Additional file 2: The population-specific interview and focus group discussion guides for the antimicrobial social norm feedback (SNF) intervention strategy based on the Consolidated Framework for Implementation Research (CFIR).

Interview guides:

[Information Statement]

Hello, we are a research team from Guizhou Medical University conducting a study on the antimicrobial intervention in primary care. We sincerely appreciate you taking the time to participate in this interview despite your busy schedule. The interview is expected to last approximately 40 minutes, during which we aim to understand your views and opinions on the antimicrobial intervention strategy.

All information you provide will be kept strictly confidential and used solely for this study. To facilitate data analysis in subsequent steps, we would like to audio-record the interview. Would that be acceptable to you? Please note that you have the right to stop the interview at any time if you feel uncomfortable or wish to withdraw. Before we begin, we want to ensure that you fully understand the purpose of this interview and your rights as a participant. If you have any questions or need further information, please feel free to ask. Once again, we truly appreciate your support and cooperation. If you have no further questions, we can begin.

To start, let us briefly introduce the antimicrobial intervention strategy, which primarily include:

1. **Peer comparison:** Through the Health Information System (HIS), private or public feedback report is periodically sent to physicians (e.g., every 10 days, fortnightly, monthly, quarterly, or irregular intervals). The report contains detailed information such as antimicrobial prescription rate (APR), inappropriate antimicrobial prescription rate (IAPR), regional or institutional precise/approximate/averaged ranking, the top N antimicrobial agents and their usage proportions, the top N diseases associated with antimicrobial prescriptions and their proportions, and the best and non-best performers for antimicrobial use.

2. **Education and training for physicians and patients:** Education and

training for physicians will be carried out through: (1) regular online and offline training sessions, (2) distribution of clinical application guidelines and educational manuals on antimicrobial agents, and (3) educational videos on appropriate antimicrobial use. For patients, they include: (1) distribution of educational pamphlets on antimicrobial agents, (2) display of educational videos in hospital waiting areas, corridors, and lobbies, and (3) posters promoting appropriate antimicrobial use in hospital bulletin boards.

3. **Supportive implementation mechanisms:** These primarily encompass: designating an intervention coordinator at each institution to promote the implementation of the antimicrobial SNF intervention strategy; presenting in the feedback report, contraindications and precautions for the top N antimicrobial agents, along with signatures from authoritative institutions or experts; displaying real-time pop-up warnings for potentially inappropriate antimicrobial use (e.g., unnecessary use, incorrect antimicrobial spectrum, combination of antimicrobial agents without indication) at the bottom left or right corners or in the center of the computer screen; and simultaneously showing an appeal window, allowing physicians to document justifications for maintained antimicrobial prescriptions.

Table 1 The interview guide for physicians in primary care institutions regarding the antimicrobial SNF intervention strategy based on the CFIR.

Instruction: In this interview, we will discuss the implementation of the antimicrobial intervention strategy. Please note that all information shared will be kept strictly confidential. We sincerely appreciate your support!

Basic Information and Background

1.What is your age? What is your position and professional title?

2.Have you always worked at this hospital? How long have you been here?

3.Have you worked in other departments before, such as the pharmacy, hospital administration, or outpatient services?

CFIR-guided interview guide for the implementation of the antimicrobial SNF intervention strategy.

1. In our previous antimicrobial intervention trial in primary care institutions, we implemented a series of measures, including a real-time pop-up warning message, a 10-day antimicrobial prescription feedback, and distribution of educational manuals. These measures significantly reduced both the overall antimicrobial prescription rate (APR) and the inappropriate antimicrobial prescription rate (IAPR) during the intervention period, demonstrating strong effectiveness. However, once the intervention stopped, we observed a rapid rebound in both APR and IAPR. **What are your thoughts on this phenomenon? What do you think might be the underlying causes of this rebound? To ensure the long-term sustainability of intervention effects, how do you think we could optimize or adjust these measures? Could you provide specific recommendations or targeted measures to enhance their long-term impact?**

2. What are your thoughts on the design of the intervention strategy in this study?

Peer comparison (Antimicrobial prescription feedback reports)

a.Do you think it is appropriate to set the best and non-best performers for antimicrobial use? Why or why not?

b.Based on the hospital's specific situation, do you think any aspects of the antimicrobial prescription feedback report should be added, removed, or optimized?

c. Are you comfortable using the hospital's Health Information System (HIS)? In terms of feedback frequency—every 10 days, fortnightly, monthly, quarterly, or irregular intervals—which would you prefer, and why?

Education and training for physicians and patients

d.Do you think the educational and training measures designed for physicians and patients are reasonable? Could you share your thoughts and causes on this?

Supportive implementation mechanisms

e. If a person were to be designated as the intervention coordinator for promoting the implementation of the antimicrobial SNF intervention strategy at your hospital, who would

you recommend? What advantages or challenges do you think this person would face in this role? (For example, consider their time availability, workload, influence, communication and coordination skills, professional knowledge, comprehension ability, and work style—whether they plan thoroughly in advance, listen and adjust during implementation, and reflect effectively afterward.)

f. Do you think it is necessary to have signatures from authoritative institutions or experts? If so, should it come from your hospital, the provincial health departments of Guizhou Province, or the municipal/county health administrative departments? Which option do you think is more appropriate, and why?

g.When the real-time pop-up warnings appear, do you think it should appear in the center of the computer screen or at the bottom left or right corners? Why? Are there any other aspects of the real-time pop-up warnings that you think should be improved?

h.Would you find it useful to have an appeal window where prescribers can briefly explain their reason for maintaining an antimicrobial prescription despite the real-time pop-up warnings? Why or why not?

i. Do you think combining real-time pop-up warning reminders with peer comparison feedback reports would be beneficial? Would this enhance the intervention's effectiveness? Why or why not?

j. The implementation of intervention strategy requires reviewing feedback reports, reading real-time pop-up warning messages, documenting the reason for antimicrobial use, attending training sessions, studying educational materials, and watching training videos. **Do you think the time required for these activities is within a reasonable range for you? Can they be smoothly integrated into your current workflow? Do you find these steps difficult to operate? (complex or not?)**

3. Do you often encounter situations where you need to prescribe antimicrobial agents? In your daily practice, do you think an intervention strategy like this is needed to provide feedback on the antimicrobial use?

4. Does your hospital have any existing assessment standards for antimicrobial use?

a.If so, were these standards established by the external regulatory authorities (such as the provincial health commission or local health bureau), or were they developed internally within the hospital? Were any specific measures implemented to help meet these standards?

b.If measures were taken, could you describe them? Were they designed by external experts or developed through internal discussions within the hospital?

c. If measures were taken, how do they compare to the intervention strategy in our study? Which do you prefer/which do you think is more effective in improving antimicrobial prescribing practices? Why?

d.If no formal assessment standards or measures exist, would you prefer the standards or intervention strategies developed by an external research team like ours, or would you rather have

them decided through internal hospital discussions? Why?

5. If our intervention strategy were to be implemented in your hospital, would there be any other pressing tasks or responsibilities in your daily work that might take priority over the implementation of this intervention strategy?

6. Have you ever participated in cross-institution collaborative projects on antimicrobial use, management, or other interventions? (For example, have you been involved in projects where external teams, like the research team from Guizhou Medical University, conducted an antimicrobial prescription control intervention at your hospital?)

a. If yes, what was your role and responsibility in these collaborations?

b. Through working with external institutions, did you gain new medical knowledge or technical skills? Did you receive any additional resources or support? (such as training, technical assistance, or financial backing) If not, what were the reasons? What major challenges did you encounter? (such as communication difficulties, misaligned objectives, or resource allocation disputes)

c. If you have not participated in such collaborations, would you be open to incorporating external resources or partners (such as district/county hospitals, Center for Disease Control and Prevention, pharmaceutical suppliers, or research teams) to implement a similar intervention? If not, why?

7. Would you be able to participate in the training sessions for this intervention strategy during the centrally scheduled time periods? If not, could you explain why?

8. What are your overall impressions of your hospital?

a. Do you often have to work overtime? Are you satisfied with your current salary and benefits?

b. How would you describe your relationship with your colleagues? Do you get along well? Do you feel that everyone is effectively fulfilling their roles? What about the leadership?

c. Do you think your hospital provides sufficient support for employees' personal growth and career development? Could you give some examples? How does this impact your motivation at work?

9. How well do different departments in your hospital collaborate in daily work? For example, how do the outpatient department, pharmacy department, medical affairs department, and infection control department coordinate with each other?

a. Do you and your colleagues/supervisors frequently hold meetings to discuss work-related issues? (If this intervention strategy were to be implemented, do you think hospital leadership would organize formal meetings to promote and enforce it? Why or why not?)

b. What tools or methods do you typically use to communicate with colleagues or supervisors? (such as email, internal communication platforms like Enterprise WeChat, social media groups like WeChat or QQ.) Have you ever experienced communication breakdowns or misunderstandings? (For example, missing WeChat messages, important notifications being buried under too many messages, or misremembering the meeting time.) When these issues arise, how do you usually handle them? Are they resolved in a timely manner?

10. Are there any existing hospital policies or incentive programs that might influence your

willingness to adopt this intervention strategy? (For example, could participating in this strategy provide more opportunities for training and professional development? Might it enhance your reputation within the hospital, earn you greater respect, or improve your chances for promotion?)

11. Based on your experience, how does your hospital typically implement a new protocol? You may describe the process before, during, and after implementation, as well as how challenges are typically handled. (For example: Does the hospital set clear goals and provide feedback channels? What are these channels? (e.g., email, phone, designated personnel, WeChat groups, debriefing meetings, etc.) Are staff encouraged to independently learn relevant knowledge? Does the hospital organize training sessions or regularly conduct reflections and evaluations? Do you think these measures help with both team and individual growth?)

12. Have you ever faced any challenges in accessing information about antimicrobial agents? (such as limited sources of information or delays in updates)

13. What patient-related challenges might arise when implementing this intervention strategy in your hospital? (Possible prompts: Will patients be cooperative? Have you encountered cases where patients insisted on receiving an antimicrobial prescription, requested a different antimicrobial agent due to dissatisfaction with effectiveness or financial concerns, or hesitated/refused to use antimicrobial agents due to concerns about side effects? How do you usually handle such situations?)

14. Do you think this intervention strategy will be helpful in your daily work? Could you elaborate on the specific aspects where it would bring assistance?

15. If this intervention strategy were to be implemented in your hospital, do you have confidence in successfully executing and applying it?

a. In which aspects do you believe you have advantages in executing this intervention strategy? (For example, professional skills, knowledge level, teamwork and coordination abilities, etc.)

b. Will your current work situation affect your implementation of this intervention strategy? (For example, workload, research commitments, income, etc.)

16. Do you think leaders in your hospital have a significant influence on your work decisions? Could you provide some examples to illustrate this?

17. In your opinion, besides the official implementation leader, do you think there are any colleagues or leaders in your hospital who might actively support the implementation of this intervention strategy? (For example, is there any physician or nurse who, due to their frequent encounters with the issue of antimicrobial misuse, particularly desires to see a change?) **How do you perceive the influence of these potential champions within the institution? Are they capable of effectively persuading other colleagues to support the intervention strategy?**

Table 2 The interview guide for pharmacists in primary care institutions regarding the antimicrobial SNF intervention strategy based on the CFIR.

Instruction: In this interview, we will discuss the implementation of the antimicrobial intervention strategy. Please note that all information shared will be kept strictly confidential. We sincerely appreciate your support!
Basic Information and Background
1.What is your age? What is your position and professional title?
2.Have you always worked at this hospital? How long have you been here?
3.Have you worked in other departments before, such as the hospital administration, or outpatient services?
4.Could you provide an overview of the usage of antimicrobial agents in your hospital? (For example: the average daily/monthly antimicrobial utilization rate, the APR and IAPR during prescription audits, and the appropriate rate of antimicrobial prescriptions in the last prescription audit.)
CFIR-guided interview guide for the implementation of the antimicrobial SNF intervention strategy.
1. In our previous antimicrobial intervention trial in primary care institutions, we implemented a series of measures, including a real-time pop-up warning message, a 10-day antimicrobial prescription feedback, and distribution of educational manuals. These measures significantly reduced both the overall APR and the IAPR during the intervention period, demonstrating strong effectiveness. However, once the intervention stopped, we observed a rapid rebound in both APR and IAPR. **What are your thoughts on this phenomenon from a pharmacist's perspective? What do you think might be the underlying causes of this rebound? To ensure the long-term sustainability of intervention effects, how do you think we could optimize or adjust these measures? Could you provide specific recommendations or targeted measures to enhance their long-term impact?**
2. What are your thoughts on the design of the intervention strategy in this study?
Peer comparison (Antimicrobial prescription feedback reports)
a.How often does your hospital conduct prescription audits? Regarding the frequency of feedback report , which option do you think is better: every 10 days, fortnightly, monthly, quarterly, or irregular intervals? Why?
Education and training for physicians and patients
b.Apart from education and training for physicians and patients, do you believe that pharmacists also require specialized educational training or other measures?
Supportive implementation mechanisms
c. If a person were to be designated as the intervention coordinator for promoting the implementation of the antimicrobial SNF intervention strategy at your hospital, who would

you recommend? What advantages or challenges do you think this person would face in this role? (For example, consider their time availability, workload, influence, communication and coordination skills, professional knowledge, comprehension ability, and work style—whether they plan thoroughly in advance, listen and adjust during implementation, and reflect effectively afterward.)

d. Do you think pharmacists can serve as the intervention coordinators of this intervention? Why? (Consider factors such as professional skills, knowledge level, time availability, workload, etc.)

e. Would you find it useful to have an appeal window where prescribers can briefly explain their reason for maintaining an antimicrobial prescription despite the real-time pop-up warnings? Are there any other aspects of the real-time pop-up warnings that you think should be improved?

f. Do you think combining real-time pop-up warning reminders with peer comparison feedback reports would be beneficial? Would this enhance the intervention's effectiveness? Why or why not?

g. What do you consider the most urgent issue that hospitals need to address in antimicrobial use? Can the aforementioned intervention strategy help resolve these issues? If so, which specific aspects of the design are relatively effective?

3. Regarding the use and management of antimicrobial agents, what are your or your department's roles and responsibilities? Has the hospital established a Pharmacist Management Team? Who are the members of this team? How often does the Pharmacist Management Team convene? Under what circumstances would a Pharmacist Management Team meeting be held? How frequently are Pharmacist Management Team meetings held to discuss antimicrobial agents? What was the content of the most recent Pharmacist Management Team meeting related to antimicrobial agents?

4. Does your hospital have any existing assessment standards for antimicrobial use?

a. If so, were these standards established by the external regulatory authorities (such as the provincial health commission or local health bureau), or were they developed internally within the hospital? Were any specific measures implemented to help meet these standards?

b. If measures were taken, could you describe them? Were they designed by external experts or developed through internal discussions within the hospital?

c. If measures were taken, how do they compare to the intervention strategy in our study? Which do you prefer/which do you think is more effective in improving antimicrobial prescribing practices? Why?

d. If no formal assessment standards or measures exist, would you prefer the standards or intervention strategies developed by an external research team like ours, or would you rather have them decided through internal hospital discussions? Why?

5. Have you ever participated in cross-institution collaborative projects on antimicrobial use, management, or other interventions? (For example, have you been involved in projects where external teams, like the research team from Guizhou Medical University, conducted an

antimicrobial prescription control intervention at your hospital?)

a. If yes, what was your role and responsibility in these collaborations?

b. Through working with external institutions, did you gain new medical knowledge or technical skills? Did you receive any additional resources or support? (such as training, technical assistance, or financial backing) If not, what were the reasons? What major challenges did you encounter? (such as communication difficulties, misaligned objectives, or resource allocation disputes)

c. If you have not participated in such collaborations, would you be open to incorporating external resources or partners (such as district/county hospitals, Center for Disease Control and Prevention, pharmaceutical suppliers, research teams, etc.) to assist in the management and control of antimicrobial drugs? If not, why?

6. What are your overall impressions of your hospital? (Feel free to take a moment to pause the recording and share your thoughts.)

a. Do you often have to work overtime? Are you satisfied with your current salary and benefits?

b. How would you describe your relationship with your colleagues? Do you get along well? Do you feel that everyone is effectively fulfilling their roles? What about the leadership?

c. Do you think your hospital provides sufficient support for employees' personal growth and career development? Could you give some examples? How does this impact your motivation at work?

7. How well do different departments in your hospital collaborate in daily work? For example, how do the outpatient department, pharmacy department, medical affairs department, and infection control department coordinate with each other?

a. Do you and your colleagues/supervisors frequently hold meetings to discuss work-related issues? (If this intervention strategy were to be implemented, do you think hospital leadership would organize formal meetings to promote and enforce it? Why or why not?)

b. What tools or methods do you typically use to communicate with colleagues or supervisors? (such as email, internal communication platforms like Enterprise WeChat, social media groups like WeChat or QQ.) Have you ever experienced communication breakdowns or misunderstandings? (For example, missing WeChat messages, important notifications being buried under too many messages, or misremembering the meeting time.) When these issues arise, how do you usually handle them? Are they resolved in a timely manner?

8. If participation in this intervention strategy could gain more opportunities for training and professional development, or boost one's chances for promotion, would this enhance enthusiasm and willingness to collaborate among you and your colleagues, thereby facilitating the implementation of this strategy?

9. Based on your experience, how does your hospital typically implement a new protocol? And how does your department handle such situations? You may describe the process before, during, and after implementation, as well as how challenges are typically handled. (For example: Does the hospital set clear goals and provide feedback channels? What are these channels? (e.g.,

email, phone, designated personnel, WeChat groups, debriefing meetings, etc.) Are staff encouraged to independently learn relevant knowledge? Does the hospital organize training sessions or regularly conduct reflections and evaluations? Do you think these measures help with both team and individual growth?)

10. Have you ever faced any challenges in accessing information about antimicrobial agents? (such as limited sources of information or delays in updates)

11. In your opinion, what factors (such as medical insurance policy support, patient education, etc.) **could potentially facilitate the appropriate use of antimicrobial agents by physicians/patients?**

12. Do you think this intervention strategy will have an impact on the daily work of pharmacists or the pharmacy?

13. In your opinion, besides the official implementation leader, do you think there are any colleagues or leaders in your hospital who might actively support the implementation of this intervention strategy? (For example, is there any physician or nurse who, due to their frequent encounters with the issue of antimicrobial misuse, particularly desires to see a change?)

Table 3 The interview guide for hospital managers in primary care institutions regarding the antimicrobial SNF intervention strategy based on the CFIR.

Instruction: In this interview, we will discuss the implementation of the antimicrobial intervention strategy. Please note that all information shared will be kept strictly confidential. We sincerely appreciate your support!

Basic Information and Background

1.What is your age? What is your position and professional title?

2.Have you always worked at this hospital? How long have you been here?

3.How long have you been working in your current management position? Have you worked in other roles before? If so, what positions were they, and for how long?

4.Could you provide an overview of the usage of antimicrobial agents in outpatient settings?

CFIR-guided interview guide for the implementation of the antimicrobial SNF intervention strategy.

1. In our previous antimicrobial intervention trial in primary care institutions, we implemented a series of measures, including a real-time pop-up warning message, a 10-day antimicrobial prescription feedback, and distribution of educational manuals. These measures significantly reduced both the overall antimicrobial prescription rate (APR) and the inappropriate antimicrobial prescription rate (IAPR) during the intervention period, demonstrating strong effectiveness. However, once the intervention stopped, we observed a rapid rebound in both APR and IAPR. **What are your thoughts on this phenomenon? What do you think might be the underlying causes of this rebound? To ensure the long-term sustainability of intervention effects, how do you think we could optimize or adjust these measures? Could you provide specific recommendations or targeted measures to enhance their long-term impact?**

2. What are your thoughts on the design of the intervention strategy in this study?

Peer comparison (Antimicrobial prescription feedback reports)

a.Do you think it is appropriate to set the best and non-best performers for antimicrobial use? Why or why not?

b.Do you think any aspects of the antimicrobial prescription feedback report should be added, removed, or optimized?

c.In terms of feedback frequency—every 10 days, fortnightly, monthly, quarterly, or irregular intervals—which would you prefer, and why?

Education and training for physicians and patients

d.Do you think the educational and training measures designed for physicians and patients are reasonable? Could you share your thoughts and causes on this?

Supportive implementation mechanisms

e.If a person were to be designated as the intervention coordinator for promoting the implementation of the antimicrobial SNF intervention strategy at your hospital, who would

you recommend? What advantages or challenges do you think this person would face in this role? (For example, consider their time availability, workload, influence, communication and coordination skills, professional knowledge, comprehension ability, and work style—whether they plan thoroughly in advance, listen and adjust during implementation, and reflect effectively afterward.)

f. Do you think it is necessary to have signatures from authoritative institutions or experts? If so, should it come from your hospital, the provincial health departments of Guizhou Province, or the municipal/county health administrative departments? Which option do you think is more appropriate, and why?

g.When the real-time pop-up warnings appear, do you think it should appear in the center of the computer screen or at the bottom left or right corners? Are there any other aspects of the real-time pop-up warnings that you think should be improved?

h.Would you find it useful to have an appeal window where prescribers can briefly explain their reason for maintaining an antimicrobial prescription despite the real-time pop-up warnings? Why or why not?

As a whole

i. Do you think combining real-time pop-up warning reminders with peer comparison feedback reports would be beneficial? Would this enhance the intervention's effectiveness? Why or why not?

j. The implementation of the intervention strategy requires reviewing feedback reports, reading real-time pop-up warning messages, documenting the reasons for antimicrobial use, attending training sessions, studying educational materials, and watching training videos. Do you think the time required for these tasks is within a reasonable range for physicians? Do you find these steps difficult to operate for the physicians in your hospital (are they complex or not)? When integrating these steps into the hospital's current workflow, what challenges do you anticipate? Are there any particular aspects that need special attention?

k.What do you consider the most urgent issue that hospitals need to address in antimicrobial use? Can the aforementioned intervention strategy help resolve these issues? If so, which specific aspects of the design are relatively effective?

3. Could you tell us some details about your hospital?

a.Hospital's social architecture: What departments make up your hospital, and what is the relationship between these departments (are they hierarchical or parallel)? Do you think this social architecture facilitates a quick response and adaptation to new antimicrobial intervention strategies?

b.Hospital's age: How long has your hospital been established? In your opinion, would older hospitals or newly established ones be more willing to adopt a new antimicrobial intervention strategy? Why?

c.Hospital's size: What is the size of your hospital (in terms of land area and number of

employees)? Do you think a larger or smaller hospital would find it easier to implement the intervention strategy in this study? Why?

d.Hospital organizational culture: What is your hospital's attitude towards new things and new technologies (is it willing to try them)? What kind of work climate does it promote (such as encouraging innovation, open communication, emphasizing discipline and efficiency)? Does the hospital offer opportunities for continuous learning and career development? How do you think these organizational culture affect the implementation of the intervention strategy?

e. Overall hospital environment: How does your hospital provide support for employees' personal growth and career development? Could you give some examples? How does this impact the motivation at work? Do all employees fulfill their roles effectively?

4. Does your hospital have any existing assessment standards for antimicrobial use?

a.If so, were these standards established by the external regulatory authorities (such as the provincial health commission or local health bureau), or were they developed internally within the hospital? Were any specific measures implemented to help meet these standards?

b.If measures were taken, could you describe them? Were they designed by external experts or research teams, or developed through internal discussions within the hospital?

c. If measures were taken, how do they compare to the intervention strategy in our study? Which do you prefer/which do you think is more effective in improving antimicrobial prescribing practices? Why?

d.If no formal assessment standards or measures exist, would you prefer the standards or intervention strategies developed by an external research team like ours, or would you rather have them decided through internal hospital discussions? Why?

5. What sources of information do you usually rely on to determine whether a measure, such as an antimicrobial intervention strategy, is effective? Do you base your judgment on personal experience and knowledge, or do you refer to research evidence, such as published literature, guidelines, reports from authoritative institutions and professionals, or patient experiences?

6. What fundamental conditions or resources do you think are necessary for piloting this intervention strategy in your hospital? (For example, statistical and computer technical support and maintenance staff, appropriate antimicrobial use plugins for the HIS, offline training venues, online training platforms, educational materials, or media equipment for broadcasting in hospital waiting areas, corridors, and lobbies.)

a. How would you assess your hospital's current conditions and resources? What essential conditions and resources are still lacking?

7. Do you believe that hospital managers would invest time and energy in focusing on the implementation of the intervention strategy? If so, how would they do so? (For example, would the primary responsible person report the status once a week, or would a summary meeting be held monthly?) **Are there any other matters you consider more important that might take priority over focusing on the implementation of this intervention strategy?**

8. What major costs do you anticipate from implementing this intervention strategy? (For example time, workload, human resources, etc.) Are these costs within an acceptable range?

9. Are you aware of any current policies or incentive mechanisms that may facilitate (or hinder) the implementation of this intervention strategy? (For example, the National Action Plan to Contain Antimicrobial Resistance (2022-2025) mandates comprehensive training for all medical staff nationwide on the appropriate antimicrobial use, with a correct knowledge acquisition rate exceeding 80%; the Regulations on the Clinical Application Management of Antimicrobial Agents stipulates that the clinical use of antimicrobial agents in care institutions should be included in their assessment index system, serving as a basis for performance evaluation, and granting or revoking (or downgrading) physicians' prescribing rights and pharmacists' dispensing qualifications based on the situation.)

10. What information or support do you think physicians and patients most desire concerning antimicrobial use? (For example, training and education, correct medication methods, side effect management, etc.) **From your perspective, what specific issues** (such as information asymmetry, patient adherence, cognitive disparities among patients, economic burdens, etc.) **may hinder our effective promotion of the correct use of antimicrobial agents by physicians/patients? Conversely, what factors** (such as medical insurance policy support, patient education, etc.) **may facilitate our better meeting the needs of these two groups?**

11. If you were aware of other primary care institutions implementing antimicrobial intervention strategies, would you consider adopting similar management strategies in your own hospital?

12. Have your hospital ever participated in cross-institution collaborative projects on antimicrobial use, management, or other interventions? (For example, have you been involved in projects where external teams, like the research team from Guizhou Medical University, conducted an antimicrobial prescription control intervention at your hospital?)

a. If yes, what was your role and responsibility in these collaborations?

b. Through working with external institutions, did your hospital receive any additional resources or support? (such as training, technical assistance, or financial backing) If not, what were the reasons? What major challenges did you encounter? (such as communication difficulties, misaligned objectives, or resource allocation disputes)

c. If your hospital have not participated in such collaborations, would you be open to incorporating external resources or partners (such as education sector, Center for Disease Control and Prevention, or research teams) to implement a similar intervention? If not, why?

13. How well do different departments in your hospital collaborate in daily work? For example, how do the outpatient department, pharmacy department, medical affairs department, and infection control department coordinate with each other?

a. Do you and your subordinates frequently hold meetings to discuss work-related issues? (If this intervention strategy were to be implemented, will you consider organizing formal meetings to

promote and enforce it? Why or why not?)

b. What tools or methods do you typically use for internal communication? (such as email, internal communication platforms like Enterprise WeChat, social media groups like WeChat or QQ.) Have you ever experienced communication breakdowns or misunderstandings? (For example, missing WeChat messages, important notifications being buried under too many messages, or misremembering the meeting time.) When these issues arise, how do you usually handle them? Are they resolved in a timely manner?

14. Is it possible that the hospital might adopt certain incentive and reward measures to enhance cooperation in implementing this intervention strategy? (For example, could the hospital consider providing those participating in this strategy with more opportunities for training and professional development, or perhaps help them enhance their reputation within the hospital, gain greater respect, or improve their chances for promotion?)

15. Based on your experience, how do you typically implement a new protocol? You may describe the process before, during, and after implementation, as well as how challenges are typically handled. (For example: Are staff encouraged to independently learn relevant knowledge? Have you encountered any difficulties or challenges when obtaining certain information, such as limited sources of information, delays in updates, technical jargon that is hard to understand, or ambiguous descriptions? Do you organize training sessions or regularly set aside time to discuss unclear or difficult aspects? Is there any follow-up or feedback on the implementation of the protocol? How is this done? And if obstacles arise during the implementation process, how are they addressed?)

16. Given your current work conditions (such as workload and time constraints), **what practical challenges or barriers do you foresee in implementing the intervention strategy?** (For example, the lack of sufficient training or guidance, gaps in professional knowledge or skills, miscommunication or information asymmetry leading to deviations in execution, resistance due to cultural norms or established practices, the pressures from patients, etc.)

17. In your opinion, besides the official implementation leader, do you think there are any groups in your hospital who might actively support the implementation of this intervention strategy? (For example, is there any physician or nurse who, due to their frequent encounters with the issue of antimicrobial misuse, particularly desires to see a change?) **How do you perceive the influence of these potential champions? Are they capable of effectively persuading other persons to support the intervention strategy?**

Table 4 The interview guide for health administrators regarding the antimicrobial SNF intervention strategy based on the CFIR.

Instruction: In this interview, we will discuss the implementation of the antimicrobial intervention strategy. Please note that all information shared will be kept strictly confidential. We sincerely appreciate your support!
Basic Information and Background
1.What is your age? What is your position and rank?
2.Have you always worked at this department? How long have you been here?
3.Have you worked in other departments before?
CFIR-guided interview guide for the implementation of the antimicrobial SNF intervention strategy.
1. In our previous antimicrobial intervention trial in primary care institutions, we implemented a series of measures, including a real-time pop-up warning message, a 10-day antimicrobial prescription feedback, and distribution of educational manuals. These measures significantly reduced both the overall APR and the IAPR during the intervention period, demonstrating strong effectiveness. However, once the intervention stopped, we observed a rapid rebound in both APR and IAPR. **What are your thoughts on this phenomenon? What do you think might be the underlying causes of this rebound? To ensure the long-term sustainability of intervention effects, how do you think we could optimize or adjust these measures? Could you provide specific recommendations or targeted measures to enhance their long-term impact?**
2. What do you consider the most urgent issue that primary care institutions need to address in antimicrobial use? Can the aforementioned intervention strategy help resolve some issues? If so, which specific aspects of the design are relatively effective?
3. What support do you think primary care institutions most desire concerning antimicrobial use? (For example, a convenient and fast chain for drug supply, training and education, correct medication methods, side effect management, etc.) **From your perspective, what specific issues** (such as information asymmetry, cognitive disparities among patients, the pressures from patients, etc.) **may hinder our effective promotion of the correct use of antimicrobial agents by hospitals? Conversely, what factors** (such as medical insurance policy support, patient education, etc.) **may facilitate our better meeting their needs?**
4. What obstacles do you think might arise if this intervention strategy is implemented across primary care institutions in the province? (For example, differences in the HIS used by these institutions) "
5. In your view, are there any organizations or institutions outside of the health sector that might offer support for our intervention strategy? (For example, are there academic institutions or industry associations that could provide technical support or training?) **How do you think such support could help us better implement the intervention strategy?** (For example, could it be used to acquire more advanced diagnostic equipment or to conduct more educational training sessions?)

6. Have you previously participated in or collaborated with entities other than primary care institutions (such as education departments, publicity departments, research teams, etc.) to implement any intervention-related projects, including antimicrobial interventions? (For example, has your institution collaborated with our research team at Guizhou Medical University to conduct an antimicrobial prescription control intervention trial in primary care institutions?)

a. If so, could you elaborate on the specific intervention project and the measures taken? Were these measures designed by research teams like ours or were uniformly designed by administrative regulatory entities (such as the National Health Commission or provincial health commissions)? Which do you perceive to be more effective, and why? Regarding antimicrobial-related intervention projects, how do you view the advantages of the intervention strategy in our research compared to currently implemented or previously implemented measures, and are there aspects where we can learn from other measures?

b. If so, in the collaborative projects, what was your role and responsibility? Did you have the opportunity to acquire new knowledge or skills? Did the hospital gain any additional resources or support (such as training, technology, or funding)? If not, why? During the collaboration, what major issues did you encounter? (such as communication barriers, inconsistent goals, disputes over resource allocation, etc.)

c. If not, would you prefer to adopt the intervention strategy designed by research teams or by administrative regulatory entities? Why? Do you hope to introduce external resources or partners (such as education departments, Center for Disease Control and Prevention, research teams, etc.) to carry out similar interventions? If not, why?

7. What sources of information do you usually rely on to determine whether a measure, such as an antimicrobial intervention strategy, is effective? Do you base your judgment on personal experience and knowledge, or do you refer to research evidence, such as published literature, guidelines, reports from authoritative institutions and professionals, or patient experiences?

8. Do you believe that health administrator would invest time and energy in focusing on the implementation of the intervention strategy? If so, how would they do so? (For example, would a summary meeting be held monthly?) **Are there any other matters you consider more important that might take priority over focusing on the implementation of this intervention strategy?**

9. Assuming the intervention strategy is to be implemented in the primary care institutions you connect with, is there a possibility that you might adopt specific incentive and reward measures to enhance the cooperation? (For example, by allocating more evaluation indicators for excellence to hospitals that perform well in its implementation.)

10. What major costs do you anticipate from implementing this intervention strategy? (For example, time, workload, human resources, etc.) Are these costs within an acceptable range?

11. Are you aware of any current policies or incentive mechanisms that may facilitate (or hinder) the implementation of this intervention strategy? (For example, the National Action Plan to Contain Antimicrobial Resistance (2022-2025) mandates comprehensive training for all

medical staff nationwide on the appropriate antimicrobial use, with a correct knowledge acquisition rate exceeding 80%; the Regulations on the Clinical Application Management of Antimicrobial Agents stipulates that the clinical use of antimicrobial agents in care institutions should be included in their assessment index system, serving as a basis for performance evaluation, and granting or revoking (or downgrading) physicians' prescribing rights and pharmacists' dispensing qualifications based on the situation.)

12. How enthusiastic are the primary care institutions you connect with when carrying out tasks under your guidance? Do you hold meetings with their responsible persons to discuss issues? (If the intervention strategy is to be implemented, will you convene formal meetings? Why?) **Have there been instances of miscommunication or misinterpretation of information? If such situations arise, how are you typically handled?**

13. Based on your experience, how do you typically implement a new protocol? You may describe the process before, during, and after implementation, as well as how challenges are typically handled.

14. Given your current work conditions (such as workload and time constraints), **what practical challenges or barriers do you foresee in implementing the intervention strategy?** (For example, the lack of sufficient training or guidance, gaps in professional knowledge or skills, miscommunication or information asymmetry leading to deviations in execution, resistance due to cultural norms or established practices, the pressures from patients, etc.)

Focus group discussion guide:

[Information Statement]

Hello everyone, I am XXX from Guizhou Medical University, and I will be the moderator for this focus group. We are conducting a study on the "appropriate use of antimicrobial agents" to better guide the public in understanding and using them correctly. Thank you all for taking the time to participate in our discussion despite your busy schedule.

To begin, let me briefly explain what antimicrobial agents are. These are medications used to treat bacterial infections, including commonly known ones such as amoxicillin, cephradine, metronidazole, clindamycin, and erythromycin. However, excessive or inappropriate use of these drugs can lead to antimicrobial resistance, making them ineffective and even resulting in situations where no drugs are available for treatment.

Now, let’ s move on to the main discussion. This discussion is expected to last about 40 minutes. Our primary goal is to gather your thoughts and opinions on educational and training measures related to the appropriate use of antimicrobial agents. These measures include:

1. distribution of educational pamphlets on antimicrobial agents；
2. display of educational videos in hospital waiting areas, corridors, and lobbies；
3. posters promoting appropriate antimicrobial use in hospital bulletin boards.

You are encouraged to share your experiences with antimicrobial agents, express your opinions, and engage in open discussion. Please feel free to speak your mind. There are no right or wrong answers, and all viewpoints are equally valued. Rest assured that all information shared will remain strictly confidential and will be used solely for this research. To facilitate data analysis in subsequent steps, we would like to audio-record this discussion. Would that be acceptable to you? If at any point you feel uncomfortable or wish to withdraw, you are free to leave the discussion at any time. Before we begin, we kindly ask you to sign an informed consent form. This ensures that you fully understand the purpose of this discussion and your rights as a

participant. If you have any questions or need further clarification, please don't hesitate to ask.

Once again, we sincerely appreciate your time and cooperation. If there are no questions, we can get started.

Table 5 The focus group discussion guide for patients regarding the antimicrobial SNF intervention strategy based on the CFIR.

Instruction: Welcome everyone to our focus group discussion on the implementation of education and training on the appropriate antimicrobial use. First, let's get to know each other a bit better. Please introduce yourself, starting from my right/left hand side, sharing your age, profession, and educational background.
CFIR-guided focus group discussion guide for the implementation of the antimicrobial SNF intervention strategy.
1. Could you share your experiences with using antimicrobial agents? **a.** Have you ever purchased or used antimicrobial agents on your own? Could you share what antimicrobial agents they were, what diseases they were used to treat, and how effective they were? **b.** Have you encountered situations where antimicrobial agents that previously worked well no longer do? Do you feel concerned in such cases? **2. Could you share your experiences of communicating with physicians during previous medical visits?** **a.** When seeking medical care, did you feel that physicians or pharmacy staff explain how to use medications and any precautions in easy-to-understand language and manner? Have you ever experienced communication issues (such as difficult-to-understand information, language barriers, or unfriendly attitudes from medical staff) that led to misunderstandings or confusion regarding medication use? **b.** Have you ever asked physicians to prescribe a specific antimicrobial agent or requested them to switch drugs because a certain antimicrobial agent was too expensive? How did the physicians react? (Did they prescribe the antimicrobial agent according to your request directly? Did they prescribe based on your actual condition and explain patiently? Did they completely ignore your request?) **3. Do you usually acquire knowledge about the appropriate antimicrobial use through certain channels? If so, what are those channels** (such as physicians, family members, friends, the internet, etc.)? **Have you encountered any difficulties when obtaining these information?** (For example, the information being too disorganized or not being able to discern which is more accurate.) **What kind of information or guidance on the antimicrobial use would you like hospitals to provide** (such as one-on-one consultations, online courses, lectures, etc.)? **4. Opinions on "education and training on appropriate antimicrobial use in this study":** **a.** If you receive an educational pamphlet on antimicrobial agents during a medical visit, would you be willing to read it? Would you read it immediately or take it home to read later? What information do you most hope to see? (Such as dosage, medication timing, common side effects, common misuse, etc.) Do you have any suggestion for the design of the pamphlet (such as length, font size, color scheme, layout of text and images, etc.)? Do you think this approach would make it convenient for you to access and understand how to use antimicrobial agents appropriately?

b.If the hospital plays educational videos on the appropriate antimicrobial use in waiting areas, corridors, lobbies, and other areas, would you pay attention to the content? How long do you prefer the videos to be? Which format do you like (such as animation, explanation by real person, case demonstrations, etc.)? If not, what are the reasons? (For example, being in a rush, not interested, preferring to look at your phone, etc.)

c. When you see health education posters on promoting appropriate antimicrobial use posted in hospital bulletin boards, would you stop to read them? Where should posters be posted to catch people's attention? (In areas with high patient flow, near registration desks, near pharmacies, or other locations?) What kind of posters do you think would attract attention (such as those with illustrations and text, bright color schemes, large fonts, etc.)? If the poster also includes a QR code that can be scanned for more detailed information or interactive content, would you try scanning it?

d.If the hospital requires the antimicrobial use according to the guidance of these measures of education and training, would you be willing to comply? Would you actively pay attention and learn? Would recommendations from health authorities, physicians, or experts (such as Zhong Nanshan) influence your trust in these measures of education and training? Why? Do you think reading posters, watching videos, and reading pamphlets are difficult tasks? Why?

e. Do you believe that measures of education and training (such as distributing educational pamphlets, playing educational videos, and posting posters) can help in the appropriate antimicrobial use in daily life? Why? Can they meet your needs for guidance on antimicrobial use? Compared to using only one measure, do you think adopting all three measures of education and training simultaneously (posters for reminders, pamphlets for detailed explanations, and videos for visual demonstrations) would be more beneficial for understanding antimicrobial use? Compared to verbal guidance from physicians, which measure do you prefer for obtaining information on antimicrobial use? Why?

5. Do the perceptions or behaviors of those around you influence your behavior of antimicrobial use?

a.Is there a perception that antimicrobial agents are the "panacea", leading you to want to use them to treat any illness? Do you adhere to physicians' instructions when taking medication? When you feel your condition is improving, do you reduce or discontinue antimicrobial use by your own? Do these perceptions and habits facilitate or hinder the appropriate antimicrobial use?

b.Do the perceptions of friends and family members influence your views on antimicrobial use? If so, how? (For example, if your family members, friends, or neighbors express skepticism towards pamphlets, videos, and posters, or have their own "folk remedies" or anecdotal evidence, how do these affect your thoughts? Why?) When seeing other patients paying attention to these pamphlets, videos, and posters, do you feel inclined to do the same?

c.Have you previously noticed any promotions on the appropriate antimicrobial use in other hospitals or clinics? If so, what forms did they take(such as posters, videos, pamphlets, etc.)?

Would you be more inclined to seek medical treatment at a hospital that offers such measures of education and training? Why? (For example, because you perceive the hospital as caring more about patients' health, providing more attentive and considerate services, being more patient-centered, or trusting this hospital more.)

6. **What factors might motivate you to more actively engage in these measures of education and training on the appropriate antimicrobial use** (such as recommendations from physicians or nurses, encouragement from family members, readability of promotional materials, subsidies, discounts, or small gifts provided by the government or hospitals, etc.) ? **In what aspects do you believe you have advantages when engaging in these measures** (such as already having a keen interest in health information, strong ability to learn new things, etc.) ? **What difficulties or obstacles might you encounter** (such as limited time, overly specialized or complex content, difficult-to-understand materials, excessive information, inability to remember many details, lack of interest, etc.) ?

7. **Summary Question:** Today, we have discussed many issues related to the antimicrobial use. Finally, is there any important question or idea that we haven't mentioned but you think is crucial to bring up to superior departments, hospitals, or physicians?

Conclusion and Thanks: This focus group discussion has now come to an end. Once again, thank you all for your active participation and valuable insights. Your feedback is extremely important to our research.