# ORIGINAL RESEARCH

# The examination of nurses' adherence to the 'five rights' of antibiotic administration and factors influencing their practices: a mixed methods case study at a tertiary hospital, Malawi

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## Abstract

**Background**

Adherence to 'Five Rights' of medication administration guidelines namely the right drug, the right patient, the right dose, the right time and the right route is the basic nursing standard and a crucial component in medication safety. Specifically for antibiotics, this helps to minimize resistance and reduce hospital costs. There is a dearth in literature on how nurses apply this standard when administering antibiotics to inpatients. This study explored nurses' adherence to the 'Five Rights' of antibiotic administration and factors influencing their practices.

**Methods**

This was a cross sectional case study using prospective observation of 23 nurses and 49 patients with pneumonia and follow up interviews with 13 nurses. Participants were selected between November 2015 and February 2016. The study setting was two medical wards of a tertiary hospital. Observations were guided using a checklist to collect quantitative data. This was followed by semi-structured in-depth interviews with nurses.

**Results**

From the quantitative data, untimely administration of antibiotics was common,with only 10.1% of patients given antibiotics at the right time. Nurses gave the right (prescribed) antibiotics in 67.3% of the patients and 59.2% of the patients received the required doses. 69.4% of the patients received the antibiotics using the right route. The right documentation of dose initiation and continuation occurred in 38.5% and 24.5% respectively. From follow up interview data, two main themes were identified: Competency gap with subthemes namely inconsistent undestanding of three/ four times a day dosing schedules and knowledge translation gap; Conflict between medication administration times and ward routines.

**Conclusions**

We found poor compliance with the 'Five Rights' of antibiotic administration. This has been attributed to both a competency gap and challenges within the hospital system.

**Key words:** Nurses, Antimicrobial resistance, antibiotic stewardship, Antibiotics, Adherence, Five Rights.

## Background

Antimicrobial resistance (AMR) is a global problem but the burden and rate of resistance is high in low and middle-income countries[1].The WHO global report from 114 countries shows that resistance to the treatment of last resort for *Klebsiellapneumonia*, carbapenem antibiotics, has spread to all regions of the world; Treatment of urinary tract infections caused by *E. coli, fluoroquinolones* has spread and treatment failure to the last resort of treating gonorrhea, third generation *cephalosporins*,has been confirmed in Austria, Australia, Canada, France, Japan, Norway, South Africa, Slovenia, Sweden and the United Kingdom[1]. In some parts of Africa, 80% of Staphylococcusaureus infections that cause urinary tract, wound, blood stream infections and pneumonia are resistant to the standard treatment of methicillin[2]. An example of this is the burden of AMR to commonly used antibiotics at Lilongwe Central Hospital in Malawi which was observed in 80% of isolates[2]. The factors contributing to the emergence of resistant bacteria are underutilization, overusing or misusing of antibiotics that lead to toxicity or prolonged hospital stays[1,3].

Antimicrobial stewardship is one of the strategies to control AMR through appropriate selection, dosing, route and duration of administering antimicrobials to optimize outcomes[4–6]. The definition is intrinsically linked to the 'Five Rights' of medication administration which is the nurses' role.

Adherence to medication administration guidelines is a crucial component in medication safety and is a basic nursing standard of practice[8]. A nurse follows a prescription issued by the clinician, and is guided by principles called 'Five Rights' to medication administration that stipulate giving: the right drug, to the right patient, at the right dose, at the right time and using the right route[8]. This task is becoming more complex and difficult for nurses[9]. Factors that contribute to AMR are directly linked to the five rights of medication administration, such that if the five rights are not followed there is ill timed dosing, inadequate antibiotics given, and this may lead to AMR[10].

Studies have shown that administration errors are responsible

for 40% of overall medication errors[11]. Therefore human behaviour adherence to medication administration is the area in most urgent need of attention[12], specifically so for antibiotic medication to prevent antibiotic resistance. Despite the role of nurses during antibiotic administration, studies exploring the appropriateness of therapeutic antibiotic use are limited, particularly in developing countries[13]. Therefore, the aim of the study was to explore nurses' levels of adherence to the 'Five Rights' of antibiotic administration and factors influencing their practices. This study is part of a mixed methods study, whose focus was to identify nurses role and the challenges they face during patient antibiotic management practices. Based on the baseline study, an antibiotic administration protocol and antibiotic administration and teaching assessment tool,were developed.

## Methodology

### Study Design

This was a sequential mixed method[14], where a quantitative method was followed by a qualitative method inorder to confirm and supplement the quantitative observational data for better understanding of the study area. We conducted a prospective observational case study[12] followed by interviews with the observed nurses. Patients with a diagnosis of pneumonia prescribed antibiotics from November 2015 to February 2016 were also included in the study.

### Study setting

The study was conducted at a tertiary hospital in Malawi. The sites selected were male and female medical wards because this is where the patients with a medical diagnosis of pneumonia are admitted and antibiotics are commonly administered. The wards have a bed capacity of 67 patients but frequently patients exceed this capacity. There are, on average, three nurses on day duty and two nurses on night duty. In total there were eleven nurses and twelve nurses in male and female wards respectively who were working in the settings full time and on locum during the study period.

### Participants and Sampling

We used typical case;A purposive type of sampling[13] to select pneumonia patients as our case for the observation (n=49). This was based on the evidence which showed that pneumonia was one of the most common admitting conditions requiring antibiotics. This ensured that we would obtain rich, in-depth data about the phenomena. The sample size was adequate because a case study research aims at understanding a case and maximizing the lessons learnt[15]. The criteria for patient participants inclusion into the study were age 18 years and above, those that were able to understand and communicate and have had antibiotics prescribed for them. Observation was followed by interview with purposively selected observed nurses (n=13).

### Data collection

#### Prospective Observation

During each round of medication administration, nurses administered other medicines apart from antibiotics, but our observation focused on antibiotic administration. Each patient was followed up until discontinuation of antibiotics, discharge, death or transfer to another ward. The researcher observed and reviewed patients records on daily basis to identify the patient who met the inclusion criteria. If a patient satisfied the inclusion criteria, informed consent was

obtained. We developed a checklist to guide data collection using basic medication guidelines including the 'Five Rights' and treatment chart of the setting ( additional file 1: Data collection tool). Using the tool we collected demographic data, clinical information and pattern of antibiotic administration. Information on factors contributing to non adherence was also collected. The researcher, while observing and participating in some of the events, reviewed patients' documents to get supporting evidence of nurses' practices and asked informal questions to the observed nurse, patient or guardian. Immediately after observation, the researcher recorded the observation on the checklist. To overcome observer fatigue[17] the primary researcher observed day and evening medication rounds and employed a research assistant (OM) who spent the night in the ward to observe evening, night and morning medication rounds. We defined antibiotic non-adherence to the prescribed regimen as a deviation from the 'Five Rights' of antibiotic administration from a doctor's prescription, the manufacturer's instructions or evidence from the literature (Table 1).

**Table 1: Definitions used to determine adherence to the 'Five Rights'**

| Standard | Definition |
|---|---|
| The right antibiotic | The antibiotic prescribed by the doctor. |
| The right time | When the antibiotic is given according to schedule and the right interval between doses. One hour early or one hour late is within acceptable range. |
| The right dose | The right strength prescribed and right number of doses based on calculation from the total days and frequency. The right duration according to prescription. |
| The right route | Mode of delivery (how it is given) prescribed by doctors or recommended in literature/drug leaflet/ guidelines. |
| The right documentation | On the treatment chart/case file, documentation of the name, dose, route and daily continuation doses. Documenting the way it has been given. |

### Follow up Interview

We then conducted interviews with some observed nurses (n=13). A semi-structured interview guide (Additional file 2: Interview guide) were used for this. Interviews were held within the ward and were tape recorded. Follow up interviews helped to elicit more information concerning adherence behaviours such as reasons and experience of nurses in this practice. This helped to explain, validate, and confirm the observed behaviours and to discern the discrepancy between what participants do (observation) and say they do (interview).

### Data management and analysis

Quantitative data were handled using Stata version 14.0 (Stata Corp, Texas, USA) and analysed using R Software. Data were plotted on bar graphs for each of the 'Five Rights' in order to visualize the distribution of non-compliance. Proportions for non-compliance were computed with one-way tabulation.

For qualitative data, we used thematic analysis following the five steps: familiarisation, conceptualisation of themes, application of themes to the data, rearranging the data

according to themes, and mapping which enabled the data to be interpreted as a whole[18]. Transcripts were sorted and categorized according to identified issues and themes. Familiarization with data occurred during the interview transcribing process to promote an in-depth knowledge of the data. This involved repeatedly reading transcripts. The data was transferred into the QSR NVivo[10] data management program. Two researchers performed line by line coding using different colour labels. This involved inductive coding of every word/phrase or sentence that described what was interpreted in the passage. In the initial phase, the researcher worked with the supervisor (NH) and each openly coded part of the documents. Then we compared the coded data to arrive at a consensus on the meaning and how the codes were applied. During indexing, the thematic framework was applied to the rest of the data with each significant statement coded. The charts assisted with identifying how wide spread different views about phenomena were derived from the interviews. During mapping and interpretation we searched for patterns, associations, concepts, and explanations in data. After the coding process, data was reviewed and the researchers decided which codes were major and which belonged in a subcategory.

### Validity and Rigor

Collecting data on the same phenomena using different approaches increased validity. This was facilitated by triangulation, a method of testing data sets from different methods for misinformation and distorted data, and verification of data through convergence of different perspectives[13]. This increased the dependability and trustworthiness of the data and its interpretation. For example, observation was clarified, elaborated and explained by interviews. In addition, we member checked with 13 observed and interviewed nurses

## Ethical Considerations

The study received ethical approval from the University of KwaZulu-Natal Human and Social Science Research Ethics Committee (HSS/0445/0150) and the University of Malawi, College of Medicine Research and Ethics Committees (P.03/15/1707). The Hospital Director also granted permission. We explained the purpose of the study to the potential nurse participants and none refused participation. We also explained the purpose of the study to patient participants. The information sheet for observation of nurse participants was given before they gave a written consent (additional file 3: Information sheet and consent for nurses). For the patients, information was given verbally using the information sheet (additional file 4: Information sheet and consent for patients) before they gave the written consent. We obtained informed written consent or witnessed consent with a thumb print if patient was illiterate, prior to the observation of patients that met the criteria. In line with the ethical principle of freedom from harm,13 any unsafe practice that could put patients at risk was intervened in by the researchers but was still recorded as an error or near miss error. These are errors that are corrected before a patient is harmed thereby providing an opportunity to identify and correct mistakes that jeopardize patient safety.16

## Results

### Participant Characteristics

We observed a total of 49 pneumonia cases. The majority (32/49; 65.3%) were female, with an overall median age of 39 years (interquartile range [IQR]: 32-48). The most common clinical presentation was fever occurring in 16 patients, followed by a clinical diagnosis of community acquired pneumonia/bacterial pneumonia, reduced oxygen saturation and shortness of breath/tachypnoea occurring in 12 patients in each category. All nurses ( 23)from the two wards were observed, eleven from male ward and twelve from female ward (Table 2). Errors  corrected before a patient was given the antibiotic  occurred eight times but were still recorded as an error.

**Table 2: The profile of nurses involved in Observation**

| Ward | Number of nurses | Age | Professional and academic Qualifications | Gender | Length of experience |
|---|---|---|---|---|---|
| Male medical ward | 11 | Mean 29. 6<br><br>Range 25-38 | 4 Diploma<br><br>3 Degree<br><br>4 Enrolled and technician (Certificate) | 7 Female<br><br>5 male | Mean 3.2 years<br><br>Range 1-44 |
| Female medical ward | 12 | Mean 32. 8<br><br>Range 24-56 | 2 Diploma<br><br>1 Degree<br><br>9 Certificate and technician | 8 female<br><br>4 male | Mean 3.3 years<br><br>Range 1 - 13 |

### Compliance with administering the prescribed antibiotic treatment

Nurses complied to the prescribed antibiotic treatment in 33 of the 49 patients (67.3%).While with 13 (26.5%) patients, nurses did not comply at least once (Fig. 1). One patient only received the prescribed antibiotic six of the 18 times that were prescribed. This was attributed to absence of the prescribed antibiotic at point of care and nurses giving an alternative antibiotic.

### Compliance with administering antibiotics at the right time

Only five (10.1%) of the 49 patients had their treatment given at the right time (Fig. 2). There was a high level of non-compliance of giving treatment at the right time with one patient not having 16 of their prescribed doses at the right time. This was more common in 8 hourly (TDS) and 6 hourly (QID) dosing schedules and was attributed to staff shortages.

### Compliance with administering the right dose

Although the majority 29/49 (59.2%) of the patients received the required number of their prescribed doses, some patients did not receive the correct doses (Figure 3). One patient missed seven doses in the course of treatment because of no documentation of whether the antibiotic was given at one time or changed from the initial prescribed antibiotic to another antibiotic, which had to be collected from the pharmacy causing delays that led to missing doses and a short supply in the ward causing the patient to receive a lesser dose.

### Compliance with administering using the right route

Nurses followed the right route in 34 of the 49 patients observed (Figure 4); only one patient experienced gross non-compliance due to challenges in maintaining an intravenous cannula because of the condition of the patient.
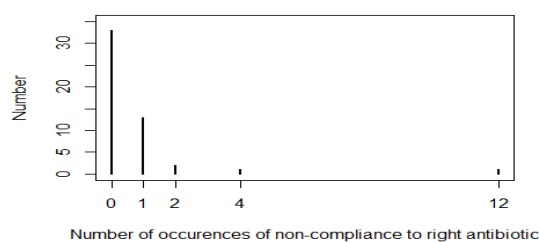
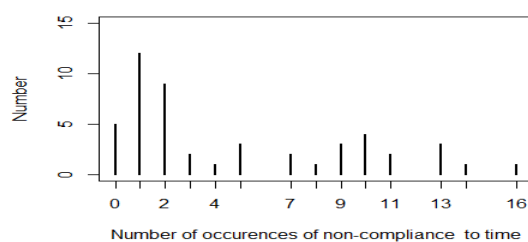**Figure 1: Compliance with administering the right antibiotic treatment**



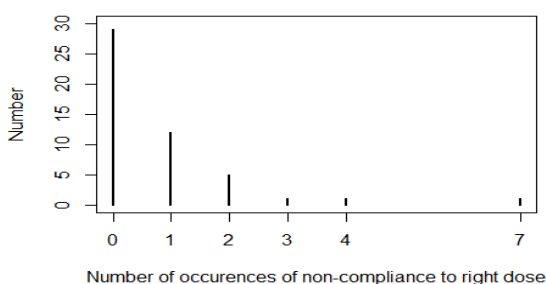**Figure 2: Compliance with administering antibiotics at the right time**



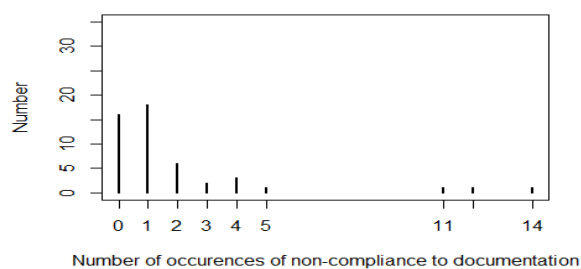**Figure 3: Compliance with administering the right antibiotic dose**



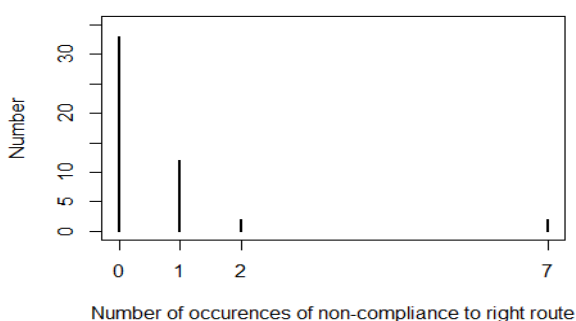**Figure 4: Compliance with administering antibiotics using the right route**



**Figure 5: Compliance with right documentation**

## Compliance with right documentation

### Documentation of Prescription time and first dose initiation time

Case note review showed that time of antibiotic prescription by doctor was documented in 31/49 (63.3%) of the patients' files. Nurses documented the time of initial drug administration in 19/49 (38. 77%). In many cases nurses documented the initial dose given in the emergency department using a tick (√). This made it difficult to calculate the time that the initial dose was administered from the time the antibiotic was prescribed, and then the time interval between the initial and the subsequent dose. However, for those patients where both times (prescription and initiation time) were indicated (n= 19); timely initiation of antibiotics occurred in six patients (35.6%) and delay in initiation occurred in 13/19 (68.42%) cases.

### Documentation of dose continuation

Non-compliance with the required documentation in the course of giving antibiotic treatment was common with only 12 (24.5%) of the 49 patients having the right treatment documentation (Fig. E).

### Results from Follow up in - depth Interview

Out of a total of 23 nurses that were observed, 13 participated in follow up interviews. Table 3 contains the demographic features of the interviewed nurses.

We identified two main themes namely: Competency gap with two subthemes: Inconsistent understanding and knowledge - translation gap of TDS and QID dosing intervals; and Conflict between medication administration times and ward routines. These factors led to poor compliance with giving the antibiotics at the right time and dose.

### Competency gap

### Inconsistent understanding of TDS - QID dosing intervals.

Participants demonstrated different understading of TDS dosing schedules.

*Normally, TDS doses are supposed to be given eight hourly. If we give in the morning, then 2pm and the night staff are supposed to give at 10pm. (03)*

*The TDS drugs which we have to give may be three times a day, normally we have to give the drug at 6am, at 2pm and maybe at 8pm. (011)*

*It is 6 am, then 2 pm and there after 6 pm while they are supposed to receive those drugs at 10 pm. (06)*

One nurse was asked what could be the effect of these time intervals:

*It's a routine there can't be any problem we do it consistently.(04)*

Some of the nurses have the knowledge that TDS means eight hourly and are able to specify the right time intervals but do not translate this into practice. However, other nurses understand TDS as three times per day but the specific times mentioned do not consider the interval. One nurse seems to consider this not as a problem as it is consistently done.

### Knowledge - translation gap

Participants demonstrated knowledge of QID dosing schedules but this is not translated into practice.

*If you are starting at 6 am, which means first dose is at 6am then 12 then 6pm again then 12 midnight. But in actual sense, QID are not*

*managed in four times, we give TDS instead of QID. (09)*

*The QID is six hourly: 6-12-6-12. But to my observation here I don't think the time is observed.(03)*

*The issue of timing the main challenge I think it's during the night. We don't normally give the patients the drugs like the timing of 10 pm, 12 midnight; we never give drugs. We just give drugs during the day. For example, drugs which are supposed to be given every six hours are started from either 5 or 6am . The next dose she gets at 10 am the next dose she gets at 2pm and the last one she gets at 6 or 7pm. That's that. So it means the patient stays from 6pm to 6am about 10 hours without drugs. (012)*

To get a better understanding of the reasons behind these challenges, the following theme emerged:

### Conflict between medication administration times and ward routines

When asked what challenges nurses experience regarding the more frequently scheduled antibiotics (TDS and QID) the following was obtained:

*There is a problem and the other problem is when you give 6am then you give 12 noon, 12 is visiting hour so you can't give treatment in that time. (013)*

*It is supposed to be at 6am and then 12 mid-day and if during the day is around 7or 8 then the night dose is around 12 midnight. So it is really a challenge to meet all those. (02)*

*QID its where there is also a problem. 12 midnight the problem is patient is sleeping ….. (013)*

There is a conflict between medication administration standard and other ward routines. For instance, patient relative visiting hour and sleeping time collide with medication rounds. Nurses feel these are blocks to adherence to administering antibiotics at the right time.

## Discussion

If we consider the primary outcome of a 75% rate of adherence to each of the 'Five Rights' to medication administration based on the guideline threshold to adherence to antibiotic initiation in pneumonia patients[17], the results show that quality of care in relation to this standard is less than optimal in all the five aspects. Indeed antibiotic administration occurs in an environment with complex interactions among many factors such as the policies, procedures, and resource challenges which may lead to errors[22]. Our findings are consistent with a survey conducted with a sample of registered nurses from the Georgia board of Nursing where 78% of nurses indicated making one or more errors and 77% of the nurses reported not following the 'Five Rights' to medication administration[22]. Factors contributing to medication errors were exhaustion, inexperience and pace/staffing/patient load. The study from Georgia focused on medication in general while the current study specifically focused on antibiotics. While observations in the current study were recorded as instances of non-compliance, which sometimes happened once in the patient antibiotic administration, the results should not be undermined because an error done once may still contribute to harm. Therefore, though it would be unreasonable to expect non-compliance not to occur at least once or compliance to occur 100%, the findings still point out that non-compliance to the 'Five Rights' may be common and would contribute to antimicrobial resistance.

The most common occurrence of non-compliance to giving the right (prescribed) antibiotic was when nurses administered an alternative antibiotic due to unavailability of the prescribed antibiotic. The substitution of the antibiotic may have negative effects to the effectiveness of the antibiotics as it was found that the alternative antibiotic could have a different dosing frequency, hence affecting the blood concentration levels of the drug[19].

Similarly, nurses faced challenges with compliance to administering at the right time and giving the right dose. The common challenges observed were antibiotic stockouts and inappropriate timing where it was either too late or too early. Interview data showed that this was due to competency challenges and conflict between medication administration times and ward routines. These led to too long intervals occurring mostly in more frequent (TDS and QID) dosing schedules. Interview data showed that some nurses had poor understanding of the dosing schedules whilst others understood it but failed to translate this into practice due to environmental challenges. This led to poor adherence to time as the more frequently given antibiotics demanded more time/nurses.There were discrepancies between what nurses said they know and what they actually do. These findings are similar to one study where it was found that antibiotics were the leading type of drug involved in medication errors as they are widely used with variations in their fixed intervals of administration (q6h, q8h, q12h, etc.)[9].

Breaking the rules to work around obstacles is considered a rule-based error as it can lead to harm[22]. The fact that the practice of giving antibiotics in too long intervals is routine and they do it consistently also demonstrates poor enforcement of practice guidelines as it shows that nurses' practices are not properly monitored. In a study aimed at reducing the medication administration error rate by changing nurses' behaviour, it was found that the longer work experience of the nurse and poor supervision led to complacency[23]. Other factors were knowledge deficits, poor communication and a culture of silence. Another study demonstrated that nursing care in relation to medication activities was based on rituals and routines, rather than the provision of individualised care[24].

Another factor was conflict between ward routines and drug administration schedules. Visiting hours and patient sleeping times were reported hindrances to drug administration. This may reflect poor guidelines or protocols; poor perception of night medication administration; poor knowledge of how antibiotics work; and a lack of critical thinking as visiting hours and sleep are prioritized over antibiotic administration. The guiding principle is that medications should be administered as closely to the prescribed time as possible to ensure peak therapeutic serum levels are achieved and maintained[19]. This is because antibiotics are time critical medicines[24]. Similary, an observation study done in a surgical ward of a European hospital found that non-compliance to antibiotics was 66.3% and 42% for prophylactic and therapeutic purposes respectively[11]. There is a need therefore to train nurses on antibiotic pharmacodynamics.

Finally, compliance with right documentation was another practical challenge. Documentation was either done or not done making it difficult to determine if and how the antibiotic was given. Case file reviews during observation revealed poor documentation. For example, in some cases where an alternative antibiotic was given; this was not documented, or if a patient did not get the right dose this was not documented as such. This is against the Nursing and

Midwifery Council Code of Conduct, which recommends making a clear, accurate and immediate record of all medicines administered, intentionally withheld or refused by the patient and where medication is not given the reason for not doing so must be recorded[20]. Documenting the reasons for delayed and omitted doses is important for other multidisciplinary team members to know[21]. The same should be the case if an alternative antibiotic has been given.

## Strengths and limitations of the study

This was a case study limited to two medical wards focusing on pneumonia as our case which may limit the generalizability of the findings. However, all the nurses were observed at different times of medication administration thus ensuring a variety of practices being captured. It is difficult to obtain factual information on nurses' behaviour of medication administration if using the methods such as auditing[23]. This study, however has reported inappropriate behaviours using more objective methods. Consequently, providing valuable insights into how nurses adhere to the 'Five Rights' of antibiotic administration is practiced.

## Conclusion

This is the first study that has provided new knowledge about the extent to which nurses adhere to the 'Five Rights' of antibiotic administration. Our study suggests considerable inappropriate administration of antibiotics in the case of pneumonia patients with nursing and environmental factors influencing this. This highlights an urgent need for antibiotic stewardship initiatives.

## Competing interests

The authors declare that they have no competing interests.

## Authors' contributions

The first author (CTM) conceptualized and designed the study, carried out data collection, analysis and drafted the manuscript. The co- authors ( ASM and VS) supervised the planning, development of study methods data analysis and interpretation and helped in drafting the manuscript. All authors read and approved the final manuscript.

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