Article

Implementation of Antimicrobial Stewardship in a District Hospital in the Ashanti Region of Ghana Using a Health Partnership Model

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Abstract: Commonwealth Partnerships for Antimicrobial Stewardship (AMS) uses a health partnership model to establish AMS in Commonwealth countries. The University Hospital of Kwame Nkrumah University of Science and Technology in partnership with Ulster University, in Northern Ireland undertook an AMS project from November 2021 to May 2022. We report on the implementation and its effect on antibiotic use and infections management at the University Hospital. The Global-Point Prevalence Survey (PPS) protocol was used to assess antibiotics use at the hospital at the beginning, midpoint and end of the project. Feedback on each PPS was given to staff to inform behaviour change and improve antibiotic prescribing. Antibiotic use reduced from 65% at baseline to 59.7% at the end of the project. The rate of health-associated infections also reduced from 17.5% at baseline to 6.5%. In addition, the use of antibiotics belonging to the WHO *Access group* at the hospital was 40% initially but increased to 50% at the project endpoint. Culture and antibiotic susceptibility requests increased from the beginning of the project from 111 total requests to 330 requests over 7 months. The AMS model implemented improved antibiotic use as well as requests for culture and susceptibility test which must be sustained.

Keywords: Antimicrobial stewardship; Point prevalence survey; Antimicrobial resistance; Ghana; CwPAMS; Antibiotic use; THET

1. Introduction

Low-and-middle-income countries (LMICs) like Ghana are known to have high burden of antimicrobial resistance (AMR) which adversely impacts on healthcare delivery and patients outcomes [1,2]. AMR is associated with significant morbidity and mortality in affected patients following infections from drug-resistant pathogens. The associated increase in healthcare costs in relation to the menace of AMR also place great economic burden on the already constrained finances of households in LMICs.

In such LMICs, interventions aimed at improving antibiotic use need to cost effective to achieve sustainable impact. A situational analysis of antimicrobial resistance challenge

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in Ghana led to the identification of many gaps regarding the use of antibiotics in the health system and measures to combat the AMR challenge [3]. Subsequently the development of Ghana's first policy and National Action Plan (NAP) guided by the Global Action Plan of WHO and partners, outlined strategies and interventions required to fight AMR in Ghana [4,5]. The action plan was based on the one health concept which takes a wholistic approach to fight AMR. It advocates for increased surveillance on AMR and antimicrobial use (AMU), infection prevention, and optimized AMU across human, animal and food production, and environmental health sectors [6].

Antimicrobial stewardship (AMS) is known to be a cost-effective means of reducing the progression of antimicrobial resistance (AMR) especially in resource-limited settings with high AMR burden [7–10]. AMS programs (ASP) enable health facilities to optimize antibiotic use and improve health outcomes from infectious disease management. Impactful ASPs should possess important core elements and structure to be successful and ensure long term and sustainable impact. WHO has developed a practical toolkit based on which institutions in LMICs can model their programs. Additionally, the Commonwealth Partnerships for AMS (CwPAMS) managed by the Commonwealth Pharmacists Association (CPA), uses a health partnership model shown to be effective in establishing ASPs in LMICs in Commonwealth countries [11]. This model leverages expertise from the National Health Service (NHS) facilities in the United Kingdom (UK) to support the implementation of AMS in LMIC Health facilities. CwPAMS based on this model has also developed a toolkit to support institutions to set up sustainable cost-effective programs to improve antibiotic use [12].

Core among AMS activities are prevalence surveillance of antibiotic use [13,14]. PPS on antibiotic use is an established standard means of measuring antibiotic use among inpatients. Their relatively inexpensive cost of delivery means they are easy to conduct in LMIC health facilities [15]. PPSs support ASPs to assess their impact on antibiotic use through multiple evaluations as well as identifying targets for improvement in antibiotic use [16,17].

A previous assessment of antibiotic use through a PPS in hospitals in the Ashanti region including the University Hospital found antibiotic use to be relatively high among inpatients with potential implications for quality of patient care in infectious disease management [17]. Based on the health partnership model established and gaps identified in the earlier study, the University Hospital of of Kwame Nkrumah University of Science and Technology (KNUST) in collaboration with the School of Pharmacy, Ulster University, Coleraine Campus in Northern Ireland, and other researchers at KNUST set up an ASP intervention and monitored over a period of seven months. The purpose of this paper is to report on the outcome of the ASP model intervention implemented and its impact on antibiotic use.

2. Materials and Methods

The intervention comprised of a bundled stewardship programme involving education, audit and feedback (information) strategy for improving antibiotic use at the University Hospital, based on the WHO AMS and Commonwealth Partnerships for Antimicrobial Stewardship (CwPAMs) toolkits. These are practical toolkits upon which AMS programmes can be modelled for impact and sustainability [12,18].

2.1. Key stages of intervention

i. In conjunction with the management of the University hospital, a multidisciplinary AMS committee was formed as a stand-alone committee.

ii. Members of this committee constituted the AMS team that implemented various components of AMS and also conducted surveillance (PPs) on antibiotic use at the hospital.

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iii. The team led by a Family Health Physician Consultant and infectious disease specialist and a clinical pharmacist/researcher subsequently carried out daily reviews of antibiotic use on the ward by pharmacists, monthly AMS team meetings and quarterly stewardship activities to achieve the objectives of the project. AMS activities carried out included the following:

a. Monitoring to ensure indications for antibiotic therapy are appropriately documented
b. Educating clinicians to take samples for culture and susceptibility analyses before empiric antibiotic therapy is initiated.
c. Conduct training seminars to provide counselling and recommendations to other clinicians to improve prescribing behaviours through seminars and ward rounds
d. In consultation with infectious disease specialist and other consultants in the hospital, select antibiotics to place on restricted access (requiring preauthorization before use) to reduce their inappropriate use.

The AMS team conducted and provided feedback to the hospital staff (especially prescribers) on antibiotic use through Point Prevalence Surveys (PPSs) at the beginning, midpoint (fourth month after project start) and at the end of the project (seventh month after project) to determine the impact of the interventions. The Global-PPS protocol was used to conduct the PPS due to its ease of use and quick feedback that could be promptly used to assess stewardship activities as well as provide information to prescribers especially on prescribing patterns.

2.2. Study Setting

The University Hospital is a 135-bed district-level hospital located on the campus of the Kwame Nkrumah University of Science and Technology (KNUST), Kumasi. It has a catchment population of over 300,000. It provides general and specialist services to students of the university, staff and their dependents as well as private patients within the Oforikrom Municipality and greater Kumasi. The hospital as part of this project set up a multi-disciplinary committee responsible for undertaking activities in antimicrobial stewardship made up of three pharmacists, a nurse (who also served as the hospital's IPC focal person), three medical doctors (one is an infectious disease specialist), a hospital administrator and two laboratory scientists.

2.3. Study Design

The intervention targeted staff from all health cadres in the hospital through hybrid training and education seminars to enable staff identify ways they could include AMS in their routine activities while creating awareness on AMR. Audits of antibiotic use (PPS) were done and feedback was given to prescribers and pharmacists in the hospital through face-to-face meetings and by sharing on their various WhatsApp platforms. A report on AMS activities including audits were also shared with the hospital management as feedback.

The PPS was a cross-sectional survey that took place on the 16th November 2021, 22nd March and 5th May 2022 at the University Hospital. The Global PPS (G-PPS) (https://www.global-pps.com/ accessed on 01 November 2021) protocol was used to measure antibiotic use at the hospital, with all patients who were already admitted early in the morning (before 8:00 a.m.) on the survey day being surveyed using the data collection forms. Data collected anonymously from both paper-based medical records as well as the Electronic Medical Records (EMR) system on the wards. No patients or prescriber's identifiers were collected during survey points. There was no direct interaction with patients. Unless a patient did not meet the inclusion criteria, every patient on the ward at the time of the survey was included in the PPS. All acute care inpatient wards, admitted pa-

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tients in the ward as at 8:00am of survey day and antibiotics administered via oral, parenteral, rectal or inhalational routes were included in the study. Three PPSs were conducted at the hospital; one at baseline, one at the midpoint and one at the end of the project.

2.4. Data Collection

Anonymized data was gathered using standardised G-PPS data collection forms from the hospital records of in-patients who satisfied the inclusion criteria on antibiotics. Data was collected by the AMS team who had previously undertaken online training on conducting PPS using the Global PPS protocol.

2.5. Data Management and Analyses

Data collected after each survey was sorted and structured to avoid data entry mix-ups. All data collected was stored on a password-protected and encrypted hospital desktop computer with restricted access to only AMS team conducting this study.

The study's data was put into the Global PPS program, an internet-based application for anonymized data entry, validation and reporting. Data were analysed and presented using median, frequencies, percentages and tables.

3. Results

3.1. Demographic characteristics of patients

A total of 152 patient records were included in the three PPSs conducted. Majority of the patients involved in the study were female (63.2%). The median age was 26.5 years (Table 1).

Table 1. Demographic characteristics of patients prescribed antibiotics at the University Hospital, KNUST.

Variables	Total n = 152 (%)	PPS 1 n = 46 (%)	PPS 2 n = 48 (%)	PPS 3 n = 58 (%)
Sex				
Male	56 (36.8)	20 (43.5)	16 (33.3)	20 (34.5)
Female	96 (63.2)	26 (56.5)	32 (66.7)	38 (65.5)
Age group (years)				
< 2	10 (6.6)	2 (4.3)	4 (8.3)	4 (6.9)
2+	142 (93.4)	44 (95.7)	44 (91.7)	54 (93.1)
Median age (Q1, Q3)	26.5 (19, 38)	43.5 (24, 64)	21.0 (11, 27)	26.0 (19, 34)

3.2. Prevalence of antibiotic use, prescription patterns and invasive device use.

Antibiotic use at baseline was 65%, and reduced to 59.7% at the end of the project. Intravenous therapy reduced from 70.8% to 64.7%. Healthcare associated infections rate also reduced from 17.5% at baseline to 6.5% (Table 2).

Table 2. Prevalence, pattern of antibiotics and invasive device use at baseline and project endpoint in the University Hospital, KNUST.

Parameter	BASELINE (%)	MIDPOINT (%)	ENDPOINT (%)
Patient prescribed at least one antibiotic	26 (65)	29 (56.9)	37 (59.7)
Intravenous therapy	17 (70.8)	16 (59.3)	22 (64.7)
Patient on multiple antibiotics	14 (58.3)	10 (37)	13 (38.2)
Healthcare associated infections rate	17.5	5.9	6.5
Peripheral vascular catheter	37 (92.5)	46 (90.2)	49 (79)
Indwelling urinary catheter	6 (15)	5 (9.8)	6 (9.7)
Tubes/drains	2 (5)	1 (2)	2 (3.2)

3.3. Antibiotic classes used among inpatients

At baseline and endpoint, third generation cephalosporins were the most used antibiotics. At midpoint, penicillin with beta-lactamase inhibitors were the most used at 21.4% (Table 3).

Table 3. Distribution of antibiotic classes used among inpatients at baseline and project endpoint in the University Hospital, KNUST.

Antibiotic Classes prescribed	BASELINE (%)	MIDPOINT (%)	ENDPOINT (%)
Penicillin with extended spectrum (Piperacillin/tazobactam)	4.8	0	3.8
Penicillin with beta-lactamase inhibitors (Amoxicillin/clavulanic acid)	11.9	21.4	17.3
2nd Generation Cephalosporins (cefuroxime)	11.9	9.5	13.5
3rd Generation Cephalosporins (Ceftriaxone, Cefixime)	21.4	14.3	21.2
Carbapenems (Meropenem)	2.4	0	1.9
Macrolides (Azithromycin)	11.9	7.1	3.8
Lincosamides (Clinidamycin)	11.9	9.5	9.6
Fluoroquinolones (Ciprofloxacin, Levofloxacin)	11.9	7.1	9.6
Imidazole Derivatives (Metronidazole, Tinidazole)	11.9	14.3	9.6
Aminoglycoside (Gentamicin, Amikacin)	0	7.1	7.7
Sulfonamide/trimethoprim	0	4.8	0
Tetracyclines (Doxycycline)	0	2.4	0

3.4. Indications for antibiotic use

Table 4 shows the indications for antibiotic use in UHS during the intervention. At baseline, lower respiratory tract infections were the highest indication for antibiotic use at 40.9%. At endpoint, 14.3% of indications were lower respiratory infections and upper urinary tract infections.

Table 4. Indications for antibiotic use among patients prescribed antibiotics at baseline and project endpoint in the University Hospital, KNUST.

Indication	BASELINE n (%)	MIDPOINT n (%)	ENDPOINT n (%)
Lower respiratory tract infections	9 (40.9)	4 (19)	3 (14.3)
Lower urinary tract infection	4 (18.2)	2 (9.5)	4 (19)
Skin and soft tissue infection	4 (18.2)	3 (14.3)	2 (9.5)
Sepsis	2 (9.1)	1 (4.8)	4 (19)
Central nervous system infections	1 (4.5)	2 (9.5)	1 (4.8)
Gastrointestinal infections	1 (4.5)	3 (14.3)	1 (4.8)
Upper urinary tract infections	1 (4.5)	2 (9.5)	3 (14.3)
Obstetric/gynaecological infections	0	2 (9.5)	1 (4.8)
Ear, nose and throat infections	0	1 (4.8)	1 (4.8)
Bone/joint infections	0	1 (4.8)	0
Bronchitis	0	0	1 (4.8)

3.5. Antibiotic use distribution according to WHO AWaRe classification

Antibiotic use according to WHO's *AwaRe* classification in the University Hospital, KNUST is presented in figure1. None of the antibiotics prescribed belonged to the Reserve category. At baseline (PPS 1) Access antibiotic use was 40% but increased to 62% at midpoint and finally levelled at 50% at the project endpoint (PPS 3).

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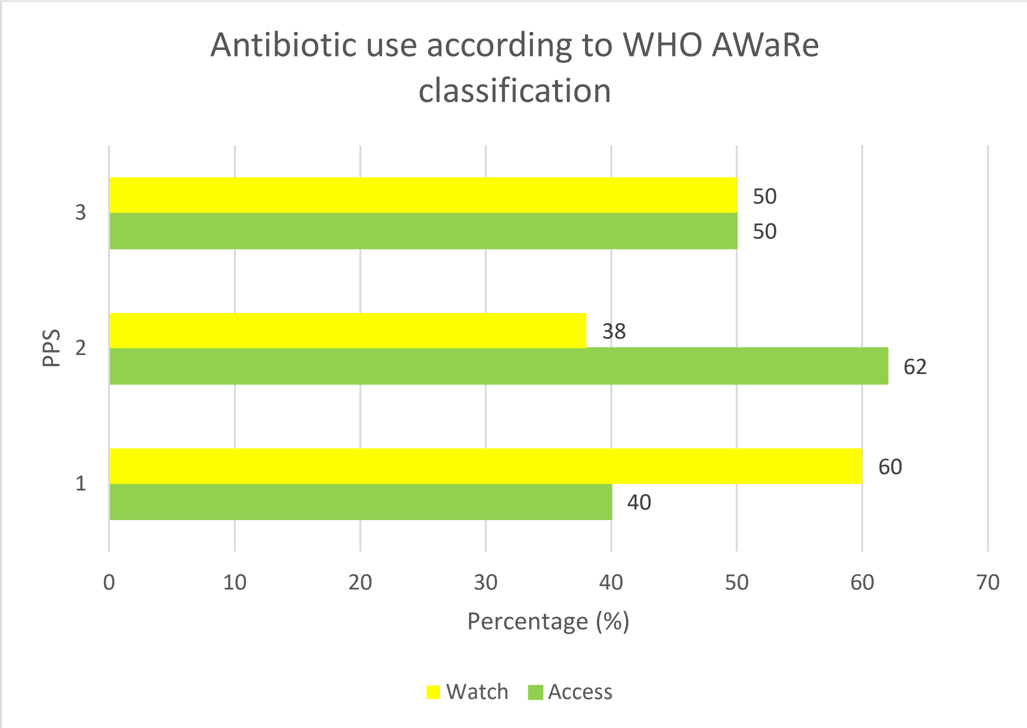

Figure 1. Antibiotic use among inpatients at the University Hospital, KNUST according to WHO AwaRe classification at project endpoint.

3.6. Culture and Drug susceptibility testing (CDST) requests

CDST requests increased from the beginning of the intervention in November 2021 with 111 total requests to 330 requests as at April 2022. The pattern of requests is provided in figure 2. Urine cultures accounted for the largest proportion of CDST requests.

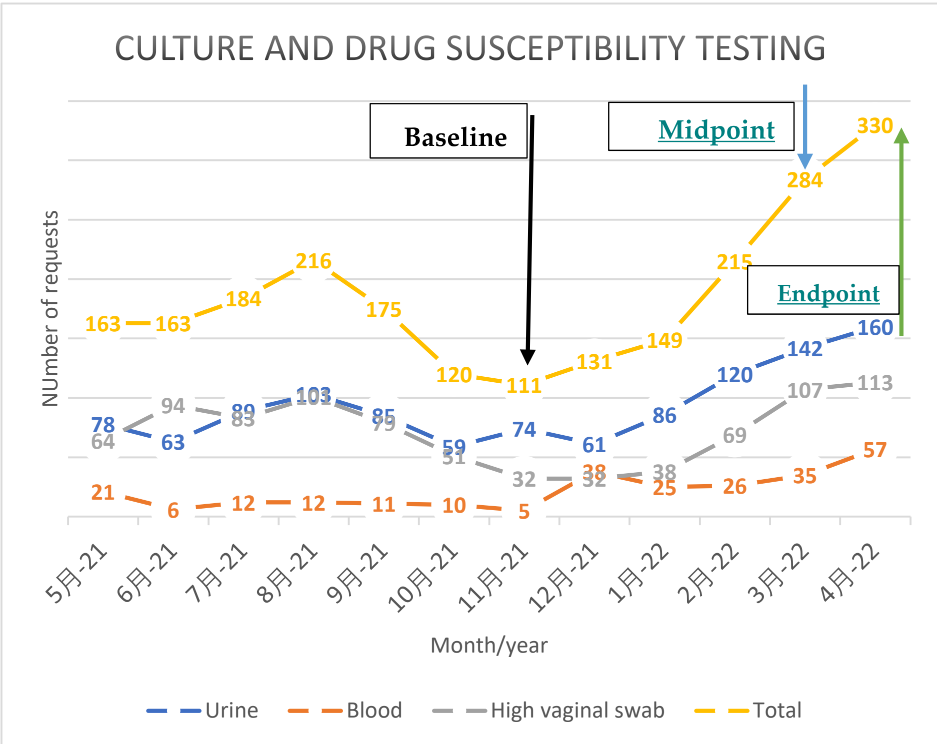

Figure 2. Culture and drug susceptibility request pattern at University Hospital, KNUST.

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4. Discussion

The multiple point prevalence surveys demonstrated the impact of the antimicrobial stewardship program (ASP) instituted at the University Hospital. At baseline, about two-thirds of patients were on antibiotics. This is more than twice the WHO optimum for rational antibiotic use in hospitals [19]. Over the period of the intervention, the prevalence of antibiotic use initially reduced by 8% but went up by 2.8% at the end which was still lower than at baseline. This is comparable to a national AMS project in China over a year (2011-2012) which reported a reduction in antibiotic use from 68% to 58% among inpatients [20]. Prevalence of antibiotic use in this project was however higher at the endpoint than in a project from Nigeria where antibiotic use reduced from 82.5% at baseline, 68.3% at midpoint and 51.1% at endpoint [21]. The Nigerian project however ran between 2015 and 2018 compared to the current project which implemented AMS over a seven-month period. Continued AMS activities may further improve the prevalence of antibiotic use in the hospital. High baseline prevalence of antibiotic use could be attributed to the COVID-19 pandemic which resulted in increased antibiotic use worldwide [22]. The pandemic may have impacted prescriber behaviours relating to antibiotic use. The initial reduction in antibiotic use at the hospital (midpoint) is likely as a result of the feedback provided to prescribers after each PPS as a means of creating awareness to improve prescribing. Additionally, the novelty of the ASP as well as the engagement surrounding it may have driven the initial drop in antibiotic use. The marginal increase between the second and third PPS could be attributed to a possible increase in infectious diseases during that time leading to increased antibiotic use. To ensure sustainability of the ASP at the University Hospital, further research is needed to understand the possible mechanisms behind the change in antibiotic use. This may include a qualitative study to assess perceptions and behavioural factors among prescribers relating to antibiotic use. Although this is higher than WHO's optimum, it is a demonstration of the potential of ASPs to improve antibiotic use in hospitals. Antibiotic use overall seemed to have improved during this period of the surveys. The ASP at KNUST needs to be sustained to further improve antibiotic use in the long term. Continuous and regular audits of antibiotic use, training of staff and implementation of evidence-based guidelines can help to sustain the programme.

The use of WHO's *Access* antibiotics increased at the midpoint of the project by 22 points and decreased by 12 points at the endpoint. *Watch* antibiotic use decreased by 10 points to 50% of all antibiotic prescriptions at the end compared to baseline. Although improved from baseline, there is room for improvement as WHO recommends *Access* antibiotics to be at least 60% and other categories below 40 [23]. *Watch* antibiotics are at increased risk of selection and development of resistance compared to *Access* antibiotics. Reducing their use among inpatients can objectively improve antibiotic prescribing. This is a key target for improvement in antibiotic use at the University Hospital as part of the ongoing AMS. This could be addressed by the implementation of AMS policies and guidelines for antibiotic use as well as the development and utilization of facility-specific antibiotic formularies.

An encouraging finding during the period was the increased number of culture and drug susceptibility test (CDST) requests between the project start date and the end point. Requests for CDST more than doubled. Increased reliance on microbiology data from CDSTs are essential to improve antibiotic use and reduce AMR. They are also invaluable to supporting the implementation of AMS. Culture positivity rate as well as turnaround times for requests were not assessed. Such assessments could help to identify quality improvement of microbiological services as well as assess the capacity of the microbiology lab to handle such increased requests.

Intravenous therapy was high but reduced at the endpoint. Intravenous therapy requires the use of invasive devices, a potential source of healthcare-associated infections (HAI) among inpatients. In order to optimize their use in the hospital, intravenous to oral switch by pharmacists could be included in the bundled programme as it contributes to reduced use of IV therapy and consequent reduction in HAIs [24]. At baseline, about a fifth of infections were considered healthcare associated while at the endpoint, HAIs reduced by eleven points. Such infections are more difficult to treat requiring improved IPC to prevent and control their spread [25]. Training provided during the intervention period on AMR and IPC may have contributed to the reduction in HAIs observed.

Strengths and limitations

The study has the following strengths. This intervention was implemented based on WHO's AMS toolkit which is based on international best practice for implementing AMS. The study was conducted and reported in accordance with the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines statement [26]. However, there are some limitations to this study; no assessment of patient outcomes was conducted. Antimicrobial consumption assessment was undertaken by employing mainly the Global PPS protocol. Future assessments could include antimicrobial consumption by defined daily dose in addition to assessing patient outcomes, and AMR situation to allow further improvements to the AMS at UHS.

5. Conclusions

Implementation of the model antimicrobial stewardship programme at the University Hospital was effective, and contributed to improved antibiotic use among inpatients. Antibiotic use prevalence at the hospital reduced over the intervention period. In addition, there was improvement in antibiotic consumption according to WHO's *AWaRe* classification. Continuous staff training in AMS, regular use of quality improvement tools for assessment and application of local data to inform efficient therapy in infections management will ensure sustenance and improvement in gains made. This will thus minimize the risk of the emergence and spread of antimicrobial resistance with optimal health outcomes from infectious disease therapy.

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Institutional Review Board Statement: Approval for this project was obtained from the management of the University Hospital, KNUST. Ethical clearance was sought and obtained from the Committee on Human Research, Publications, and Ethics of KNUST. (CHRPE/AP/470/22 of 15 August 2022). Data confidentiality: The electronic databases are kept in a password-protected computer of the principal investigator. No patient identifiers were used in this study.

Informed Consent Statement: As this was a record review study with no patient identifiers, the issue of informed patient consent did not apply.

Data Availability Statement: Requests to access these data should be sent to the corresponding author. Additionally, data collected in this study was recorded using the G-PPS online tool and anonymously accessible upon registration.

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