Percentages may not sum to 100 because of rounding. AWaRe = WHO Access, Watch, Reserve classification.

Table 3: ***Distribution of Responses to Attitude Statements (N = 245)***

Statement	Agree, n (%)	Neutral, n (%)	Disagree, n (%)
AMR is a serious problem in South Sudan	202 (82.4)	26 (10.6)	17 (6.9)
Lack of laboratory support makes good AMS difficult	196 (80.0)	34 (13.9)	15 (6.1)
I would benefit from additional AMS training	196 (80.0)	27 (11.0)	22 (9.0)
AMS is relevant to my daily work	192 (78.3)	18 (7.3)	35 (14.3)
The WHO AWaRe classification is useful	179 (73.0)	41 (16.7)	25 (10.2)
Antibiotic overuse is a problem in this hospital	175 (71.4)	37 (15.1)	33 (13.5)
I have personal responsibility for AMS	163 (66.5)	38 (15.5)	44 (18.0)
Colleagues use antibiotics appropriately	142 (57.9)	69 (28.2)	34 (13.9)
Patient pressure often influences my decisions[a]	110 (44.9)	43 (17.6)	92 (37.6)
Antibiotics for viral infections are acceptable if expected[a]	82 (33.5)	28 (11.4)	135 (55.1)

Note. Agree combines "agree" and "strongly agree"; disagree combines "disagree" and "strongly disagree". Mean attitude score = 76.63% (*SD* = 10.24); positive attitude (≥ 80%) = 111 (45.3%), negative = 134 (54.7%). [a]Negatively worded item, reverse-scored.

Self-reported practice diverged markedly by cadre (Tables 4 and 5). Doctors had the lowest mean practice score (71.76%) and only 23.0% (95% CI [14.9, 33.7]) reported appropriate practice. Although 83.8% often or

always consulted national guidelines, fewer than two-thirds requested cultures (64.9%), de-escalated therapy (56.8%) or preferred Access over Watch agents (60.8%), fewer than half prescribed the shortest effective course (48.6%), and 55.4% often or always prescribed antibiotics for viral infections. Pharmacists (82.44%) and nurses (83.95%) reported higher practice scores, with 73.1% of each cadre classified as appropriate; the weakest pharmacist behaviours were reporting non-prescription dispensing to supervisors (57.7%) and asking about allergies (65.4%), and the weakest nursing behaviour was monitoring for adverse reactions (73.1%).

Table 4: ***Self-Reported Antimicrobial Stewardship Practices by Professional Cadre***

Practice item	Often/always, n (%)	Never to sometimes, n (%)
Doctors (n = 74): prescribing		
Consult national treatment guidelines	62 (83.8)	12 (16.2)
Request culture and sensitivity testing	48 (64.9)	26 (35.1)
Choose Access over Watch antibiotics	45 (60.8)	29 (39.2)
De-escalate antibiotic therapy	42 (56.8)	32 (43.2)
Prescribe antibiotics for viral infections[a]	41 (55.4)	33 (44.6)
Prescribe the shortest effective course	36 (48.6)	38 (51.4)
Pharmacists (n = 26): dispensing		
Counsel patients on antibiotic use	22 (84.6)	4 (15.4)
Dispense only against a valid prescription	21 (80.8)	5 (19.2)
Check for drug interactions	21 (80.8)	5 (19.2)
Refuse inappropriate prescriptions	20 (76.9)	6 (23.1)
Ask about allergies	17 (65.4)	9 (34.6)
Report non-prescription dispensing to supervisor	15 (57.7)	11 (42.3)
Nurses (n = 145): administration and monitoring		
Educate patients to complete the full course	117 (80.7)	28 (19.3)
Report adverse drug reactions	116 (80.0)	29 (20.0)
Administer antibiotics on time	114 (78.6)	31 (21.4)
Check for allergies before administration	114 (78.6)	31 (21.4)
Document administration accurately	112 (77.2)	33 (22.8)
Monitor for adverse reactions	106 (73.1)	39 (26.9)

Note. Items are ranked within cadre. [a]Undesirable behaviour; higher frequency indicates poorer stewardship (reverse-scored in composite scores).

Table 5: ***Composite Practice Scores and Practice Levels by Professional Cadre***

Cadre	n	*M* (*SD*)	Inappropriate, n (%)	Moderate, n (%)	Appropriate, n (%) [95% CI]	α
Doctors	74	71.76 (10.62)	6 (8.1)	51 (68.9)	17 (23.0) [14.9, 33.7]	.388
Pharmacists	26	82.44 (11.76)	1 (3.8)	6 (23.1)	19 (73.1) [53.9, 86.3]	.659
Nurses	145	83.95 (13.09)	6 (4.1)	33 (22.8)	106 (73.1) [65.4, 79.7]	.659

Note. Practice levels: appropriate ≥ 80%, moderate 60–79%, inappropriate < 60%. α = Cronbach's alpha. Because practice items differ by cadre, scores are not directly comparable across cadres; doctors' composite should be interpreted with caution given low internal consistency.

4.2 Inferential Statistics

Knowledge varied significantly by cadre, $F(2, 242) = 3.34$, $p = .037$, $\eta^2 = .027$, with LSD comparisons showing that doctors outscored nurses by 5.23 percentage points ($p = .026$); doctors and pharmacists did not differ ($p = .816$). Knowledge also differed by age group, $F(3, 241) = 2.85$, $p = .038$, $\eta^2 = .034$, with those aged 40–49 years outperforming those aged 20–29 ($p = .007$) and 30–39 ($p = .005$), and by qualification, $F(3, 241) = 3.09$, $p = .028$, $\eta^2 = .037$, with master's graduates outperforming diploma ($p = .005$) and bachelor's holders ($p = .040$). Trained professionals scored 7.94 points higher than untrained colleagues, $t(243) = -3.79$, $p < .001$, $d = 0.50$, a medium effect, and the proportion with good knowledge was 44.8% among trained versus 26.2% among untrained staff, $\chi^2(2) = 10.79$, $p = .005$, Cramér's $V = .21$. By contrast, attitude scores did not differ by any characteristic tested (Table 6).

Table 6: ***Bivariate Comparison of Knowledge and Attitude Scores by Participant Characteristics***

Characteristic	n	Knowledge		Attitude	
		M (*SD*)	Test statistic	*M* (*SD*)	Test statistic
Professional cadre					
Doctor	74	70.68 (17.54)	$F(2, 242) = 3.34$	77.43 (8.84)	$F(2, 242) = 0.72$
Pharmacist	26	71.54 (16.17)	$p = .037*$	77.92 (12.78)	$p = .488$
Nurse	145	65.45 (15.63)	$\eta^2 = .027$	75.99 (10.43)	$\eta^2 = .006$
Formal AMS training					
Yes	96	72.50 (16.29)	$t(243) = -3.79$	76.85 (10.65)	$t(243) = -0.28$
No	149	64.56 (15.83)	$p < .001***$, $d = 0.50$	76.48 (10.00)	$p = .783$, $d = 0.04$
Gender					
Male	134	67.01 (16.55)	$t(243) = -0.69$	77.03 (10.84)	$t(243) = 0.67$
Female	111	68.47 (16.36)	$p = .492$, $d = 0.09$	76.14 (9.49)	$p = .501$, $d = 0.09$
Age (years)					
20–29	135	67.04 (13.99)	$F(3, 241) = 2.85$	—	—
30–39	84	66.19 (17.83)	$p = .038*$	—	—
40–49	19	77.89 (20.16)	$\eta^2 = .034$	—	—
50 and above	7	70.00 (25.17)		—	—
Highest qualification					
Diploma	130	65.54 (15.51)	$F(3, 241) = 3.09$	—	—
Bachelor's	99	68.99 (16.87)	$p = .028*$	—	—
Master's	14	78.57 (17.91)	$\eta^2 = .037$	—	—
Other	2	65.00 (21.21)		—	—

Note. Scores are percentages. Effect sizes (η^2, Cohen's *d*) were derived from the reported test statistics. Dashes indicate comparisons not performed. $*p < .05$. $***p < .001$.

In the multivariable model for good knowledge (Table 7), which was statistically significant, $\chi^2(4) = 13.77$, $p = .008$, and well calibrated (Hosmer–Lemeshow $p = .816$), formal AMS training was the only independent predictor: trained professionals had approximately twice the odds of good knowledge (AOR = 2.07, 95% CI [1.14, 3.77], $p = .018$) after adjusting for cadre and gender. The attenuation of the cadre effect after adjustment suggests that part of the doctor–nurse knowledge difference is explained by unequal access to training. The model for positive attitudes was not significant, $\chi^2(4) = 2.48$, $p = .649$, and no predictor reached significance.

Table 7: ***Multivariable Logistic Regression for Good Knowledge and Positive Attitudes (N = 245)***

Predictor	Good knowledge (≥ 80%)			Positive attitude (≥ 80%)		
	AOR	95% CI	*p*	AOR	95% CI	*p*
Formal AMS training (ref. = no)						
Yes	2.07	[1.14, 3.77]	.018*	1.18	[0.67, 2.08]	.576
Professional cadre (ref. = nurse)						
Doctor	1.38	[0.72, 2.65]	.340	1.00	[0.54, 1.86]	.997
Pharmacist	1.74	[0.72, 4.19]	.220	1.22	[0.52, 2.84]	.650
Gender (ref. = female)						
Male	0.62	[0.36, 1.07]	.089	1.42	[0.85, 2.36]	.181
Model summary						
Omnibus $\chi^2(4)$	13.77		.008	2.48		.649
Hosmer–Lemeshow *p*		.816			—	
Nagelkerke R^2		.076			—	

Note. AOR = adjusted odds ratio; CI = confidence interval; ref. = reference category. The training estimate for knowledge is the reciprocal of the originally estimated AOR for no training (0.483, 95% CI [0.265, 0.880]). $*p < .05$.

Among doctors, the practice model was not significant, $\chi^2(4) = 1.80$, $p = .773$, and neither training, gender nor experience predicted appropriate practice (Table 8). Among pharmacists, bivariate analysis showed no association with gender or training (both $p = .568$), and the small stratum precluded modelling. Among nurses, experience was associated with practice scores at the bivariate level, $F(2, 142) = 3.58$, $p = .030$, $\eta^2 = .048$, and the multivariable model was significant, $\chi^2(5) = 19.45$, $p = .002$: nurses with 1–5 years of experience had more than seven times the odds of appropriate practice compared with those with 11 or more years (AOR = 7.31, 95% CI [1.68, 31.85], $p = .008$). Department was

significant as a block ($\chi^2(3) = 11.74$, $p = .008$), although no individual department differed from the reference.

Table 8: Multivariable Logistic Regression for Appropriate Practice among Doctors and Nurses

Predictor	AOR	95% CI	*p*
Doctors (n = 74); model $\chi^2(4) = 1.80$, $p = .773$			
Formal AMS training: yes (ref. = no)	1.06	[0.28, 4.02]	.928
Gender: male (ref. = female)	0.48	[0.15, 1.51]	.207
Experience 1–5 years (ref. = 11+ years)	0.72	[0.17, 3.07]	.656
Experience 6–10 years (ref. = 11+ years)	0.64	[0.12, 3.43]	.599
Nurses (n = 145); model $\chi^2(5) = 19.45$, $p = .002$			
Experience 1–5 years (ref. = 11+ years)	7.31	[1.68, 31.85]	.008∗∗
Experience 6–10 years (ref. = 11+ years)	2.75	[0.41, 18.46]	.297
Medical ward[b]	1.39	[0.35, 5.54]	.642
Surgical/paediatric ward[b]	2.04	[0.50, 8.39]	.325
Outpatient department[b]	0.33	[0.08, 1.27]	.107

Note. AOR = adjusted odds ratio; CI = confidence interval. Pharmacists (n = 26) were not modelled because of the small stratum size. [b]Reference category = obstetrics and gynaecology; department was significant as a block, $\chi^2(3) = 11.74$, $p = .008$. ∗∗$p < .01$.

4.3 Hypotheses Testing

Table 9 summarises the decisions on the four null hypotheses. H01 and H02 were rejected, confirming that capability varies systematically with professional and educational characteristics and is responsive to training. H03 was retained, indicating that attitudinal ambivalence is diffuse across the workforce rather than concentrated in identifiable sub-groups. H04 was partially rejected: the null was retained for doctors and pharmacists but rejected for nurses, among whom shorter experience predicted appropriate practice.

Table 9: Summary of Hypothesis Testing

Null hypothesis	Test and key statistic	Decision
H01: Knowledge does not differ by cadre, age or qualification	ANOVA: cadre $F(2, 242) = 3.34$, $p = .037$; age $F(3, 241) = 2.85$, $p = .038$; qualification $F(3, 241) = 3.09$, $p = .028$	Rejected
H02: Formal AMS training is not associated with good knowledge	$\chi^2(2) = 10.79$, $p = .005$; AOR = 2.07, 95% CI [1.14, 3.77], $p = .018$	Rejected
H03: Attitudes do not differ by cadre, training or gender	$F(2, 242) = 0.72$, $p = .488$; $t(243) = -0.28$, $p = .783$; $t(243) = 0.67$, $p = .501$; model $p = .649$	Not rejected
H04: Characteristics are not associated with appropriate practice	Doctors: model $p = .773$; pharmacists: $p = .568$; nurses: 1–5 years AOR = 7.31, $p = .008$	Partially rejected (nurses)

Note. Decisions are based on $\alpha = .05$. AOR = adjusted odds ratio.

4.4 Discussion of Results

This first assessment of AMS KAP in South Sudan reveals a workforce that endorses stewardship, possesses moderate but uneven knowledge, and reports practice, particularly prescribing practice, that falls well short of both. Read through the COM-B lens, the findings pointless to a deficit of will than to a deficit of capability in specific conceptual domains, compounded by severely constrained opportunity.

Capability. The proportion with good knowledge (33.1%) exceeds that reported among Ghanaian hospital staff (8.9%; Sefah et al., 2023) and Nigerian physicians (22.3%; Ogoina et al., 2021), but is far below the 75% observed among Zambian AMS participants (Mudenda et al., 2024), a contrast best explained by the latter's purposive selection of stewardship-engaged staff. The more instructive finding is the shape of knowledge. Participants mastered institutional and procedural facts, yet two-thirds could not interpret the AWaRe Access category and nearly half did not know that antibiotics are ineffective against viruses. This mirrors the multi-country pattern in which professionals recognise the AWaRe label without being able to operationalise it (Akpan et al., 2024; Saleem et al., 2025). In a hospital where ceftriaxone dominates prescribing (Otim et al., 2021), this gap is consequential: without the cognitive schema of Access-first prescribing, the national commitment to 70% Access use (United Nations General Assembly, 2024) has no bedside foothold. The independent effect of training (AOR = 2.07; $d = 0.50$) is consistent with Ghanaian and Ethiopian evidence (Getu et al., 2025; Sneddon et al., 2020) and, crucially, identifies the most modifiable capability lever. The attenuation of the cadre effect after adjustment for training further suggests that nurses' lower knowledge

reflects exclusion from training opportunities rather than an intrinsic professional deficit, echoing Balliram et al. (2021) and Tembo et al. (2022). That knowledge peaked at 40–49 years and among master's graduates, yet was unrelated to years of experience, implies that structured learning rather than accumulated time on the job builds stewardship capability.

Motivation. Only 45.3% met the positive-attitude threshold, lower than the 58–79% reported in Uganda and Ghana (Kimbowa et al., 2022; Sefah et al., 2023). Item-level responses, however, show that this is not hostility to stewardship: over four-fifths recognised AMR as a national threat and wanted training. Rather, attitudes are depressed by perceived infeasibility, with 80% stating that inadequate laboratory support makes stewardship difficult, and by normative pressure, with 44.9% acknowledging patient influence. In Theory of Planned Behaviour terms, favourable evaluations are being overridden by low perceived behavioural control and strong subjective norms (Ajzen, 1991; Chan et al., 2024). The finding that one-third accept antibiotics for viral infections when patients expect them, despite 84.9% correctly defining AMS, is a direct signature of this normative override. The absence of any demographic predictor of attitudes (H03 retained) contrasts with Ugandan findings in which gender and education predicted attitudes (Kimbowa et al., 2022), and implies that the constraint is environmental and shared, so that attitude change requires system-level rather than sub-group-targeted interventions.

Behaviour and opportunity. The most striking result is the prescriber gap: only 23.0% of doctors reported appropriate practice, compared with 73.1% of pharmacists and nurses, even though doctors had the highest knowledge. More than half often prescribed antibiotics for viral infections and fewer than half used the shortest effective course. This is lower than the 31.6% good-practice rate among Nigerian physicians (Ogoina et al., 2021) and is congruent with the empirical, Watch-heavy prescribing documented at the same hospital (Otim et al., 2021). COM-B explains the paradox: doctors carry the decision burden under maximal diagnostic uncertainty, with no culture results to de-escalate against, frequent Access stock-outs, heavy workloads and no audit or feedback, so that physical and social opportunity, not capability, is the binding constraint (Fletcher et al., 2025; Nkinda et al., 2022). The fact that training did not predict doctors' practice, although it predicted knowledge, is perhaps the study's most policy-relevant inference, because it confirms that education alone will not close the prescribing gap (Siachalinga et al., 2022). Pharmacists' and nurses' higher scores plausibly reflect more protocolised tasks, but should be interpreted cautiously: 80.8% of pharmacists reported dispensing only against prescriptions, far above the regional non-prescription dispensing norm (Orisile et al., 2024; Poyongo & Sangeda, 2020), which suggests a combination of the salaried hospital context and social desirability. The fact that 42.3% did not reliably report non-prescription dispensing points to weak supervisory accountability (Otieno et al., 2022).

Among nurses, the more than seven-fold higher odds of appropriate practice among those with 1–5 years of experience, relative to those with over a decade, runs counter to the intuitive expectation that experience improves practice but agrees with Ethiopian evidence that younger health workers report better AMR practices (Getu et al., 2025). Two mechanisms are plausible: recent curricula may place greater emphasis on medication safety and stewardship, and long-serving staff may experience "practice drift" towards expedient routines in an unsupervised environment. The wide confidence interval warrants caution, but the implication, that experienced nurses require structured refresher training and mentorship, is robust to either mechanism.

Collectively, the results support a three-tier interpretation that refines the classical KAP model. Knowledge is moderately responsive to training; attitudes are uniformly constrained by system realities; and practice, especially prescribing, is governed by opportunity. Stewardship gains at Juba Teaching Hospital will therefore depend on pairing capability building with diagnostic investment, an AWaRe-based formulary, prescribing restriction and audit-and-feedback, the multifaceted combination that has shown the most consistent effect in African hospitals (Siachalinga et al., 2022; Wesangula et al., 2025). Several limitations temper these conclusions. Practices were self-reported and probably overestimate adherence; the cross-sectional design precludes causal inference; the single-site sample limits generalisability; the small pharmacist stratum constrained statistical power; and the low internal consistency of the knowledge, attitude and doctors' practice scales means that composite classifications are indicative, which is why item-level findings were prioritised. Future work should triangulate self-reports with point-prevalence surveys and prescription audits and develop psychometrically validated, domain-specific AMS scales for fragile settings.

5. Conclusion and Recommendations

5.1 Conclusion

This study establishes the first behavioural baseline for antimicrobial stewardship in South Sudan. Healthcare professionals at Juba Teaching Hospital possess moderate knowledge with critical blind spots in the AWaRe classification, viral–bacterial differentiation and diagnostic stewardship; they endorse stewardship but feel constrained by absent laboratory support and patient pressure; and they report practices that diverge sharply by cadre, with doctors displaying a pronounced knowledge–practice gap. Formal AMS training doubles the odds of good knowledge but does not by itself translate into better prescribing, while early-career nurses outperform their more experienced colleagues.

Interpreted through the COM-B model, the evidence indicates that capability can be built through training, but that behaviour will change only when opportunity is restructured. Stewardship in this setting must therefore be conceived as a health-system reform rather than an educational campaign.

5.2 Recommendations

Based on the study findings, the following recommendations were made

1. **Institutionalise stewardship governance.** Juba Teaching Hospital should constitute a multidisciplinary AMS committee within a functioning Drug and Therapeutics Committee, with a designated pharmacist-led stewardship lead, an AWaRe-based hospital formulary and pre-authorisation for Watch and Reserve antibiotics, particularly ceftriaxone.
2. **Deliver targeted, competency-based training.** Mandatory, case-based AMS training should be provided to all cadres, prioritising nurses and early-career staff, with explicit modules on AWaRe application, viral–bacterial differentiation, culture-guided de-escalation and shortest effective duration, and with refresher training and mentorship for experienced nurses.
3. **Restructure opportunity for prescribers.** The Ministry of Health and partners should invest in a minimum microbiology capacity (blood and urine culture with susceptibility testing), point-of-care tests such as C-reactive protein, reliable supply of Access antibiotics, and pocket or mobile guideline tools to reduce diagnostic uncertainty.
4. **Introduce audit and feedback.** Quarterly point-prevalence surveys using WHO methodology, with prescriber-level feedback and AWaRe consumption indicators, should benchmark progress towards the national 70% Access target, with results reported routinely to hospital management and the national AMR coordinating mechanism.
5. **Address normative pressure.** Patient-facing communication on the futility of antibiotics for viral illness, together with delayed-prescribing and shared decision-making protocols, should be implemented to support clinicians in resisting patient demand.
6. **Strengthen accountability and research.** A non-punitive reporting pathway for inappropriate dispensing should be established, AMS competencies should be embedded in pre-service curricula, and future studies should validate domain-specific KAP scales and use objective audits across multiple South Sudanese hospitals to evaluate interventions.

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