NOTTINGHAM TRENT UNIVERSITY

MAKERERE UNIVERSITY

Week 3
Antibiotic Usage In Humans

Booklet analysing and comparing antibiotic use in humans within the United Kingdom (UK) and Uganda.

Booklet content:

This booklet analyses and compares antibiotic usage in humans within the United Kingdom (UK) and Uganda.

Authors:
Allysia Funge (Nottingham Trent University)
Shaharazad Rebelo Ebrahimi (Nottingham Trent University)
Suzan Nakalawa (Makerere University)
Carol Esther Nabbanja (Makerere University)

Published July 2021

Health system in the UK:

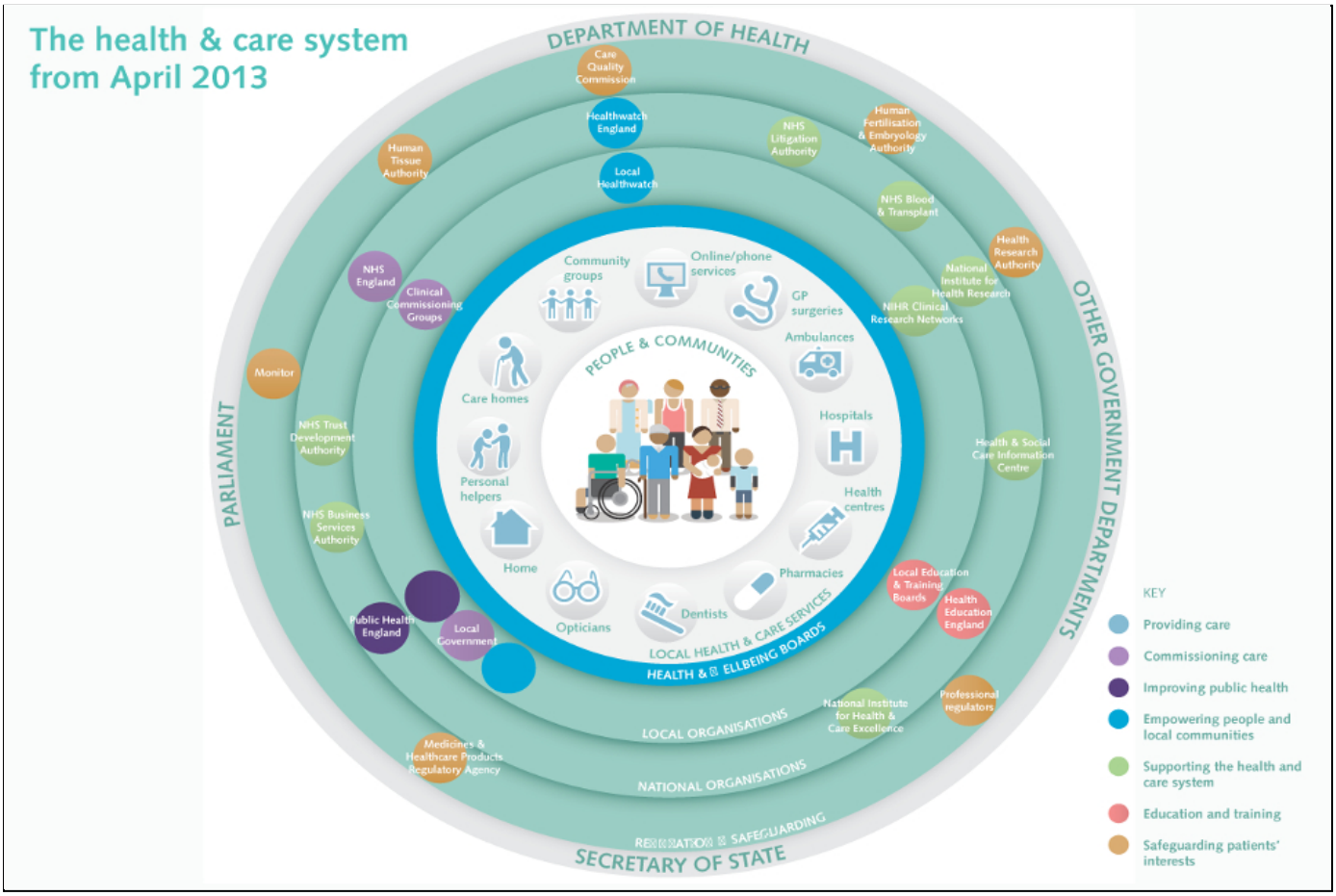

Figure 1. The UK health and care system since April 2013, including care services provided and organisations involved (The health and care system explained, 2013).

The UK healthcare system is comprised of four separate systems:

1) National Health Service (NHS), England.
2) Health, Social Services and Public Safety, Northern Ireland.
3) NHS, Scotland.
4) NHS, Wales.

This new healthcare system has been fully operational from 1st April in 2013 with aims to meet the Health and Social Act ambitions. The role of the Department of Health is 'To help people live better for longer'.

Figure 2. Care in the NHS (MS Trust, 2018).

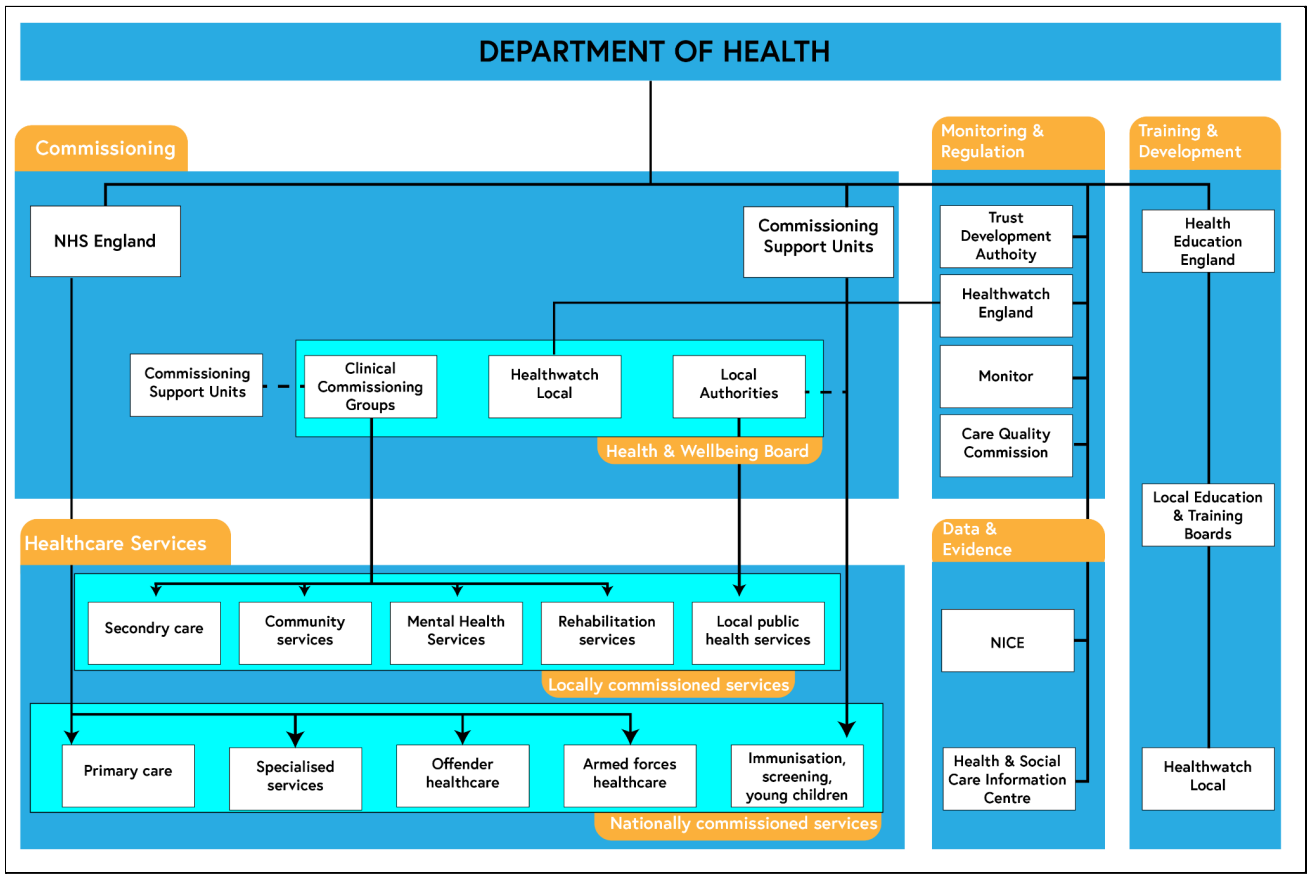

Figure 3. Structure of the NHS in England. (NHS England, 2014).

In the NHS, health care is organised and funded by region:

- **England:** Care is administered by Clinical Commissioning Groups (CCGs), which replaced Primary Care Trusts (PCTs) in April 2013.
- **Scotland, Wales and Northern Ireland:** Care is administered by organisations known as Health Boards.

Primary care services can take place in:

- GP practices
- Local health centres
- Community clinics
- Patients home

Primary health care professionals refer the patient to a secondary care service when they are unable to resolve the patient's condition themselves.

Secondary Care services can take place in:

- Hospitals
- Clinics

There are times whereby patients require access to more specialised equipment and expertise for their condition. In this case, the GP or care professional in their local hospital will refer the patient to tertiary services.

Tertiary Care services can take place in:

- Specialist centres e.g. The Royal Marsden (Cancer patients) / The National Hospital for Neurology and Neurosurgery in London.

Health system structure in Uganda

Uganda at a glance:

- Population: 42,862,958 (2017).
- Per capita income: $1,820.
- Life expectancy at birth: F 64/M 62 years.
- Infant mortality rate: 43/1,000 live births (Uganda, 2021).

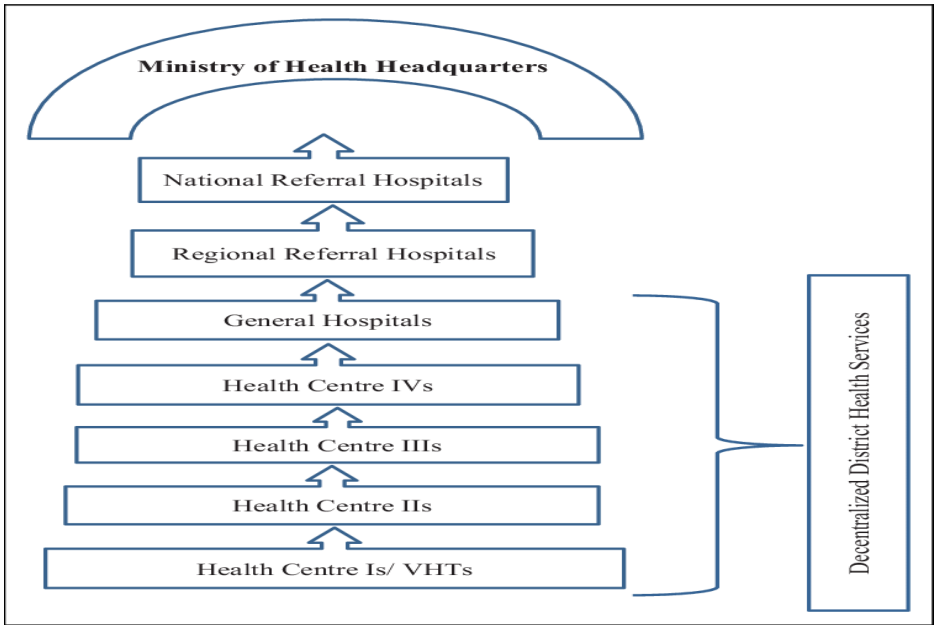

Figure 4. An illustration of Uganda's Health system structure (Mukose et al., 2021).

The major aim of Uganda's health system is to deliver a **national minimum health care package** to Ugandans. Uganda runs a **decentralized health system** with national and district levels.This works on a referral basis that is if a health centre I cannot handle a case, it refers it to a unit the next level up. The lowest rank of the district-based health system consists of Village Health Teams (VHTs). About 50% of healthcare provision is delivered by public or government owned facilities and the remaining 50% by private providers. The public sector facilities include two National Referral Hospitals, Mulago and Butabika in Kampala, four specialised government hospitals, fourteen Regional Referral Hospitals, 43 General Hospitals, and 112 District Health Center IV's, one per District. Basic services are provided in Health Centers III and II to provide diagnosis and maternity care, and health information is disseminated to village households by unpaid volunteer Village Health Teams at the lowest level (Acup et al., 2021).

Health system reforms were made to improve the health systems in the country. Due to these reforms there has been an increasing use of government mechanisms at the national,sectoral, and local government levels for purposes of planning, financing, procurement,and monitoring and evaluation within the country(Ssengooba et al., 2021). These reforms included the following.

- Abolition of user fees while in the public government hospitals.
- Government partnering with Private not for profit organizations and private health care providers.
- Encouraging the autonomy of public Hospitals.
- A resource allocation system was introduced for the country's health system.
- A decentralised human resource recruitment process.

Access to healthcare in the UK:

UK residents are entitled to free healthcare through the NHS (National Health Service).

- It is a residence-based system and all UK residents can access free services.
- Nationals from outside the UK can only access free NHS services after they have settled and resided in the UK.
- It is possible for an expatriate to register for UK healthcare via their GP.
- Since 2015, those entering the UK for a duration of 6 months or longer must pay health surcharges of at least £150-200 (Buswell, 2021).

Private UK healthcare is used by 10.5% of the UK population, who pay for private health insurance.

- Private healthcare allows access to quicker attention, shorter waiting times, access to specialists and advanced facilities.

Some types of healthcare accessible:

- **Women** can access healthcare through their general practitioner (GP) or well woman clinics, such as gynaecology services, free contraception, free sexual health services and free contraception.
- **Children** in the UK are entitled to a free vaccination program that includes: flu vaccine, MMR (measles, mumps and rubella) vaccine and a 6-in-1 vaccine against infections such as whooping cough.
- **Dental care** is free for those under 18, pregnant and people who had given birth within the last 12 months.
- **Mental health care** is free on the NHS but often requires GP referral. Some of the care includes drug and alcohol services, psychological therapy and children's mental health services.
- **Other health care** services are accessible to all, but often not NHS associated, and these include chiropractic treatment and osteopathy.

Places to access healthcare:

- First point of contact for medical queries, excluding emergencies, are **GP surgeries**.
- **NHS walk-in centres** are accessible for UK residents and they provide primary care services.
    - There are around 80 centres that provide assistance with minor injuries, illnesses and infections.
    - Some centres offer access to doctors and nurses but cannot offer full GP services.
- **Hospitals** are secondary care services for emergency treatment or treatment due to doctor referral.
    - NHS hospitals are free whereas independent hospitals require payments.
- Residents can also receive **non-emergency advice via the healthcare helpline 111**.
- UK **pharmacies** are located beside GP surgeries, within retail stores or independently.
    - They provide access to medicine and prescribed medication, such as antibiotics.
    - Only those who are exempt can receive free medication.

What age can you buy medication?

- There are legally **no age restrictions for buying medicines**, however in the UK **all antibiotics are prescribed by a health profession** (i.e. GP, hospital doctor, dentist, nurse).
- Some retail outlets, containing pharmacies, have their own policies against the sale of medication to children (16 or under).
- Pharmacists can only prescribe antibiotics if they are qualified as PIP (pharmacists independent prescriber).
    - PIP's provide similar health advice to doctors and work to help GP surgeries and hospitals cope with busy wards.

Access to healthcare in Uganda:

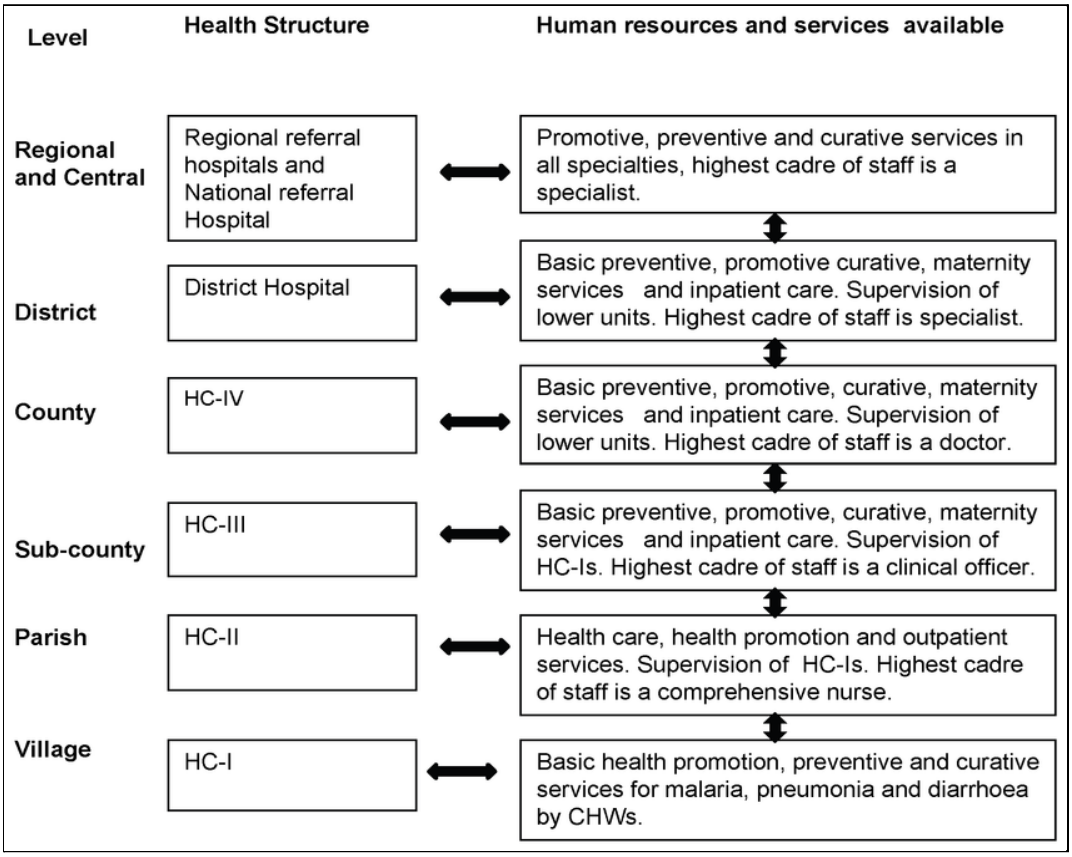

Figure 5. An illustration of Health access and services in Uganda (Nanyonjo et al., 2021).

The Ministry of health in Uganda measures health care access based on residence within 5km of a health facility. The ministry of health helpline is 0800100066. In Uganda, the doctor patient ratio is 1:25000 and nurse to patient ratio is 1:11,000. This is below that recommended by WHO which is 1:1000.

People access healthcare through government and private health facilities, pharmacies. The government hospitals have free health services and the health sector allocation was 8.9% of the national budget according to the financial year (2019/2020).There are so many patients in government facilities since they are cheap.
However people in rural areas are restrained by a poor road network, few ambulances and long distances compared to urban centers. In UDHS 2011,it was found out that 41% of reproductive women country wide reported they have a serious problem in accessing facilities due to distance (Acup et al., 2021).

Some people prefer private health care facilities and clinics. These usually have more drugs, better patient care and are well stocked with equipment. However they are expensive and charge for every service so a few Ugandans can afford. Some Ugandans have health insurance therefore access health services for free and bills are covered by these insurance companies

Both government and private facilities can refer patients to over counter community pharmacies and licensed drug shops to buy prescribed drugs like antibiotics.
All these health facilities are accessed by walking, riding,and driving. Vehicles increase access by reducing travel time.

Figure 6. An Image showing patients with lists of prescribed medicines in a government hospital (Youth-Commonwealth, 2021).

Figure 7. An Image showing people standing in a queue at a private pharmacy (Stat-Uganda, 2021).

Most common infections in the UK and their treatment:

Antibiotics are the most widely prescribed antimicrobial agent (Cosford, 2017).

Antibiotics are important for serious infections such as:

- Meningitis
- Sepsis
- Bacterial pneumonia

Known reasons for the development of antimicrobial resistance (AMR):

- Overuse of antibiotics.
- Misuse of antibiotics.

These lead to the development of infections that are becoming increasingly difficult to treat and potentially life-threatening.

How can individuals prevent infections, caused by AMR, from occurring in the first place?

- Lower the need for antibiotic usage, this will reduce the development of AMR.
- Comprehensive infection prevention and control.

In the UK, the number of infections caused by Gram-negative, resistant organisms are increasing rapidly.

These infections caused by resistant organisms can result in:

- Significant illness / death upon spreading.
- Local infections in the organ system.
- Sepsis, a potentially catastrophic systemic infection caused when the organism enters the host bloodstream.

The most common Gram-negative bloodstream infection (BSI) is caused by *Escherichia coli*:

- Counts for 55% of all Gram-negative BSIs.
- 40,580 cases of *E.coli* BSI were reported by NHS trusts in England between 1st April 2016 and 31st March 2017.
- 5,738 NHS patients died within 30 days of *E.coli* BSIs between 2016 and 2017.

In April 2017, the government had ambitions to decrease both healthcare associated bloodstream infections (BSIs) and also reduce inappropriate antimicrobial prescribing by 50% by 2021.

The Benefits of reducing (*E.coli)* BSIs:

1) Improved patient safety:
    - Reduced infection rates.
    - Reduced mortality.
    - Reduced length of stay.
    - Appropriate antimicrobial prescribing.
2) Improved patient experience:
    - Prevention of avoidable infections.
    - Reduced length of inpatient stay.
3) Potentially avoid the the need for hospital admission
4) Improved population health:
    - Reduced need for antibiotics.
5) Could save the NHS between £900 to £2400 per patient for each *E.coli* BSI prevented.

Table 1. Treatments for common bacterial infections in the UK and the bacteria that cause them (NICE, 2021).

Bacterial Infection	**Bacterial agent**	**Treatment**
Acute sore throat	*Streptococcus pyogenes*	• First choice: phenoxymethylpenicillin • Penicillin allergy: clarithromycin OR erythromycin (preferred if pregnant.)
Bacterial respiratory infection (and pneumonia)	Most likely: *Streptococcus pneumoniae.* *Can also be: Staphylococcus aureus* or *Haemophilus influenzae.*	• Macrolide antibiotics such as azithromycin and clarithromycin (First-line antibiotics) or doxycycline. • Chest x-rays • Blood tests
Bacterial vaginosis (BV)	*Gardnerella vaginalis*	• Antibiotic: Metronidazole (available in pill or gel form)
Urinary tract infection (UTI)	*Escherichia coli (about 90% of the time)*	• Nitrofurantoin (First-line antibiotics, taken orally) • Other antibiotics: fosfomycin and pivmecillinam.
Impetigo (affects epidermis)	*Streptococcus and Staphylococcus aureus.*	• Mupirocin cream or ointment • retapamulin ointment • Oral antibiotics for severe/widespread impetigo: amoxicillin/clavulanate, certain cephalosporins, or clindamycin. • Topical antiseptic: Hydrogen peroxide 1%
Eczema	*Staphylococcus aureus*	• Emollients (moisturising treatments) • Topical corticosteroids. • Oral antibiotic: flucloxacillin
Bacterial conjunctivitis	*Streptococcus pneumoniae, Haemophilus influenzae and Staphylococcus aureus*	• Ophthalmic antibiotic eye drops with chloramphenicol. • For moderate and severe bacterial conjunctivitis, the latest fluoroquinolones, including moxifloxacin, besifloxacin, and levofloxacin, are generally effective.

Most common bacterial infections in Uganda and their treatment:

Most bacterial infections among people within Uganda are either Community Acquired or Hospital acquired infections which are referred to as Nosocomial Infections.

- **Nosocomial infections (NIs**) are hospital acquired infections developing at least 48–72 h after admission. They are the commonest complications affecting hospitalized patients but are more frequent in intensive care units where outbreaks usually originate. These include Pneumonia (usually ventilator-associated), Urinary Tract Infection (usually catheter-associated) and primary bloodstream infection (usually associated with the use of an intravascular device) (Agaba, Tumukunde, Tindimwebwa and Kwizera, 2017).
- **Community Acquired Infections** (CAIs) on the other hand are infections that a person acquires while in a community setting or in the hospital environment with less than 48 hours of admission. Examples include Urinary Tract Infections (UTIs) and Typhoid (Odoki et al., 2019).

The increase of both community and hospital acquired antimicrobial resistant bacteria is threatening the effective treatment of patients making the available treatment options severely limited because the bacteria are now frequently displaying multi drug resistance. However, these infections can be prevented through infection prevention control practices as simple as hand hygiene and watchful programs on Antimicrobial stewardship.

Table 2. Most common bacterial infections in Uganda.

Bacterial Disease/Infection	**Bacterial agent**	**Treatment**
Urinary Tract Infections In Uganda, the prevalence of UTIs was found to be 29 for every 218 hospital cases and had a 20–60% drug resistance rate among antenatal mothers in Mulago hospital (Odoki et al., 2019).	*Escherichia coli*, *Staphylococcus aureus, Klebsiella pneumoniae e.t.c*	Amoxicillin, Cotrimoxazole. Amoxicillin-clavulanate or gentamicin(in case of resistance)
Typhoid Typhoid is endemic in Uganda, with more than 56,000 cases per year under 15 years of age (Uganda, 2021)	*Salmonella enterica typhi*	Ciprofloxacin Azithromycin Vaccines are available as well.
Pneumonia Pneumonia accounts for 10 percent of under five deaths in Uganda. At least 25 children in Uganda die of pneumonia every day (Ministry of Health, 2021)	Streptococcus pneumoniae	Antibiotics by IV (intravenous) or by mouth (oral) Azithromycin
Septicaemia In Uganda, for every 1.5 million live births annually, 142,000 die every year and 33% of these deaths occur in the neonatal period (0–28 days of life) (Ditai et al., 2018)	*Staphylococcus aureus, Escherichia coli*.	Ampicillin and Gentamicin as first-line and third-generation Cephalosporins as second-line treatment
Sexually Transmitted Diseases like: ● Gonorrhea ● Chlamydia ● Syphilis	Treponema pallidum Neisseria gonorrhoeae Chlamydia trachomatis	Doxycycline Azithromycin

The most used antibiotics in humans in the UK, their uses and accessibility:

Antimicrobial resistance:

- **At least 20% of antibiotics prescribed in UK primary care services are inappropriate.**
- This misuse/ overuse/ over administration has thus led to antimicrobial resistance (AMR) being 1 of 13 biggest global health challenges (World Health Organisation, 2020).
- The UK has created a five-year national action plan which targets the reduction of antimicrobial, specifically antibiotic, use by 15% by 2024 (Department of Health and Social Care, 2019).
- Antibiotic consumption has increased drastically within secondary care for inpatients since 2014; reasons include antibiotic shortages and replacements consisting of single broad-spectrum antibiotics.
- Antibiotic resistance in the UK has increased by 2.4% from 2015 till 2019. This equates to 21/ 100 people having a bloodstream infection in association with a resistant pathogenic infection.

Antibiotics definition:

- Antibiotics are used to **treat/ prevent spread of bacterial infections only**.
- They are not effective on viral infections (e.g. respiratory tract infections like the cold).
    - Their use for fungal and viral infections have led to further increase in AMR.
    - Public Health England (2019) stated that 165 new antibiotic resistant infections are present every day in England.

Antibiotic 6 group classification:

- **Penicillins** (e.g. penicillin and amoxicillin). They treat infections such as skin, chest and urinary tract infections.
- **Tetracyclines** (e.g. tetracycline and doxycycline). They are used to treat a wide range of infections, commonly used to treat acne and skin condition rosacea.
- **Macrolides** (e.g. erythromycin and clarithromycin). They are useful for treating lung and chest infections or an alternative for those with penicillin allergy/ to treat penicillin resistant strains of bacteria.
- **Cephalosporins** (e.g. cephalexin). They are used to treat a wide range of infections, but some are effective in treating serious infections such as meningitis and septicaemia.
- **Aminoglycosides** (e.g. gentamicin and tobramycin). They are only used in hospitals to treat very serious illnesses such as septicaemia as they can cause serious side effects including hearing loss and kidney damage. They are usually administered by injection but can be given as drops for some ear or eye infections.
- **Fluoroquinolones** (e.g. ciprofloxacin and levofloxacin). They are antibiotics once used to treat a wide range of infections, especially respiratory and urinary tract infections. However, they are no longer used routinely because of the risk of serious side effects (NHS, 2019).

All antibiotics cannot be purchased over the counter as prescription is needed.

Antibiotic usage and consumption:

- The UK One Health Report on antibiotic use and antibiotic resistance published in 2019 (Veterinary Medicines Directorate, 2019) stated that in humans, **the most common antibiotics prescribed from primary and secondary care were Penicillins followed by Tetracyclines and then Macrolides.**
    - 330.2 tonnes of Penicillin antibiotics prescribed in 2017.
        - Less than the 339.1 tonnes of Penicillin antibiotics prescribed in 2013.
- The ESPAUR (English Surveillance Programme for Antimicrobial Utilisation and Resistance) report 2019-2020 (Public Health England, 2020) reported that **antibiotic consumption has decreased** from 19.4 (2015) defined daily dose consumption levels per person per day to 17.9 (2019).

The most used antibiotics in humans in Uganda, their uses and accessibility:

Antibiotics are grouped as penicillins, cephalosporins, tetracyclines, fluoroquinolones, and aminoglycosides. They are used to treat only bacterial infections.

Table 3. Most commonly used antibiotic agents in Uganda and their uses.

ANTIBIOTIC AGENT	MAJOR USE
Co-trimoxazole	To treat bacterial infections eg pneumonia, bronchitis, UTIs, ear and intestinal infections.
Metronidazole	To treat skin infections, mouth infections, bacterial vaginosis, pelvic inflammatory disease.
Chloramphenicol	To treat eye infections like conjunctivitis and some ear infections.
Sulfamethoxazole-trimethoprim	To treat UTIs, ear infections, bronchitis, traveler's diarrhoea.
Amoxicillin	To treat chest infections, dental abscesses, UTIs and ear infection.
Ampicillin	To treat meningitis,UTIs, throat and lung infections.
Ciprofloxacin	To treat pneumonia, gonorrhea, typhoid fever, infectious diarrhoea.

How are these antibiotics accessed?

- *Over-the-counter prescriptions in community pharmacies and drugshops.*
  In Uganda, approximately 4 in every 10 individuals who visit a healthcare facility are treated with an antibiotic, and these antibiotics are largely given as over-the-counter drugs at community pharmacies within the country. However, the main problem here is underdosing.
- During hospitalisation while in clinics, health centres,hospitals or at pre admissions.

It should be noted that in Uganda, some antibiotics can be accessed without prescriptions by a medical doctor. This has contributed to their misuse through **under-dosing and overdosing**. In most drug shops, children can buy these antibiotics without written permission or guardian guidance. This has contributed to **Antimicrobial Resistance.**

Furthermore, a study on surgical wound infections showed that there is more resistance to **cheaper and common** antibiotics within the country(Agaba, Tumukunde, Tindimwebwa and Kwizera, 2017).

Bibliography:

Acup, C., Bardosh, K., Picozzi, K., Waiswa, C. and Welburn, S., 2021. *Factors influencing passive surveillance for T. b. rhodesiense human african trypanosomiasis in Uganda*. [online] Available at: <https://www.researchgate.net/publication/303423939_Factors_Influencing_Passive_Surveillance_for_T_b_rhodesiense_Human_African_Trypanosomiasis_in_Uganda> [Accessed 4 July 2021].

Agaba, P., Tumukunde, J., Tindimwebwa, J. and Kwizera, A., 2017. Nosocomial bacterial infections and their antimicrobial susceptibility patterns among patients in Ugandan intensive care units: a cross sectional study. *BMC Research Notes*, [online] 10(1). Available at: <https://bmcresnotes.biomedcentral.com/articles/10.1186/s13104-017-2695-5#article-info> [Accessed 4 July 2021].

Buswell, G., 2021. *Healthcare in the UK: a guide to the NHS* [online]. Expatica. Available at: https://www.expatica.com/uk/healthcare/healthcare-basics/the-national-health-service-and-health-insurance-in-the-uk-1092057/ [Accessed 30 June 2021].

Cosford, P., 2017. *Health Matters: Preventing infections and reducing AMR*. [online] GOV.UK. Available at: <https://publichealthmatters.blog.gov.uk/2017/11/13/health-matters-preventing-infections-and-reducing-amr/> [Accessed 3 July 2021].

Department of Health and Social Care, 2019. *Antimicrobial resistance: UK launches 5-year action plan and 20-year vision* [online]. GOV.UK. Available at: https://www.gov.uk/government/news/antimicrobial-resistance-uk-launches-5-year-action-plan-and-20-year-vision [Accessed 29 June 2021].

Ditai, J., Mudoola, M., Gladstone, M., Abeso, J., Dusabe-Richards, J., Adengo, M., Olupot-Olupot, P., Carrol, E., Storr, J., Medina-Lara, A., Faragher, B. and Weeks, A., 2018. Preventing neonatal sepsis in rural Uganda: a cross-over study comparing the tolerance and acceptability of three alcohol-based hand rub formulations. *BMC Public Health*, [online] 18(1). Available at: <https://bmcpublichealth.biomedcentral.com/articles/10.1186/s12889-018-6201-3#article-info> [Accessed 4 July 2021].

GOV.UK. 2013. *The health and care system explained*. [online] Available at: <https://www.gov.uk/government/publications/the-health-and-care-system-explained/the-health-and-care-system-explained> [Accessed 2 July 2021].

Ministry of Health, M., 2021. *Pneumonia is at the forefront of national and global health agendas - Ministry of Health | Government of Uganda*. [online] Ministry of Health | Government of Uganda. Available at: <https://www.health.go.ug/2020/01/31/pneumonia-is-at-the-forefront-of-national-and-global-health-agendas/> [Accessed 4 July 2021].

MS Trust, 2018. *Care in the NHS*. [online] MS Trust. Available at: <https://mstrust.org.uk/a-z/care-in-the-nhs> [Accessed 3 July 2021].

Mukose, A., Bastiaens, H., Buregyeya, E., Naigino, R., Makumbi, F., Musinguzi, J., Van geertruyden, J. and Wanyenze, R., 2021. *Health Provider Perspectives of Health Facility Preparedness and Organization in Implementation of Option B+ among Pregnant and Lactating Women in Central Uganda: A Qualitative Study*. [online] Available at: <https://www.researchgate.net/publication/331553611_Health_Provider_Perspectives_of_Health_Facility_Preparedness_and_Organization_in_Implementation_of_Option_B_among_Pregnant_and_Lactating_Women_in_Central_Uganda_A_Qualitative_Study> [Accessed 4 July 2021].

Nanyonjo, A., Makumbi, F., Etou, P., Tomson, G. and Källander, K., 2021. *Perceived Quality of Care for Common Childhood Illnesses: Facility versus Community Based Providers in Uganda*.

NHS England, 2014. Understanding the new NHS. [online] Webarchive.nationalarchives.gov.uk. Available at: <https://webarchive.nationalarchives.gov.uk/20170504162917/https://www.england.nhs.uk/wp-content/uploads/2014/06/simple-nhs-guide.pdf> [Accessed 3 July 2021].

NHS, 2019. *Uses Antibiotics* [online]. NHS: NHS. Available at: https://www.nhs.uk/conditions/antibiotics/uses/ [Accessed 30 June 2021].

NICE, 2021. Summary of antimicrobial prescribing guidance – managing common infections. [online] Nice.org.uk. Available at: <https://www.nice.org.uk/Media/Default/About/what-we-do/NICE-guidance/antimicrobial%20guidance/summary-antimicrobial-prescribing-guidance.pdf> [Accessed 4 July 2021].

Odoki, M., Almustapha Aliero, A., Tibyangye, J., Nyabayo Maniga, J., Wampande, E., Drago Kato, C., Agwu, E. and Bazira, J., 2019. Prevalence of Bacterial Urinary Tract Infections and Associated Factors among Patients Attending Hospitals in Bushenyi District, Uganda. *International Journal of Microbiology*, [online] 2019, pp.1-8. Available at: <https://www.hindawi.com/journals/ijmicro/2019/4246780/> [Accessed 4 July 2021].

Public Health England, 2019. *165 new antibiotic resistant infections every day in England* [online]. Public Health England: Public Health England. Available at: https://www.gov.uk/government/news/165-new-antibiotic-resistant-infections-every-day-in-england [Accessed 1 June 2021].

Public Health England, 2020. *English Surveillance Programme for Antimicrobial Utilisation and Resistance (ESPAUR)* [online]. Public Health England: Public Health England. Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/936199/ESPAUR_Report_2019-20.pdf [Accessed 1 June 2021].

Ssengooba, F., Rahman, S., Hongoro, C., Rutebemberwa, E., Mustafa, A., Kielmann, T. and McPake, B., 2021. *Health sector reforms and human resources for health in Uganda and Bangladesh: mechanisms of effect*. [online] Available at: <https://www.researchgate.net/publication/6534723_Health_Sector_Reforms_and_Human_Resources_for_Health_in_Uganda_and_Bangladesh_Mechanisms_of_Effect> [Accessed 4 July 2021].

Stat-Uganda, N., 2021. *Community health workers must lead the Covid-19 fight in Uganda - STAT*. [online] STAT. Available at: <https://www.statnews.com/2020/03/28/community-health-workers-lead-covid-19-fight-uganda/> [Accessed 5 July 2021].

Uganda, C., 2021. [online] Google.com. Available at: <https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=&cad=rja&uact=8&ved=2ahUKEwiR_8_oo8rxAhUtxYUKHUcNAJwQFjABegQIBRAD&url=https%3A%2F%2Fwww.coalitionagainsttyphoid.org%2Fwp-content%2Fuploads%2F2019%2F11%2FUganda-infographic-10-2019-final.pdf&usg=AOvVaw2B_TpaMirokq7vcalgX3Hv> [Accessed 4 July 2021].

Uganda, C., 2021. [online] Google.com. Available at: <https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=&cad=rja&uact=8&ved=2ahUKEwjY-LbGisvxAhVvyoUKHVDcCj8QFnoECAIQAA&url=https%3A%2F%2Fwww.cdc.gov%2Fglobalhealth%2Fcountries%2Fuganda%2Fdefault.htm&usg=AOvVaw2gwZeqPEK8QxYYdX7X5E6p> [Accessed 5 July 2021].

Veterinary Medicines Directorate, 2019. *UK One Health Report - Joint report on antibiotic use and antibiotic resistance, 2013-2017* [online]. New Haw, Addlestone: Veterinary Medicines Directorate. Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/921039/Ted_Final_version__1318703-v45-One_Health_Report_2019_FINAL-accessible.pdf [Accessed 1 June 2021].

World Health Oragnisation, 2020. *Urgent health challenges for the next decade* [online]. World Health Organisation: World Health Organisation. Available at: https://www.who.int/news-room/photo-story/photo-story-detail/urgent-health-challenges-for-the-next-decade [Accessed 30 June 2021].

Youth-Commonwealth, U., 2021. *“Breaking out of the poverty trap in rural Uganda”* | *YourCommonwealth*. [online] YourCommonwealth | The Youth Perspective. Available at: <https://www.yourcommonwealth.org/youth-networks/youth-development/breaking-out-of-the-poverty-trap-in-rural-uganda/> [Accessed 5 July 2021].