

# ASLM

AFRICAN SOCIETY FOR LABORATORY MEDICINE

ADVANCING THE LABORATORY PROFESSION AND NETWORKS IN AFRICA

## ANTIMICROBIAL RESISTANCE (AMR) COMMUNITY OF PRACTICE (CoP)



### Surgical Site Infections and Antibiotic Resistance Profiles after Bellwether Procedures in Rural Liberia: A Mixed-methods Study

**Remy Pacifique Ntirenganya, BSc.(Hons)Pharm, MMSc**

Pharmacy Department Lead  
Partners In Health, Liberia



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- ❑ Bellwether procedures<sup>1,2</sup>
  - C-section, laparotomy & repair of open fracture
  - Proxy for emergency and essential surgical care
- ❑ Surgical site infections (SSIs)<sup>3,4</sup>
  - Infections that occur after surgery
  - SSI rate (11%) in Low income countries(LICs)<sup>5</sup>
  - Main cause of all healthcare-related infections in LICs
  - Impact on patient clinical outcomes
- ❑ Antimicrobial resistance (AMR)<sup>5,6</sup>
  - Occurs when bacteria, viruses, fungi and parasites change over time & no longer respond to medicines
  - Makes SSIs harder to prevent or treat SSIs
  - High impact on patient clinical outcomes
- ❑ Antibiotic resistance profiles
  - Based on laboratory testing of bacteria to find out if they are resistant to one or more antibiotics.
- ❑ Challenges
  - Lack of diagnostic capacity & AMR data from LICs<sup>5</sup>
    - Widespread of undetected AMR
    - Impact on clinical management of SSIs

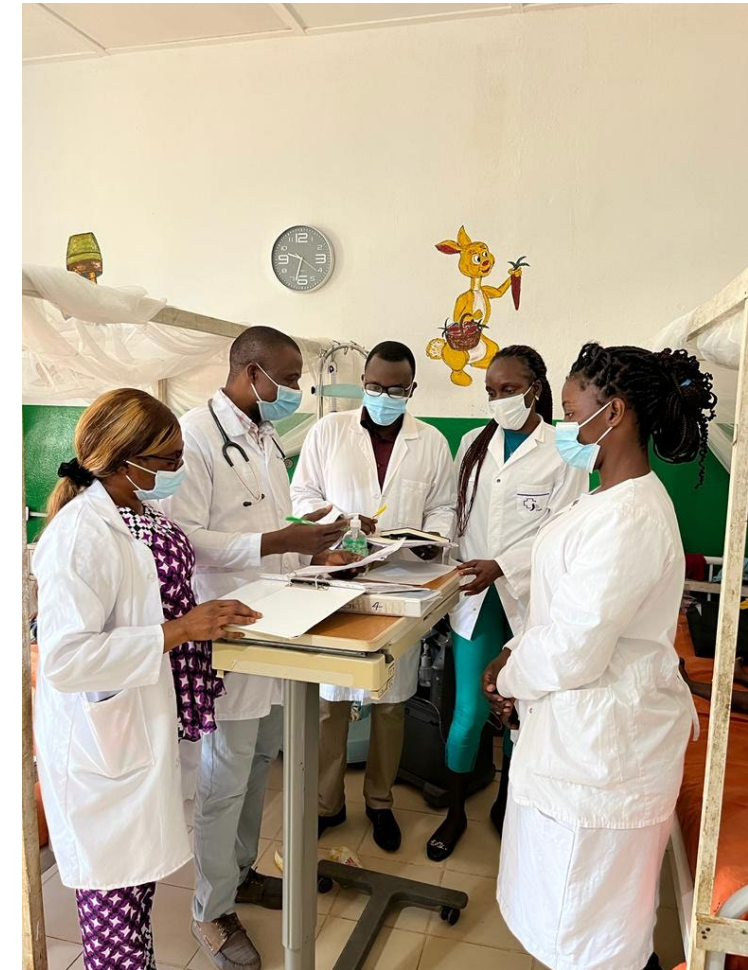
## ❑ Licensed Pharmacist

### ○ Over 10 years of experience:

- Global health procurement & supply chain management.
  - Availability, accessibility, affordability
- Clinical pharmacy practice.
  - Effective & safe use

### ○ Interests:

- Pharmacoepidemiology, pharmacoconomics, pharmaceutical policy & regulations.



## Case scenario

### ☐ Maria\*

- 35-year-old
- Married
- 5 children (10,7,6,4,2)

### ☐ Poor family

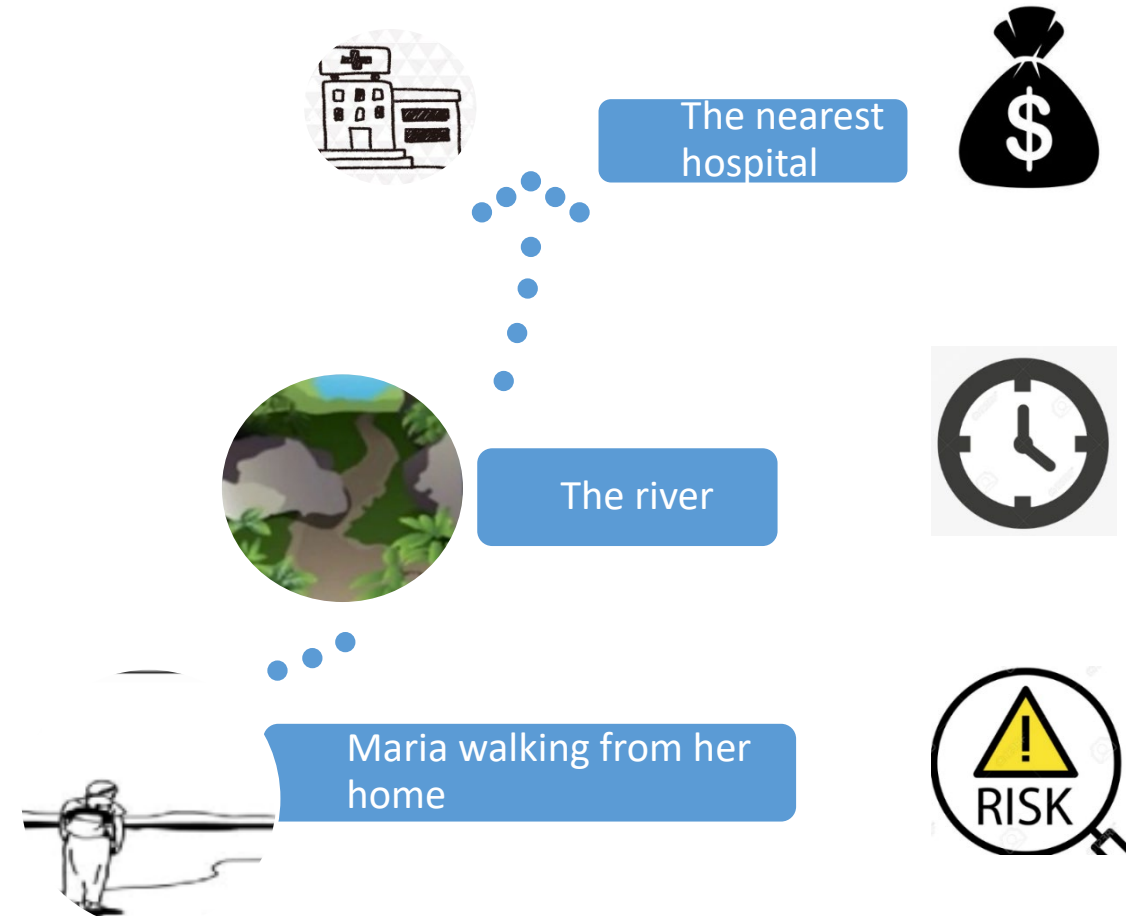
### ☐ Remote village

### ☐ Subsistence farming

### ☐ Lack of basic infrastructure

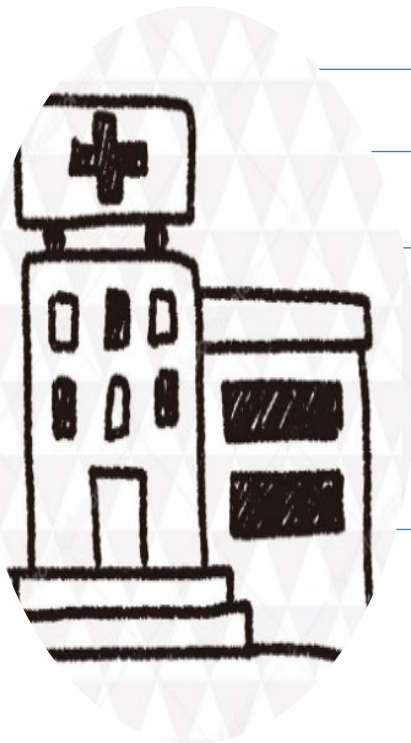



## Journey & barriers to accessing healthcare services





*\*Name changed to protect her privacy*


## Maria's experience at the nearest public hospital





 Prolonged hospital stay

 SSI, antibiotic resistance

 Stock out of medicines & supplies

 Cesarean section


 High risk pregnancy


 Long waiting time


## Maria's experience at the NGO-supported hospital





 Short hospital stay

 Wound healed, Maria discharged.

 Targeted treatment & wound dressing

 Diagnostics: 1) culture & sensitivity test, 2) Antibiotic resistance profile

 Patient examination

 Short waiting time





Map of Liberia

- ❑ **Area:** 111,369 sq km
- ❑ **Population:** 5,214,030 (July 2021 est.)<sup>1</sup>
  - >60% of pop. under the age of 25
- ❑ **GDP:** \$3.11 Billion (April 2021 est.)<sup>1</sup>
  - Population below poverty line: 50.9% (2016 est.)
  - Civil wars from 1980 to 2003
- ❑ **Health**
  - Ebola pandemic
  - Healthcare expenditure 6.7% (2018)<sup>1</sup>
  - Healthcare expenditure per capita \$53(2019)<sup>2</sup>
  - Weak health system
- ❑ **Administrative divisions:** 15 counties

# Background-Maryland county



Map of Liberia

- Population: ~175,000 (Dec 2020 est.)
  - J.J. Dossen Memorial Hospital(JJDMH)
    - 99-bed secondary level hospital
    - Recently established bacteriology lab.

Rural southeast Liberia

Remote & hard to reach

Lack of basic infrastructure

Poverty

Affected by civil wars



Road network, Maryland county



Ruined buildings, Maryland county



Remote village, Maryland county

- ❑ **Goal:** To assess surgical site infections and antibiotic resistance profiles after Bellwether procedures in rural Liberia.
- ❑ **Location:** Maryland county, Liberia.
- ❑ **Timespan:** August 2021 –May 2022.



## ❑ Mixed-methods study

- January 1<sup>st</sup> –December 31<sup>st</sup> , 2021

## ❑ Study setting:

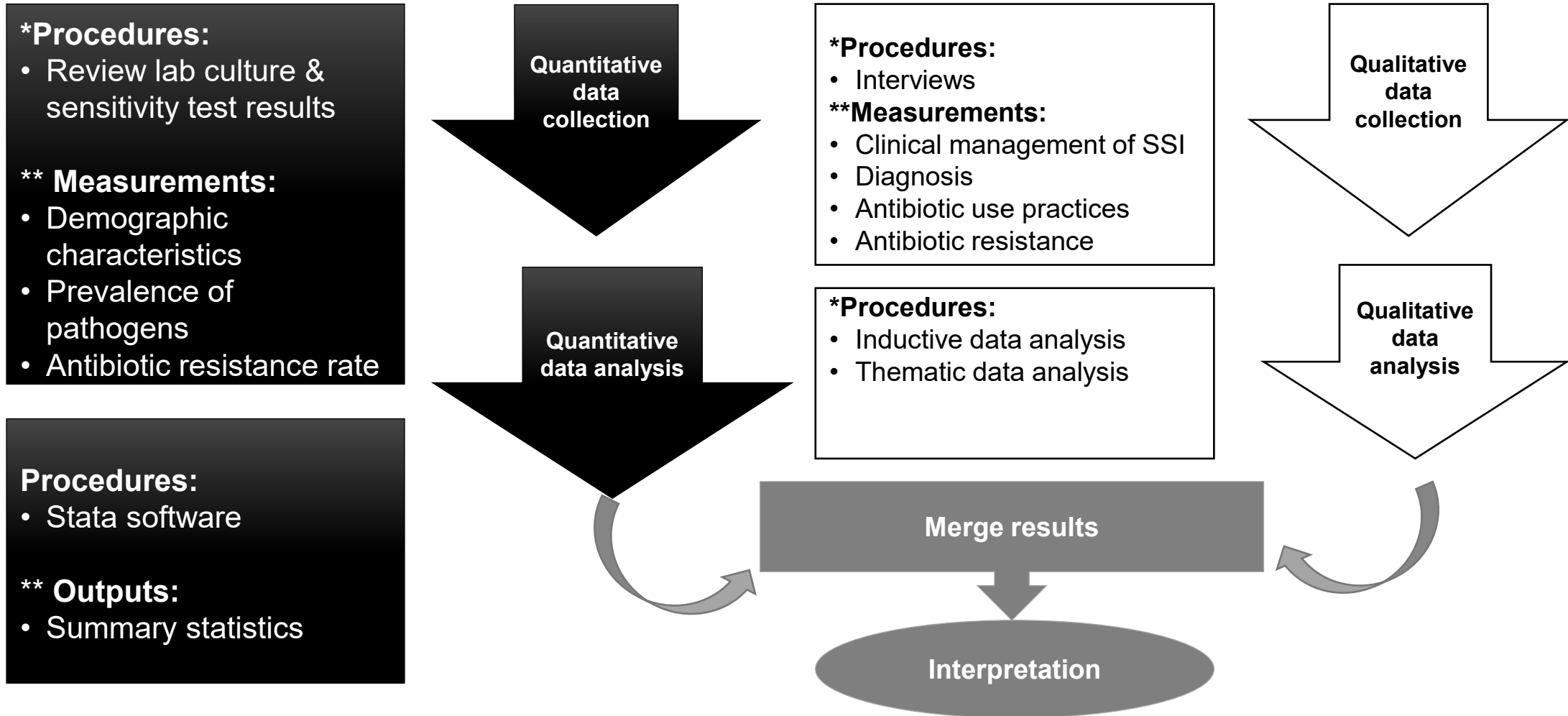
- J.J. Dossen Memorial Hospital
  - (OB/Gyn, Med/Surg wards)
  - Bacteriology lab

## ❑ Study population:

- Adult patients
  - Bellwether procedures
- Clinicians
  - Physicians, nurses & midwives



*Qualitative interview with a midwife at JJDMH*



- Of 435 Bellwether surgical procedures at JJDMH during the study period,
  - Twenty (4.6%) had suspected SSIs and swabs were sent to the lab for testing.
    - Of the 20, 18 (90.0%) had bacteriologically-confirmed SSIs.

**Table 1: Demographic and clinical characteristics of patient encounters whose wound swabs were tested at JJDMH Bacteriology Laboratory, Jan-Dec 2021 (N=20)**

| <b>Age group</b>                  | <b>N</b>  | <b>%</b>    |
|-----------------------------------|-----------|-------------|
| <b>18-28</b>                      | <b>13</b> | <b>65.0</b> |
| 29-39                             | 4         | 29.0        |
| 40-49                             | 2         | 10.0        |
| 60-69                             | 1         | 5.0         |
| <b>Gender</b>                     |           |             |
| <b>Female</b>                     | <b>18</b> | <b>90.0</b> |
| Male                              | 2         | 10.0        |
| <b>Type of surgical procedure</b> |           |             |
| <b>Cesarean section</b>           | <b>17</b> | <b>85.0</b> |
| Repair of open fracture           | 2         | 10.0        |
| Laparotomy                        | 1         | 5.0         |
| <b>Ward</b>                       |           |             |
| <b>Obstetric/gynecology ward</b>  | <b>17</b> | <b>85.0</b> |
| Medical/surgical ward             | 3         | 15.0        |
| <b>Culture growth</b>             |           |             |
| <b>Culture growth</b>             | <b>18</b> | <b>90.0</b> |
| No culture growth                 | 2         | 10.0        |



**Table 2: Distribution of bacterial isolates from patient wound swabs at JJDMH, Jan-Dec 2021 (N=22)**

| Microscopy Gram stain†                           | N         | %           |
|--|-----------|-------------|
| <b>Gram-negative</b>                             | <b>16</b> | <b>72.7</b> |
| Gram-positive                                    | 6         | 27.3        |
| <b>Bacterial isolate</b>                         |           |             |
| <b><i>Gram-negative (N=16)</i></b>               |           |             |
| <i>Acinetobacter calcoaceticus</i>               | <b>8</b>  | <b>50.0</b> |
| <i>Escherichia coli</i>                          | <b>4</b>  | <b>25.0</b> |
| <i>Pseudomonas aeruginosa</i>                    | 2         | 12.5        |
| <i>Klebsiella pneumoniae</i> ††                  | 1         | 6.3         |
| <i>Burkholderia cepacia</i>                      | 1         | 6.3         |
| <b><i>Gram-positive (N=6)</i></b>                |           |             |
| <i>Staphylococcus aureus</i>                     | <b>2</b>  | <b>33.3</b> |
| <i>Coagulase negative staphylococcus species</i> | <b>2</b>  | <b>33.3</b> |
| <i>Group G streptococcus</i>                     | 1         | 16.7        |
| <i>Enterococcus species</i>                      | 1         | 16.7        |

† Four cultures had two distinct pathogens identified.

†† Extended-spectrum  $\beta$ -lactamase (ESBL) pathogen.

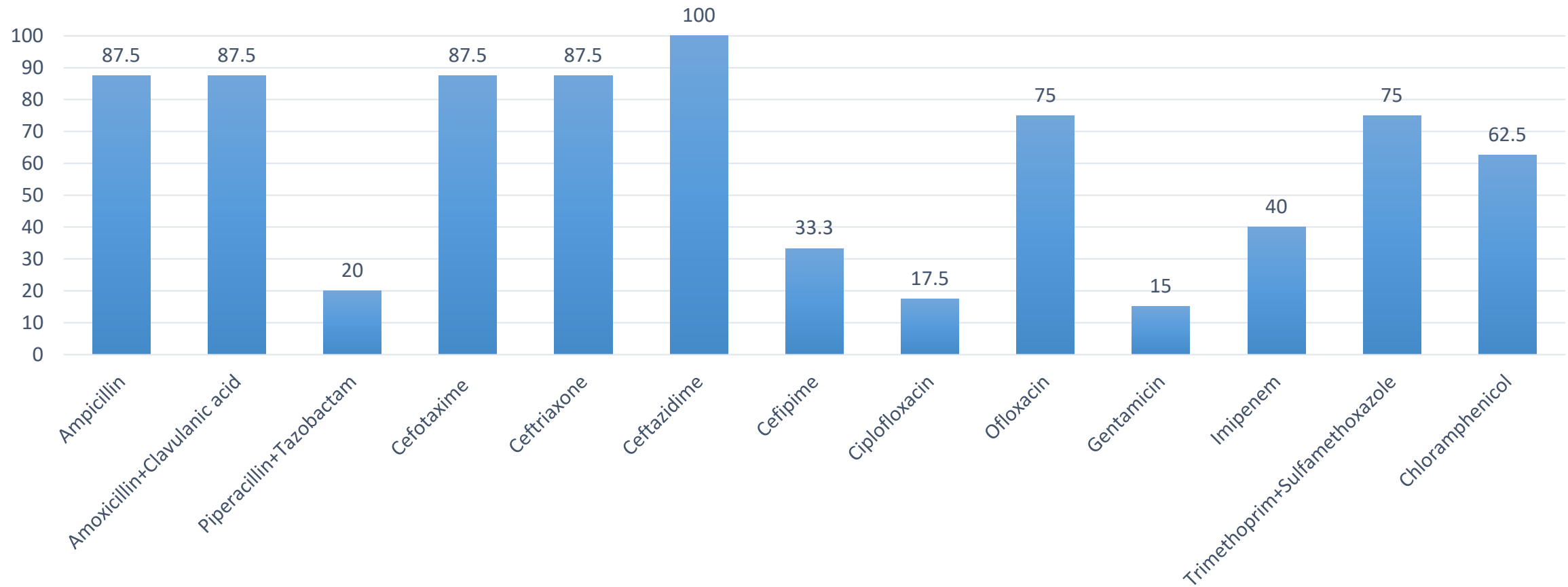
# Quantitative results

**Table 3: Antibiotic resistance profiles among gram-negative pathogens from patient wound swabs, listed as number and percentage testing non-susceptible (intermediate or resistant) to each antibiotic at JJDMH (N=16, Jan-Dec 2021)**

| Pathogen                                    | Resistance profile n (%) |                 |              |                 |              |                 |                 |              |              |                |                 |              |              |
|---|--------------------------|-----------------|--------------|-----------------|--------------|-----------------|-----------------|--------------|--------------|----------------|-----------------|--------------|--------------|
|   | AMP<br>n (%)             | AMC<br>n (%)    | TZP<br>n (%) | CTX<br>n (%)    | CRO<br>n (%) | CAZ<br>n (%)    | FEP<br>n (%)    | CIP<br>n (%) | OFX<br>n (%) | GM<br>n (%)    | IPM<br>n (%)    | SXT<br>n (%) | C30<br>n (%) |
| <i>Acinetobacter calcoaceticus</i><br>(n=8) | –                        | –               | 6(75.0)      | –               | –            | <b>5(100.0)</b> | <b>7(100.0)</b> | 5(62.5)      | –            | <b>6(75.0)</b> | <b>6(75.0)</b>  | 4(50.0)      | –            |
| <i>Escherichia coli</i> (n=4)               | 3(75.0)                  | 3(75.0)         | 1(25.0)      | 3(75.0)         | 3(75.0)      | –               | –               | 1(25.0)      | 2(50.0)      | 0(0.0)         | 1(25.0)         | 3(75.0)      | 1(25.0)      |
| <i>Pseudomonas aeruginosa</i><br>(n=2)      | –                        | –               | 0(0.0)       | –               | –            | –               | 0(0.0)          | 0(0.0)       | –            | 0(0.0)         | 0(0.0)          | –            | –            |
| <i>Klebsiella pneumoniae</i><br>(n=1)       | <b>1(100.0)</b>          | <b>1(100.0)</b> | 0(0.0)       | <b>1(100.0)</b> | 1(100.0)     | –               | –               | 0(0.0)       | 1(100.0)     | 0(0.0)         | <b>1(100.0)</b> | 1(100.0)     | 1(100.0)     |
| <i>Burkholderia cepacia</i><br>(n=1)        | –                        | –               | 0(0.0)       | –               | –            | –               | 0(0.0)          | 0(0.0)       | –            | 0(0.0)         | 0(0.0)          | –            | –            |
| <b>Overall resistance rate (%)</b>          | <b>87.5</b>              | <b>87.5</b>     | <b>20.0</b>  | <b>87.5</b>     | <b>87.5</b>  | <b>100.0</b>    | <b>33.3</b>     | <b>17.5</b>  | <b>75.0</b>  | <b>15.0</b>    | <b>40.0</b>     | <b>75.0</b>  | <b>62.5</b>  |

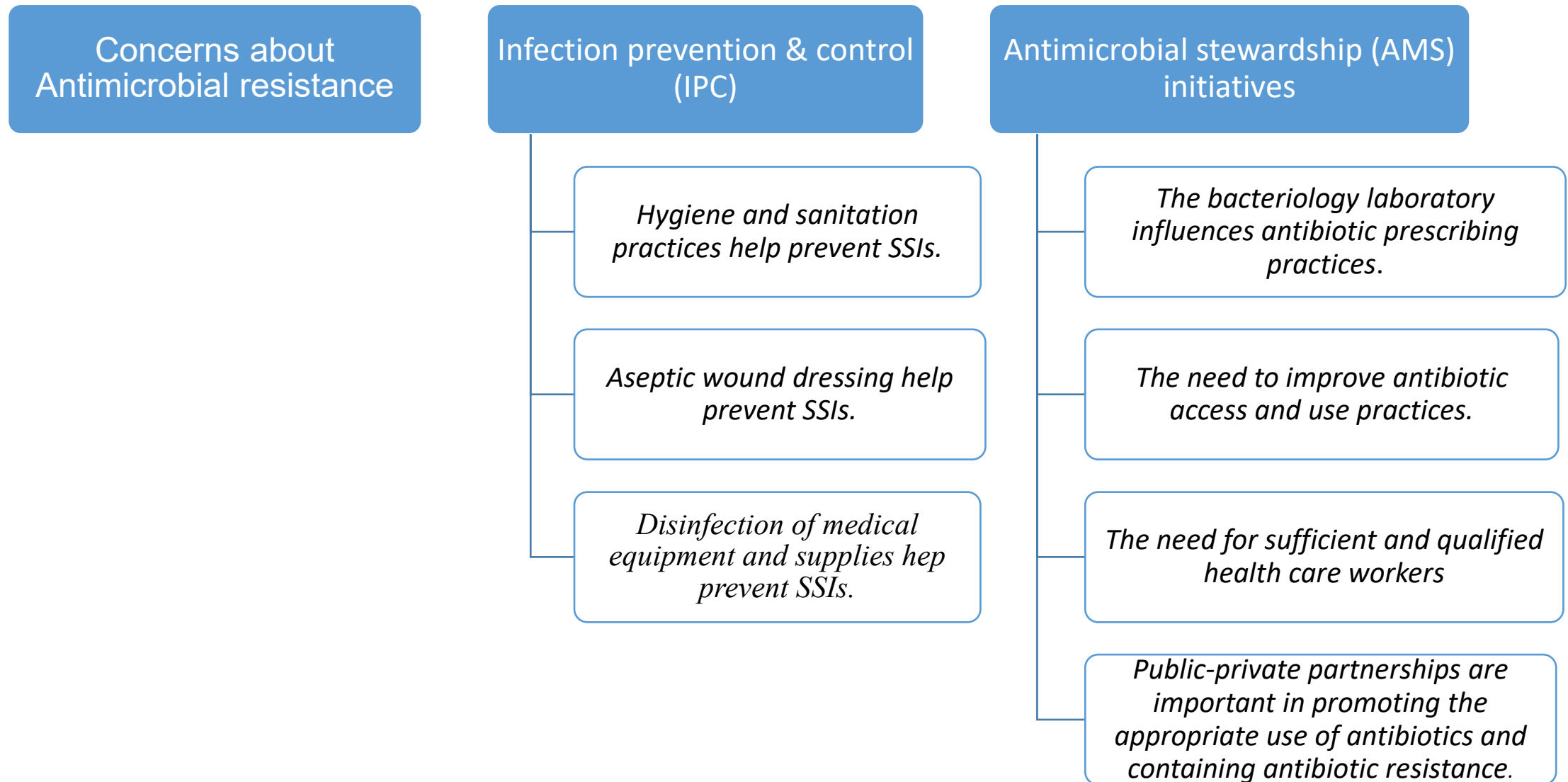
AMP: Ampicillin; AMC: Amoxicillin+Clavulanic acid; TZP: Piperacillin+Tazobactam; CRO: Ceftriaxone; CAZ: Ceftazidime; FEP: Cefepime; CIP: Ciprofloxacin; OFX: Ofloxacin; GM: Gentamicin; IPM: Imipenem; SXT: Trimethoprim+Sulfamethoxazole; C30: Chloramphenicol; - indicates "Not tested"

## Overall antibiotic resistance among gram-negative pathogens isolated from wound swabs at JJDM (N=16, Jan-Dec2021)



- ❑ Qualitative data for two physicians, four nurses, and four midwives.
- ❑ The majority 9 (90.0%) were female clinicians between 29-40 years old.





## Theme 1: Concerns about antibiotic resistance

- ❑ Antibiotic resistance is a threat
  - Cases of multidrug-resistant pathogens
- ❑ Factors contributing to the spread of antibiotic resistance
  - Misuse of antibiotics,
  - Easy access to antibiotics from private drug stores,
  - Overdose of antibiotics,
  - Inappropriate prescribing of multiple antibiotics for a long duration

**“Yeah, I think [antibiotic resistance] is a problem because a lot of the patients by the time they come to us or to me in the facility, they have been on a lot of antibiotics ...a lot of drug stores are out there in the streets. So, the majority of them by the time they are really coming to us, they have already been on several antibiotics. They tell you, ‘I’ve been taking Amoxicillin, I’ve been taking Cipro [Ciprofloxacin], I’ve been taking this and this’. So, by the time they reach us, they have been on antibiotics for a long time minimum, like two weeks. And when they see things are not changing, that’s when they really come to the facilities. And a lot of them when we take the samples to the laboratory, a lot of them are resistant to a majority of the antibiotics.”** *-Physician, J.J. Dossen Memorial Hospital.*

## Theme 2: Infection prevention and control practices

### A. Hygiene and sanitation practices help prevent SSIs

- Hand hygiene
- Use of personal protective equipment
- Prevent the spread of SSIs

**“We do our hand hygiene, you wash your hands, you use your gloves from patients to patient.”-Midwife, J.J. Dossen Memorial Hospital.**

## Theme 2: Infection prevention and control practices

### B. Aseptic wound dressing help prevent surgical site infections

- Clean the wound,
- Use of sterile materials and supplies.
- Aseptic procedures which prevent the development of infections.
- Regular wound dressing

“So, we normally tell them depending on the severity, if the infection is not much **we can do daily dressing of the wound**, and they should make sure that **the supplies that they are using to dress the wound are sterile**, you know, **they should make sure they have sterile equipment, sterile gauze** and you know, **there should be aseptic methods** of which they are handling this wound” -*Physician, J.J. Dossen Memorial Hospital*



## Theme 2: Infection prevention and control practices

### C. Disinfection of medical equipment & supplies helps prevent surgical site infections

- Use of sterile materials and supplies.
- Prevent the development of infections.

“We normally have those sterile gauze that are prepared, ...and take them and they are **autoclaved and they are sterilized** well to be used. They also have **sterile wound dressing equipment and instruments**, which can be used for this wound dressing....”

*-Physician, J.J. Dossen Memorial Hospital.*

## Theme 3: Antimicrobial stewardship initiatives.

### A. The bacteriology laboratory influences antibiotic prescribing practices.

- Enthusiasm for the bacteriology laboratory at their hospital.
- Take patient swabs for culture and sensitivity testing.
- Empirical vs targeted treatment.

“If I notice a patient in my ward developed a SSIs, first of all, I **collect the wound swab and send it to the lab** [Bacteriology laboratory] and wait for **lab results to know the best antibiotic to use.**”-  
*Midwife, J.J. Dossen Memorial Hospital.*

“In sense that **it [lab] helps us to get exactly what we are looking for our patients.** Over the time, **it has helped us, and most of our patients have recovered...**Once we **get the culture and sensitivity results and then we select the right medication based on lab results,** the recovery process for the patient will speed up.”-*Physician, J.J. Dossen Memorial Hospital.*

## Theme 3: Antimicrobial stewardship initiatives.

### B. The need to improve antibiotic access and use practices.

- Concerns about the widespread misuse of antibiotics
- Inappropriate prescription of antibiotics without proper diagnosis
- Pressure to prescribe antibiotics

“One of them is we noted that at the OPD [Outpatient department], **many patients when they go there, they're prescribed antibiotics, without doing any investigations, they just assume a patient has this condition and they give them antibiotics...**Patients themselves and the health care providers who like just giving antibiotics to everyone that walks into the OPD [outpatient department] tend to really cause the spread of antibiotic resistance.” -Physician, from *J.J. Dossen Memorial Hospital*.

“Yes, we have a lot of cases like that, where **they want us to prescribe antibiotics for them...**”-Nurse, *J.J. Dossen Memorial Hospital*.

## Theme 3: Antimicrobial stewardship initiatives.

### C. The need for sufficient and qualified health care workers.

- Link between antibiotic resistance to the lack of available, qualified healthcare providers.
- Understaffing makes healthcare workers are overwhelmed.
- Impact on the quality of care that they are able to provide to patients, especially in terms of infection prevention.
- Need for more specialists - notably those in pharmacology.

**“There is still a lot that is needed to standardize care throughout the country. And that comes with trainings. There should be enough trainings and all health care workers that involved should be trained on antibiotic use. And I believe there is that training, but there should be in depth trainings...There is also a need for other specialists such as pharmacologists or the pharmacists at a big number in this country... And the few staff that are available need trainings to promote the appropriate use of antibiotics.”**

*-Physician, J.J. Dossen Memorial Hospital.*

## Theme 3: Antimicrobial stewardship initiatives.

### D. Public-private partnerships are important in promoting the appropriate use of antibiotics and containing antibiotic resistance.

- Need for government-development partners' collaboration
  - The diagnostic capacity to promoting the appropriate use of antibiotics and containing the spread of AMR.
- Quality of care

“Actually, it's one of the, the achievements, I would say that Partners In Health, working alongside other development partners, the national government, the county leadership and J.J. Dossen Hospital, has helped a lot of us **including other clinicians**, even the residents that are now rotating here. We have our residents rotating in the lab. They acquire skills and they are **able to give the patients quality care** because once patients are able to know exactly what is happening to them, **they are able to receive the quality care and the appropriate antibiotics so that they prevent antibiotic resistance**. I believe that the lab has actually improved our practice, because we are **in the** direction of evidence-based care to all the patients, and so we can make every patient receive quality care.”  
*-Physician, from J.J. Dossen Memorial Hospital.*





- ❑ Cases of extended-spectrum  $\beta$ -lactamase (ESBL) pathogens and cases of Carbapenem-resistant Enterobacteriaceae (CRE).
  - CRE are associated with healthcare exposures, and they can spread rapidly in healthcare facilities <sup>15,16,17</sup>
  - CRE can cause infections with mortality rates of 40% to 50%. <sup>18,19,20</sup>

- ❑ IPC practices and AMS initiatives have the potential to limit or contain the spread of resistant pathogens.
  
- ❑ Lack of access to water, sanitation, and hygiene infrastructure.<sup>21</sup>
  - Impact on both health and healthcare provision, including surgical care.
  
- ❑ Significant reduction in SSIs & antibiotic use associated with antimicrobial stewardship programs.<sup>22,23</sup>
  - Role of the bacteriology lab.

## ❑ Limitations

- Relied on lab data from the laboratory registry.
  - May be subject to missing or misreporting errors.
- Small sample at a single hospital.
  - May not represent all SSIs at the hospital.

## ❑ Strength

- A convergent mixed-method study design
  - Triangulation of data from multiple high quality sources & informants

- High rates of AMR among postoperative SSIs in rural Liberia.
- Need to strengthen IPC and AMS practices.
- Inform policy & practice toward evidence-based decisions.
- Impact on postoperative clinical outcomes.

- Aldeyab M, Harbarth S, Vernaz N, Kearney M, Scott M, et al. The impact of antibiotic use on the incidence and resistance pattern of extended-spectrum beta-lactamase-producing bacteria in primary and secondary healthcare settings. *Br J Clin Pharmacol* 2012;74:171–9.
- Allegranzi B, Bagheri Nejad S, Combescure C, et al. Burden of endemic health-care-associated infection in developing countries: Systematic review and meta-analysis. *Lancet Lond Engl.* 2011; 377(9761): 228–241. DOI: [https://doi.org/10.1016/S0140-6736\(10\)61458-4](https://doi.org/10.1016/S0140-6736(10)61458-4)
- Allegranzi B, Bischoff P, de Jonge S, et al. New WHO recommendations on preoperative measures for surgical site infection prevention: an evidence-based global perspective. *Lancet Infect Dis.* 2016;16:e276–87.
- Allegranzi B, Zayed B, Bischoff P, et al. New WHO recommendations on intraoperative and postoperative measures for surgical site infection prevention: an evidence-based global perspective. *Lancet Infect Dis.* 2016;16:e288–303.
- Allegranzi, B., Bagheri Nejad, S., Combescure, C., Graafmans, W., Attar, H., Donaldson, L., & Pittet, D. (2011). Burden of endemic health-care-associated infection in developing countries: systematic review and meta-analysis. *Lancet*, 377(9761), 228–241.
- Anguzu JR, Olila D: Drug sensitivity patterns of bacterial isolates from septic post-operative wounds in a regional referral hospital in Uganda. *Afr Health Sci.* 2007, 7 (3): 148-154.

- Barlam TF, Cosgrove SE, Abbo LM, MacDougall C, Schuetz AN, Septimus EJ, et al. Implementing an antibiotic stewardship program: guidelines by the infectious diseases society of america and the society for healthcare epidemiology of america. *Clin Infect Dis* 2016;62(10):e51–77. [32]
- Bartlett JG, Gilbert DN, Spellberg B. Seven ways to preserve the miracle of antibiotics. *Clin Infect Dis*. 2013;56(10):1445–1450.
- Bebell LM, Ngonzi J, Bazira J, et al. Antimicrobial-resistant infections among postpartum women at a Ugandan referral hospital. *PLOS ONE*. 2017; 12(4): e0175456. DOI: <https://doi.org/10.1371/journal.pone.0175456>
- Bebell, L. M., & Muiru, A. N. (2014). Antibiotic use and emerging resistance: how can resource-limited countries turn the tide? *Global Heart*, 9(3), 347–358.
- Biccard BM, Madiba TE, Kluyts HL et al. Perioperative patient outcomes in the African Surgical Outcomes Study: a 7-day prospective observational cohort study. *Lancet*. 2018; 391: 1589-1598
- Brink A, Messina A, Feldman C, Richards G, Becker P, Goff D, et al. Antimicrobial stewardship across 47 South African hospitals: an implementation study. *Lancet Infect Dis* 2016, doi:[http://dx.doi.org/10.1016/S1473-3099\(16\)30012-3](http://dx.doi.org/10.1016/S1473-3099(16)30012-3).
- **Alabi SA, Picka SW, Sirleaf R, Ntirenganya PR et al. Implementation of an antimicrobial stewardship programme in three regional hospitals in the south-east of Liberia: lessons learned. *JAC-Antimicrob. Res.* Vol 4 (3), June 2022, dlac069, <https://doi.org/10.1093/jacamr/dlac069>**



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# THANK YOU

