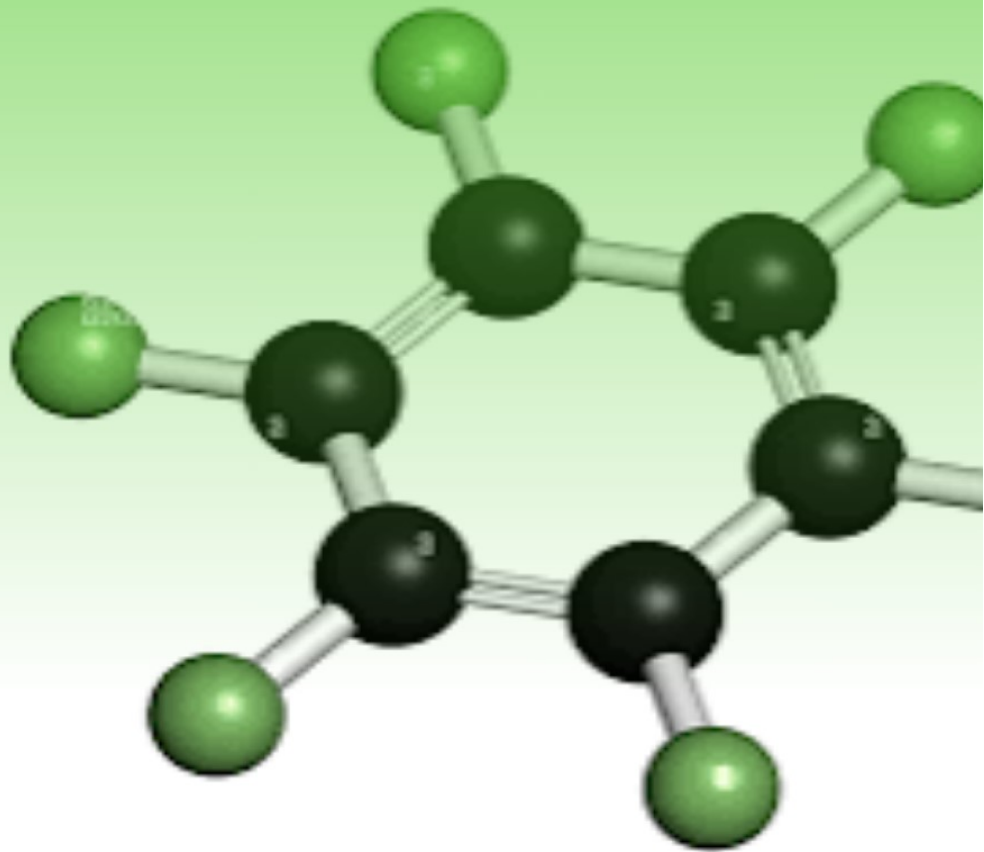


THE MUPSA

PHARMACEUTICAL

JOURNAL



25th Edition

Per Medicatum Servium

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VISION STATEMENT

To be the leading pharmacy students' body in Africa.

MISSION STATEMENT

To promote unity among pharmacy students so as to address their social, academic and advocacy needs as well as professionalism among pharmacy students hence strengthening pharmaceutical health care delivery in Africa.

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MESSAGE FROM THE EDITOR-IN-CHIEF

Dear Esteemed readers,

I take the honor to welcome you all to the 25th edition of the MUPSA Pharmaceutical Journal (MPJ). The MPJ is a compilation of literary works curated mostly by members of the Makerere University Pharmacy Students Association (MUPSA). Owing to the pertinence of the pharmacy sector to everyone, contributions are welcome from all sections of the community. The display of this creativity is centered around topics related to the practice of the elite profession of pharmacy. This year, we bring it to you sizzling hot; it's back, it's bigger and it's better!

The MPJ is one of many initiatives by MUPSA to contribute to the holistic development of the next generation pharmacists. It is universally acknowledged the importance of medical research and writing in the professional practice of the ten-star pharmacist. In light of this, the MPJ is a platform on which pharmacists in training get to practice their skills in literary communication and producing literary works. It is in light of this that I would like to acknowledge the past editors of the MPJ as well as those who contributed literary works to be included in those journals. Much gratitude is owed to those gallant ladies and gentlemen.

This 25th edition of the MPJ has been put together to completion by the combined effort of a team of seven enthusiastic ladies and gentlemen who were the editors of this issue and of whom I was leader. These were Mr. Gobba Solomon, Mr. Limo

Sam, Ms. Nuwagaba Heidi, Ms. Mazira Gloria, Ms. Kansiime Loretta, Ms. Nairuba Rebecca and I. This team comprises pharmacy students to whom I owe much appreciation as well.

Included in the issue is a communication from the Head of the Department of Pharmacy, Dr. Robert BD Otto, a senior member of the profession who has been in practice for quite a while and thus has amassed a high level of experience. Get to check out his communication in this issue as well. In addition, we have communications from our MUPSA chairperson 2023/2024, Mr. Onyango Frank. Lastly, in case you missed out on the 3rd Uganda Pharmaceutical Symposium, we've got you covered. A rundown of the event is included here. The symposium is the biggest annual event organized by UPSA and MUPSA had the privilege of hosting the third that was held in March last year.

All said, it is in my best wishes that you have a good time going through the beautiful pieces included within this journal. I also would like to implore the future pharmacy students to continue this great work that is the MPJ and make it better and better each and every passing year. With that, allow me to pass on my advance appreciation to you for taking time to go through this 25th edition of the MPJ.

Chelimo Betony
Editor in Chief

25th MUPSA Pharmaceutical Journal.



MESSAGE FROM THE HEAD OF PHARMACY DEPARTMENT, MAKERERE UNIVERSITY

Dr. Robert BD Otto (MPS)

Cordial greetings to the readers of this 25th edition of the MPJ. A special thank you to the MUPSA cabinet of 2023/2024 for putting this up. I would also like to thank the students' fraternity of the Makerere University School of Pharmacy for your continuous engagement since I took over office as Head of Department last year.

I am Dr. Robert BD Otto, a trained and licensed pharmacist, proud to be a practicing pharmacist. It is also a pleasure to be working with a team to train the next generation of pharmacists.

Over time, there have been changes in the profession that bring about the need to recognize specialties within the field. We are currently in consultations with stakeholders such as the National Drugs Authority and the Ministry of Health on a way forward in this regard.

There is also a need to increase the practicality of pharmacist training, so that we can have more skilled pharmacists. The ideal training assesses 60% from practicals and 40% from theory. This is to be seen in a new curriculum

we intend to roll out in the future. There also need be a mindset change in regarding expertise. Instead of using academic qualification, we need to use experience to grade level of expertise. Another are that needs consideration is the admission into pharmacy school. This is currently based on academic qualification alone and yet this is insufficient to determine an individual's ability to become a good pharmacist. There needs to be a practical testing point before entry into pharmacy and other medical courses in which those who demonstrate a certain level of skillfulness are deemed fit to train and qualify as pharmacists. This is done in some other countries and should also be started here.

My advice to the pharmacy student out there is to study the course diligently, and look out for areas of specialization where they can fill a niche or create one. Also, do not be distracted too much by the chase for money as you study. You have the rest of your life to work.

With all that said, I would love to wish you the best.

25TH MPJ COMMUNICATIONS



WORD FROM THE CHAIRPERSON, MUPSA.

FRANK ONYANGO

Chairperson MUPSA, 2023-2024

As we gather to reflect on another year of growth, achievement, and resilience, I am honored to address you in this year's MPJ. In the 35 years since inception of the pharmacy program, we have continually demonstrated our commitment to excellence, innovation, and service within the pharmaceutical community.

I would like to thank the current executive and the entire MUPSA for their tireless effort towards the organization in ensuring that our flag flies high in Uganda. This past year has presented us with unprecedented challenges, yet it is through these challenges that we have discovered the depth of our collective strength and determination. In the face of adversity, our members have demonstrated remarkable resilience, adaptability, and compassion. Whether through virtual learning, or community outreach initiatives, we have remained steadfast in our dedication to advancing the field of pharmacy and serving the needs of our communities.

As pharmacy students, we are not merely bystanders in the ever-evolving landscape of healthcare; we are active participants, catalysts for change, and advocates for progress. Our commitment to lifelong learning, professional development, and ethical practice sets us apart as leaders in our field and stewards of public health

and it's against this background that we were able to formulate MOSQUIT, the mosquito repellent which has proved to be the most efficacious mosquito repellent on Ugandan market and east Africa as a whole, great thanks to Dr. Drabe Nickson and Mr. Sabila for the guidance

In the year ahead, let us continue to embrace opportunities for growth, collaboration, and innovation. Let us challenge ourselves to think creatively, act boldly, and uphold the highest standards of integrity and professionalism. Together, we have the power to shape the future of pharmacy and make a meaningful difference in the lives of those we serve.

As we celebrate our achievements and look forward to the opportunities that lie ahead, let us remember the values that unite us: integrity, compassion, and a relentless pursuit of excellence. It is these values that define us as members of MUPSA and inspire us to strive for greatness in all that we do.

I am immensely proud of what we have accomplished together, and I am confident that the best is yet to come. As we embark on the next chapter of our journey, let us do so with courage, conviction, and unwavering dedication to our shared mission.

Thank you for your continued support, dedication, and passion for the field of pharmacy. Together, we will continue to shape the future of healthcare and make a positive impact on the world around us.



A delegation of MUPSA representatives showcasing the MUPSA Mosquit mosquito repellent lotion at the Pharmacy Expo held at UMA Show grounds, Lugogo from February 22-24, 2024.

Interview with Dr. Lutoti Stephen



Dr. Lutoti Stephen is the current secretary of the Pharmaceutical Society of Uganda and a lecturer at Makerere University. He teaches a variety of course units spanning the four years of pharmacy training, is a researcher and head of department pharmacognosy at the school of pharmacy. He is also a registered pharmacist, an entrepreneur, leader and ten-star pharmacist. Beyond these, he is a father, husband and a mentor. Most of all, he is an alumnus of MUPSA.

The 25th edition of the MPJ caught up with him to discuss with him about the field of pharmacy and the training of pharmacy professionals. To him is much gratitude owed for granting us this opportunity to inspire us thus. Pleasantries exchanged during the interview have been omitted herein.

MPJ: Could you please share a brief of your experience as a MUPSA member and later mentor.

Dr. LS: I became a MUPSA member in 2001 when I was a first year student of Bachelor of Pharmacy at Makerere University. In 2002, I served as Academic Affairs Secretary. In 2003 and 2004, I served as Treasurer for MUPSA. In 2005, I served as Chairperson Electoral commission MUPSA. Over time I have been attached to student affairs providing professional talks at events organized by MUPSA and other pharmacy student associations. I have mentored MUPSA students through research, practical sessions and class room activities as their lecturer. I have also had a number of MUPSA students do industrial training and community pharmacy placement under my supervision in my facilities and other settings.

MPJ: What is your view of the Pharmacy Practice in Uganda today?

Dr. LS: There are many opportunities but also a myriad of challenges to the practice of Pharmacy in Uganda. There is no doubt that we have had some difficult years for the profession. There are lots of legislative changes being proposed particularly the proposal to split the National Drugs Authority (NDA) and create a new Animal Drugs Authority, pending National Medicines and Food Authority Bill, National health insurance bill, Veterinary practitioners Bill among others. The stakes have been high in debating issues to gain consensus on each of this bills and the processes are still on going. There are also challenges with practical training of intern pharmacists and their registration as pharmacists after completion of internship; Questions on governance of the National Drug Authority, National Medical Stores and Ministry of Health particularly as regards accountability, transparency, strategic visioning, equity and inclusiveness keep heating headlines in social media debates among members of the society, other health professionals and the general public. We are endlessly being challenged with encroachment on the pharmacy profession and practice field by local and foreign non pharmacy professionals not only in community pharmacy settings but also hospital, regulatory environments and manufacturing facilities. This is the time to stand together as Pharmacy professionals and change the

course of events in this country for better pharmacy practice legislations and better practice. The investors must get value of their investment. We need policies and regulations that encourage growth of Uganda's Pharmaceutical sector. We need to be innovative and accountable in our practice.

MPJ: How do you rate the trend in the changes in the field of Pharmacy in Uganda and on the global scale?

Dr. LS: Pharmacy practice is a term that was introduced long time ago but just adopted to explain the evolution of pharmacy profession by Hepler and Strand in 1989. The evolution is characterized by three stages that include:

Stage 1: Traditional pharmacy practice (or product-oriented practice). At this stage, pharmacists were predominantly involved in technical or product-related practice, such as dispensing, inventory control, sterile and non-sterile drug manufacturing, etc.

Stage 2: Clinical pharmacy practice (or service-oriented practice). Pharmacists at this stage try to get close to patients on the ward or OPD by providing clinical pharmacy services, e.g. ADR monitoring, TDM, IV drug admixture, etc.

Stage 3: Pharmaceutical care practice (or patient-focused practice). It is called medication therapy management (MTM) in the US, or medicines management/optimization in the UK. Pharmacists need to optimize the use of medicines in terms of benefits and risks by working closely with other healthcare professionals and patients.

Pharmacist Demand Index (PDI) reports perceptions of the demand for pharmacists among a panel of individuals that participate in the hiring of pharmacists on a direct and regular basis. PDI is based on panelists' views about supply and demand for pharmacists; it is an indicator, not an objective measure of the pharmacist workforce situation.

MPJ: What fields of specification are feasible for the average young pharmacist?

Dr. LS: Bachelor's degree is a foundation and can lead one to any other field depending on their career aspirations. If considering managerial positions, you will need to add masters or

Interview with Dr. Lutoti Stephen (Cont'd)

post graduate diploma in management, business administration, Public Administration among others. Specialization can be through acquiring additional qualifications or concentrating on practice in a particular field such that you become specially skilled in the thing and you are regarded as an expert. Acquiring additional qualifications as a pharmacist will take you far and improve your resume. What is feasible for Ugandan pharmacist is that one can acquire the additional qualification easily even within the East African Community. In fields like Industrial pharmacy, procurement and Supply chain management, Pharmacognosy, Clinical pharmacy, Pharmaceutical analysis and Pharmaceutical biotechnology. There are professional courses like CIPS, ACCA and CPA that can give one added advantage in their career. It is also possible to further your studies in the basic biological sciences like physiology, biochemistry and microbiology. These can give you opportunities to enter into research and academia as well. As a student, you need to work hard at all levels such that you get good grades that will help you secure scholarships for further studies at both local and international universities. Be on the lookout for calls. Get a mentor and network as much as possible with other students both in Uganda and outside Uganda. Think through your career path early enough and be focused.

MPJ: To what extent are you content with the system of training the next generation pharmacists in Uganda today?

Dr. LS: To a lesser extent. The training is not hands on. Students are not receiving enough practical exposure. Teaching resources are limited. Some universities admit beyond the capacity to train. Few lecturers. Inadequate laboratory resources and attitude of some of the students to practicals is poor. Even with community placements some students dodge. There is also bad habit of examination malpractice during assessments. There are efforts to improve training in some institutions but others are not doing much.

MPJ: What might need to be changed in that regard?

Dr. LS:

✓Need to have core competencies defined in core competency framework. This will guide universities during curriculum development and reviews.

✓ The Council of Pharmaceutical Society of Uganda (PSU) is charged with mandate of securing highest practicable standards in the practice of pharmacy. PSU should intensify support supervision exercises and engage universities to provide required resources for training of pharmacy students.

✓ Pharmacy students through their student associations should demand for quality training facilities, engage management and other relevant stakeholders in this respect.

✓ Harsh disciplinary measures should be implemented against those students involved in examinations malpractice

✓ Students should have mentors and ensure they sign a mentorship agreement with their mentors.

✓ Admission into Universities should merge available training resources in respect to infrastructure, teaching aids, laboratory supplies, number of lecturers and external collaborations made for teaching and research purposes.

✓ Students should embrace practicals as part of learning.

MPJ: What words of advice do you have for the next generation pharmacist?

Dr. LS: As the next generation pharmacist, be innovative applying what you have learnt either individually or as a group. Historically, a number of innovations are made by students. This is no exception to pharmacy students. What have you innovated since primary school? Innovation is transforming an idea into products or services. You can improve existing products or services. Next generation pharmacists must be innovative. Challenge yourself. Your brain is not for decoration. Be innovative. There is a lot you can achieve as a pharmacist. Every profession has its challenges and opportunities. Don't join those who lament. You can succeed in any of the fields of pharmacy provided you are focused and innovative. It is never late to have a meeting with yourself and think about your career. Above all network as much as possible, have a good social profile and trust in God for success.

By Nairuba Rebecca



Dr. Lutoti Stephen (MPS)

25TH MPJ—MUPSA INNOVATIONS

MosQuit Lotion; Could this be the game changer in the fight to reduce malaria infections in Uganda and across the globe?

By: Asasira Nkahebwa (Head, MUPSA Scientific Committee, 2023-24)

Ochom Joel Felix (Projects Secretary, MUPSA, 2023-24)

Malaria is a mosquito borne infectious disease that affects humans and other animals, presenting with symptoms that typically include fever, body weakness, vomiting, and headaches. In severe cases, it can cause jaundice, seizures, coma or death.

In the year 2020 Uganda had the 3rd highest global burden of malaria cases (5.4%) and the 5th highest level of deaths (3.5%). It also had the highest proportion of malaria cases in East and Southern Africa – 23.2% in 2020. (WHO global Malaria report 2022)

As of 4th May 2023, Uganda, WHO noted that Uganda has the World's Highest malaria incidence rate of 478 cases per 1000 individuals per year and further states that malaria is the leading cause of sickness and death in Uganda responsible for 40 percent of all out patients visits and 25 percent of hospital admissions

On this note, the students of Pharmacy at Makerere University have come up with a formulation to prevent mosquito bites to intervene the current surge. This would supplement on the integrated malaria prevention strategies currently available in Uganda, the most widely used being insecticide-treated nets. The current integrated approach is not without constraints and shortcomings;

some of which include the high cost of some methods such as house screening. There also exist justifiable concerns of potential side effects of residues from indoor spraying. Also, the nets widely used only provide bed time protection and do not render any outdoor or out of bed protection.

It is against this background that we opted for an alternative prevention strategy that would provide all round defense against indoor and outdoor bites especially before bedtime. The MUPSA MosQuit mosquito repellent lotion has been formulated! Made from ingredients derived from natural Ugandan plant species, the topical formulation is cost friendly and with a high degree of safety on all skin types. MosQuit lotion is very convenient to use, spreads easily on the skin, is less greasy and moisturizes the skin in addition to providing a smooth sensation to the skin and a sweet fragrance. The lotion can also be used to provide relief to the itching and inflammation that is subsequent to insect bites. The product is suitable for all individuals above the age of 3 years.

We can all reduce malaria cases and together have a malaria free country through the MUPSA MosQuit mosquito repellent lotion.



Medical Research and Writing

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Medical research and writing is a crucial component of the healthcare industry, as it enables medical professionals and scientists to advance their knowledge and understanding of diseases, treatments, and other medical conditions. Medical research and writing involves conducting scientific studies, analyzing data, and publishing research findings in scientific journals or other publications. In this article, we will delve deeper into the importance of medical research and writing, its key components, and the skills required to excel in this field.

Importance of Medical Research and Writing

Medical research and writing play a critical role in advancing medical knowledge and improving patient outcomes. The research findings help healthcare providers make informed decisions about treatment options, drug development, and disease prevention. Moreover, medical research and writing also helps in identifying the risk factors associated with various medical conditions, which can assist in developing public health policies and interventions.

Medical research and writing are also essential in developing evidence-based medicine. Evidence-based medicine refers to medical practice that is based on research evidence and clinical expertise. Evidence-based medicine allows healthcare providers to deliver the most effective treatments to their patients, which ultimately leads to improved health outcomes.

Components of Medical Research and Writing

Medical research and writing consist of several components, including:

Study Design: The study design is a critical component of medical research and writing. It involves selecting the appropriate research methodology and designing the study to ensure that the research questions are answered effectively.

Data Collection and Analysis: Data collection and analysis involve gathering data through various methods, such as surveys, interviews, or clinical trials. The data is then analyzed using statistical methods to identify patterns and trends.

Literature Review: A literature review is a critical component of medical research and writing. It involves reviewing existing research literature to identify gaps in knowledge and areas where further research is needed.

Manuscript Writing: Manuscript writing involves summarizing

the research findings in a concise and clear manner. The manuscript should include an introduction, methods, results, and discussion sections.

Publication: The final component of medical research and writing is publication. The research findings are published in scientific journals, which allows other researchers to review and build upon the findings.

Skills Required for Medical Research and Writing

To excel in medical research and writing, several skills are required, including:

Research Skills: Medical researchers must have strong research skills to perform studies, collect and analyze data, and review existing literature.

Writing Skills: Strong writing skills are essential for medical researchers to communicate their findings effectively. Medical researchers must be able to write clearly and concisely, using appropriate scientific terminology.

Analytical Skills: Analytical skills are essential for medical researchers to interpret data accurately and identify trends and patterns in research findings.

Time Management Skills: Medical researchers must be able to manage their time effectively, as research projects often have strict deadlines.

Collaboration Skills: Medical research often involves collaboration with other researchers, healthcare providers, and professionals. Therefore, it is important for medical researchers to have strong collaboration skills to work effectively with others.

Conclusion

Medical research and writing play a crucial role in advancing medical knowledge and improving patient outcomes. Medical research and writing involves several components, including study design, data collection and analysis, literature review, manuscript writing, and publication. To excel in medical research and writing, several skills are required, including research skills, writing skills, analytical skills, time management skills, and collaboration skills. By advancing medical knowledge and improving patient outcomes, medical research and writing make a significant contribution to the healthcare industry.

Biosensor technology in clinical application

By: **Limo Sam**

Supervised by: Dr. Drabe Nickson

Dr. Mugenyi Naithan

ABSTRACT

Globalization has made it easier for new and unknown diseases to spread, which can lead to various infectious viral, bacterial, and fungal infections in the general population. For instance, it has been demonstrated that having multiple viruses infecting a person increases their chance of serious illness and even death, especially for viruses like the coronavirus, Ebola, and monkey-pox that are extremely contagious and have few available treatments or vaccines.

The ongoing emphasis on raising the standard of living has prompted the creation of more effective, long-lasting, and affordable analytic methods in the field of healthcare. One of the most important technologies for preventing pandemics and developing diagnostic tools to control the spread of infection is biosensor technology.

Biosensors have several advantages over other conventional analytical techniques for example; high specificity and selectivity, high reproducibility, miniature solvents and organic reagents are needed, efficient and cost effective, fast and real time detection and their ability to be incorporated into simple portable devices which can easily be used

The primary objective of this review is to examine the ways in which biosensors are employed in the medical industry to effectively detect illnesses and keep track of common disorders like blood pressure and blood sugar levels. We also discuss the principles of biosensors, their advantages over conventional techniques and also their challenges and limitations especially in Uganda

INTRODUCTION

A biosensor can be generally defined as a device that consists of a biological recognition system, often called a bioreceptor, and a transducer. The interaction of the analyte with the bio receptor is designed to produce an effect measured by the transducer, which converts the information into a measurable effect, such as an electrical signal. [17]. Biosensors have several applications including drug development, medical diagnostics, biomedicine, food safety and processing, environmental monitoring, defense, and security The biological recognition system consists of the following elements.

- **Analyte:** This is the substance that must be found, such as glucose in a glucose level monitoring

- **A bioreceptor** is a biological molecule that can uniquely identify an analyte.

An antibody, enzyme, protein, or nucleic acid are a few examples. When the bioreceptor and the analyte contact, a signal, such as light, heat, or PH, is generated. a method known as bio-recognition

- **Transducer:** This device transforms the bio recognition signal into a measurable characteristic, such as an electrical signal

- **Electronics:** This is the section of a biosensor where the transduced signal is processed and made ready for display. It is made up of intricate electronic circuitry that performs signal conditioning tasks like signal amplification and digital signal conversion from analog form. The display unit of the biosensor then quantifies the signals that have been processed.

- **Display.** As a result, the user receives clear information that can be seen, read, and comprehended. It may contain information from a computer display, printed charts, curves, or numbers.

The most common biosensors include home pregnancy test kits which measure the levels of HCG, and glucose monitoring sensors in diabetes patients which keeps track of glucose levels.

Some watch size wearable ECG wireless sensors have also been created which are used to track blood pressure in hypertension patients for a given period. Blood glucose sensors Use test strips with enzyme coating, which are produced with a precise quantity of unique enzymes that can only react to one blood sample. Test strips cannot be reused because they are designed for single use only. The test strip connects with the blood glucose meter once it has been inserted and has collected a blood sample. The meter then calculates the quantity of glucose in the blood and presents the result on the screen.

However, biosensors have a wide range of applications, including environmental monitoring, food safety, drug discovery, biodefense, industrial processes, agriculture and plant biology, and medical diagnostics. High sensitivity, high linearity, high repeatability, high selectivity, and high stability are the characteristics of biosensors that make them the technique of choice in all these fields.

According to Fracchiolla et al [14] and Turner [15], the first biosensor developed by Clark and Lyons [13] to quantify glucose in biological samples employed the method of electrochemical detection of oxygen or hydrogen peroxide utilizing an immobilized glucose oxidase electrode.

Since then, remarkable advancements have been made in both technology and applications of biosensors using cutting-edge strategies for example electrochemistry, nanotechnology, and bioelectronics (Turner, 2013). Biosensor performance changed from traditional electrochemical to optical/visual, polymers, silica, glass, and nanomaterials to improve the detection limit, sensitivity, and selectivity. Interestingly, microbes and bioluminescence (Du et al) [16]

MATERIALS AND METHODS

The term biosensors was searched on Pubmed, Scencedirect, frontiersin.org, research gate and google academia. And articles based on application of biosensors were selected and compiled to produce this write up.

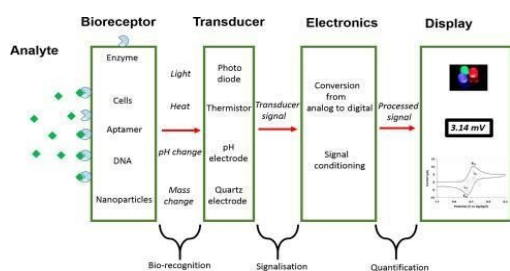


Fig.1 functioning of a biosensor

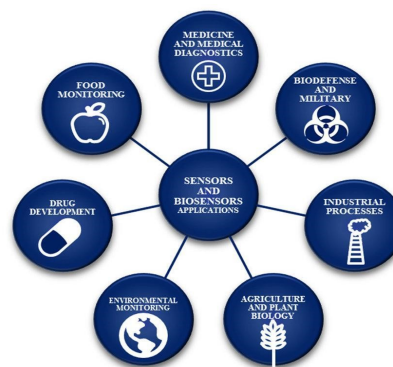


Fig. 2 Applications of biosensors

RESULTS AND DISCUSSION

It was noted that, with over one million people suffering from it, heart failure is currently the biggest problem. Fluorometric, enzyme-linked immunosorbent assay, and immunoaffinity column assay are methods for detecting cardiovascular disorders. They are time-consuming, difficult, and call for skilled labor. Electric measurement-based biosensors use biochemical molecule recognition to achieve the appropriate selectivity with a particular biomarker of interest makes work much simpler.

Also, the coronavirus disease 2019 (COVID-19) pandemic was caused by the novel human coronavirus. After its initial confirmation in December 2019 [8,9], Several researchers were inspired by the pandemic to create biomedical innovations and disease-controlling diagnostic tools [10,11,12]. The important technologies for the development of medical systems to prevent pandemics are biosensors for instant virus detection and diagnosis procedures for identifying infected human persons [6,7]. In this context, precise medical diagnosis necessitated the use of high-sensitivity and -accuracy biosensors. As a preventative step against the transmission of viruses, excellent usability and widespread accessibility of sensors and procedures are needed [8,9,10]. Such sensors should also be very compatible with digital communication networks, allowing for digital transformations in medical systems worldwide

Moreover, Sarah Saha et al. created a wearable device in [1] to assess blood flow in patients. The ability to integrate the entire sensor into a watch-sized device marks a crucial technological advancement for the future generation of biosensors since it enables continuous, entirely non-invasive monitoring of health parameters, which may have an impact on personalized treatment.

In [2], Brunetti et al. modeled an optoelectronic biosensor based on a multiparameter analysis using optical and electrical sensing techniques to track the evolution of bacterial biofilms. The sensor is made up of two parallel arrays of interdigitated micro- and nanoelectrodes. The examination of the metabolic condition of the bacteria requires the electrical response of both micro- and nanoelectrodes, which can be particularly effective in determining the effectiveness of antibiotics on the biofilm. The capacity to identify and monitor a biofilm in real-time while also analyzing its metabolic condition and evolution phase is the main benefit of this sensing configuration based on a multiparameter approach. Optoelectronic tools can have a significant impact on investigations of antimicrobial resistance (AMR).

Pouras et al. and Baird et al. found in [6 and 7] that biological diagnoses and biosensors are crucial due to the aging and population increase of the world as well as the issues brought on by chronic lifestyle disorders. Our healthcare system would be

greatly impacted by new molecular diagnosis. The ability to provide precise and customized therapy as well as early diagnosis is one of the key advantages of biomarker screening. It offers the chance to make a diagnosis based on the patient's understanding of molecules, which is considerably more likely to be accurate and independent of the exterior clinical manifestations.

Currently, Polymerase chain reaction-based methods are regarded as the gold standard for the diagnosis of viral illnesses. Before DNA amplification happens, though, it makes use of sophisticated and pricey machinery. Hence, using biosensors simplifies the process by offering direct real-time testing, quick responses, and great viral adaptability. Furthermore, multi-virus biosensors have been created with increased precision, sensitivity, and selectivity for multi virus samples

The usage of biosensors for medical diagnostics is now growing significantly. For example, Glucose biosensors are widely used in clinical applications for the diagnosis of diabetes mellitus, which calls for exact blood-glucose level monitoring. 85% of the large global market for blood-glucose biosensors is made up of home use. [3]

Advantages of biosensors over conventional analytical methods

Real time monitoring	delayed results
portable and easier to use	most times need specialized bigger equipment
rapid results	much time consuming
non invasive	invasive techniques used
high sensitivity and specificity	low sensitivity and specificity
can detect multiple analytes	often specific to only one analyte

Challenges limitations of biosensors

Cost:

The high cost of biosensors in Uganda is one of the key obstacles to their use. Given their high cost, biosensors may be out of reach for many healthcare facilities and patients, particularly in rural areas with scarce healthcare resources and infrastructure. This may restrict the use and accessibility of biosensors in the nation.

Training

The usage and interpretation of biosensor results may need greater training for healthcare practitioners in Uganda. Even though biosensors are made to be user-friendly, further training can still be necessary to make sure that healthcare practitioners can use them successfully and correctly interpret their results. Lack of training might result in inaccurate data interpretation, which can affect the precision of diagnosis and treatment strategies.

CONCLUSION AND FUTURE DIRECTIONS

In conclusion, biosensors have great potential to improve healthcare delivery in Uganda, especially in the diagnosis, monitoring, and treatment of infectious and chronic diseases. Biosensors have been instrumental in improving patient outcomes in Uganda, especially in rural areas. Despite their many benefits, there is a need for more investment in research and development, as well as training of healthcare professionals, to overcome the challenges faced by biosensors in Uganda. With continued investment and support, biosensors can make an even greater impact on the medical field in Uganda.

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THE CHANGING ROLES OF A PHARMACIST.

Like all things, the role of a pharmacist is changing. Pharmacists play quite the role in the health landscape. For long, the profession has been underutilized. Actually, one may say that pharmacists are the most underutilized amongst the trained health professionals. However, this all might be coming to an end.

The practice seems to be shifting towards a patient centered approach. Here, the pharmacist collects the raw data and information regarding a patient, analyzes it, and along with the patient and other healthcare professionals and proceeds to put together a treatment plan that is tailored to meet the patient's needs. This treatment plan is usually cost effective and the role further entails the pharmacist to do a follow up and monitor as deemed necessary.

For long, the pharmacist has been the master of the molecule or rather

drug but the new dawn comes with more responsibility. This is surely more tasking but the outcome is worth the toil. Limited clinical exposure has been one of the major challenges of pharmaceutical care, but with this new direction, this shall be history.

In the UK, the new roles are being incorporated by small degrees and so far, so good. The pharmacists get to discuss various therapies possible with the patient to enable them make an informed decision regarding treatment. Exciting, isn't it! This change does Hepler and Strand justice. I suppose we can rightfully call them foreseers.

By Kafuko Ronald Buyinza

BPharm IV

Oral Health Behavior in Kampala, Uganda.

By; *KAJUMBA FAITH.C.PATIENCE*

The concept of Oral health is defined by the Centre of Disease Control and Prevention as the health of teeth, gums and the entire orofacial system that allows us to smile, speak and chew. There are a number of diseases that tend to affect our oral health and these include cavities (tooth decay), periodontal disease and oral cancer. One could also add that the mouth is a reflection of what is inside the body hence making oral health care a major indicator of overall health, well being and quality of life.

In 2006, the National Oral Health Policy cited that oral diseases are an important public health concern because their prevalence, severity or public demand for services greatly impact on individuals and society.

Focusing on the concept of oral health behavior, it is described as a complex effect on an individual's oral health, habits, nutritional preferences and the pattern of a person's utilization of dental services. Since all these behaviors exist in a social framework of lifestyles typical of the relevant culture, not only one of the above mentioned parameters but also the indirect influences on the people's oral health should be taken into account.

It should be noted that these parameters are determined principally by the social opportunity structure offered by a society which underlies the distribution of access to knowledge about oral health and in turn focusing on the availability and utilization of dental services along with the provision of the necessary funding.

When we look at the empirical studies done at an international level, the unequal distribution of oral morbidity in industrial societies is highlighted as well as the persisting oral health problems that are seen in the lower social profile.

However, this is not the case in Uganda. According to the National Oral Survey conducted in 1987, Kampala district had the highest prevalence of oral diseases in Uganda with the main reason for tooth loss being tooth decay. This implies that modifying oral health behavior would greatly avert oral diseases and conditions.

It was further cited by the Makerere University Medical School in 2005 during a study that was carried out comparing urban and rural areas that Kampala district had a higher prevalence of caries due to a high DMFT score in all age groups as compared to other rural areas. It also noted that most caries go undetected hence posing a tremendous concern to awaken the zealous need to improve oral health especially in Kampala District.

On observing the pattern of dental caries observed in the patients of Mulago Dental School Clinic Uganda, it was noted that different attitudes between men and women towards dental attendance, a lack of financial independence for women and difference in dietary pattern between housewives and working men was the reason for 54.5% and 45.5% of the 1800 caries recorded between men and women respectively.

Interestingly, statistics by the British dental journal (2009) showed that 40% of the dentate adults said they often went for regular dental checkups and this was associated with greater frequency of toothbrushing, use of additional dental hygiene products, lower plaque and calculus levels. This justifies how focusing on oral health behavior can great-

ly reduce the prevalence of oral diseases and conditions in Kampala.

The main strategy to defend is raising the awareness of oral disease risk and appropriate means of oral health care through the development and implementation of appropriate information, education and communication strategies to foster the empowerment of communities in Kampala district. This could be done through the following ways;

Inter-sector collaboration with parties like the Ministry of Health, Uganda Medical and Dental Practitioners Council and Uganda Dental Association among others to organize dental camps transversing nursery, primary and secondary schools, prisons, elderly homes and even churches in Kampala district that will involve oral health examination exercises, clinical outreach visits and oral health education using both the practitioners and dental students.

It will further involve identifying and developing collaborative approaches to initiatives with common risk factors like the Ministry of Works and Transport, Ministry of Agriculture to mention but a few.

The second would be to create a public-private partnership for dental health services in order to provide accessible and affordable oral health to the people in Kampala district and also include them in creating awareness by offering, information concerned with preventative care involving:

Promoting a well balanced diet low in free sugars and high in fruits and vegetables that favors water as the main drink.

Discouraging use of all forms of tobacco including chewing of Areca nut and informing the people in the area about the dangers of their consumption.

Encouraging people to reduce alcohol consumption

Encouraging use of protective equipment when doing sports and traveling in bicycles and motorcycles to reduce risk of facial, especially oral injuries.

This important aspect of awareness can also be raised through community participation that involves working with the public health officers, nurses and doctors together with the vital health team to hold focus group discussions, interview guides and meetings informing the people about the aspects of oral health care including the oral health habits and the common risk factors for oral diseases. This builds capacity and provides technical assistance to support a life course approach and a population based strategy to reduce sugar consumption, control risk factors and promote use of fluoride containing tooth paste.

Also working with the District Education Officer to include oral health education in the curriculum with detailed aspects of the main components of oral health care by providing oral health education booklets and templates, holding parent-teacher meetings informing them about the value of oral health care as a branch of primary health care and seminars to teach the various components of oral healthcare in order to encourage children to adopt improved oral hygiene.

Integrating oral health policy elements and strategies into programs and policies of all sectors that have an impact on community health including maternal and child health health promotion, HIV/AIDS and STDs health promotion among others would also be vital.

Therefore through resource allocation, we as a community can create days to supply fluoridated toothpaste along with other supplies and in turn teach both adults and children how to apply proper oral health habits. This would motivate the children and adults to improve on their oral health care hence their general health.

Recruiting and promoting oral health staff in the district along with identifying their requirements and training needs in order to improve the level of skilled personnel that would play a huge role in promoting awareness and oral health seeking behavior. This will go hand in hand with monitoring the implementation of the health promotion strategy in order to provide appropriate disease prevention and health promotion measures based on cost effective and evidence based strategies.

After acquiring trained oral health care personnel, allocating resources for collection of data in order to carry out research findings can improve the oral health care of Kampala district . This can be carried out during outreach programs and camps in various areas of the community as it will play a role in monitoring the strategies implemented and their challenges.

In conclusion, oral health behavior in Kampala district is an aspect that has to be taken into account, monitored and improved in-order to avert the prevalence and incidence of oral health diseases and conditions.

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POTENTIAL SOLUTION TO ANTIBIOTIC RESISTANCE WITH ANTI-HERPES DRUG

Antibiotic resistance is a major threat to global health, with the World Health Organization (WHO) ranking it as one of the greatest challenges facing humanity. Bacteria are becoming resistant to traditional antibiotics, rendering them ineffective against diseases such as pneumonia and salmonella. Researchers at the University of Geneva (UNIGE) have discovered that edoxudine, an anti-herpes drug, can weaken the protective surface of the Klebsiella pneumoniae bacterium and make it easier for immune cells to eliminate it.

Klebsiella pneumoniae is a common hospital-acquired infection that can cause respiratory, intestinal, and urinary tract infections. Its high virulence and resistance to most antibiotics makes it particularly dangerous, with some strains killing up to 50% of infected individuals. To test the effectiveness of various drugs against the bacterium, the UNIGE team used the amoeba Dictyostelium,

which captures and ingests bacteria in a similar way to immune cells. The team genetically modified the amoeba to show whether the bacteria it encountered were virulent or not.

Edoxudine was found to be particularly effective at altering the surface layer that protects Klebsiella pneumoniae from the external environment, making it vulnerable. Unlike antibiotics, edoxudine does not kill the bacteria, reducing the risk of developing resistance. While the effectiveness of edoxudine against the bacterium in humans has yet to be confirmed, it was found to be effective even against the most virulent strains of Klebsiella pneumoniae at lower concentrations than those prescribed for herpes treatment.

By: Kintu Hannington

Effective Antimicrobials: A public or common good?

Nabisere Vivian (MBChB)

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Numerous national and international organizations, researchers, and policymakers have become increasingly interested in examining the causes of antimicrobial resistance (AMR), and the number of research papers on the topic has increased as a result of the significant rise in health and financial losses associated with specific drug-resistant infections in many countries. Pahlman and colleagues examined 77 papers using McDougall's version of critical interpretive synthesis to identify recurring concepts and arguments in the AMR literature in public policy, political science, and applied ethics. They found there is a lack of conceptual clarity in the literature regarding whether antimicrobials are a public or common good where the terms "public good" and "common good" appear to be used interchangeably in the context of health security and AMR, reflecting ambiguity, and sometimes meaningful differences, in how antimicrobials are conceived of as a good. The aim of this article is to clarify the confusion. (Pahlman et al., 2022)

First off, according to the World Health Organization, antimicrobial resistance (AMR) is the phenomenon in which bacteria, viruses, fungi, and parasites evolve over time and cease to respond to antimicrobials (antibiotics, antivirals, and antifungals), increasing the risk of infection spread, life-threatening illness, and death. In other words, AMR is a failure of antimicrobial effectiveness. Public goods are also non-rivalrous and non-excludable, which means that they can be used concurrently by multiple persons without lowering their utility or requiring payment. An illustration of a public good is a strong national defense system. The supply of common goods can run out, yet people are free to utilize them without restriction (Public and Private Goods / The Tragedy of the Commons, n.d.). In the majority of low middle-income countries, per capita consumption of antimicrobials is still considerably lower than rates in high-income countries, (Klein et al., 2021) and the regulation of access to antimicrobials is lacking. Furthermore, overuse of antimicrobials increases the chances of their ineffectiveness through antimicrobial resistance which can be treated as depletion in a sense.

In conclusion Antimicrobials can therefore be considered to be common goods since, despite their limited availability, their usage and effectiveness are advantageous to all. Common products like antimicrobials are vulnerable to "the Tragedy of the Commons" since they are scarce but readily accessible.

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ADVANCEMENTS IN THE MEDICAL FIELD

ARTIFICIAL INTELLIGENCE IN THE PHARMACEUTICAL INDUSTRY

Pharmaceutical and biotech companies are adopting more efficient automated processes that incorporate data-driven decisions and use of predictive analytical tools

Artificial intelligence can be implemented in almost every aspect of pharmaceutical industry, right from drug discovery and development to manufacturing and marketing

Artificial intelligence systems are designed to deliver better outcomes as they continually learn from new data and experience, they can be a powerful tool in the research and development wing of the pharmaceutical industry

AI has been applied in the pharmaceutical industry in different perspectives including; research and development, drug discovery and design, drug adherence and dosage and disease diagno-

sis.

The world realized the true potential of artificial intelligence after the outbreak of COVID -19 to all geographical regions of the universe, AI and technology helped pharmaceutical companies to figure out the right vaccines and the greatest of all, accelerating the production process to meet the global need

COVID 19 set a new world order in the post COVID era of pharmaceutical companies using AI and technology.

“EVERY ONE MUST EMBRACE ARTIFICIAL INTELLIGENCE”

By: ASIIMWE PETER BROWN

DO WOMEN AGE DIFFERENTLY FROM MEN?

There is evidence to suggest that women and men may experience the aging process differently. For example, women generally live longer than men, and they are also more likely to develop certain age-related conditions, such as osteoporosis and Alzheimer's disease.

However, the reasons for these differences are not fully understood, and it is likely that a combination of biological, environmental, and social factors contribute to the way that aging presents in women and men. Some research suggests that hormonal differences between women and men may play a role in the way that they age, as well as differences in lifestyle and access to healthcare

A new study has found that the anti-aging drug rapamycin may only be effective in extending lifespan and slowing age-related diseases in female fruit flies and mice, but not in males. The researchers observed that rapamycin increased autophagy, the cell's waste disposal process, in female intestinal cells, but male intestinal cells already had a high basal autophagy activity that could not be further increased by the drug. This suggests that sex may be a decisive factor in the effectiveness of anti-aging drugs and highlights the need for personalized treatments that take

into account sex-specific differences.

The researchers, led by Yu-Xuan Lu, conducted the study in order to understand why the life expectancy of women is significantly higher than that of men and why women are more prone to age-related diseases and adverse drug reactions. "Our long-term goal is to make men live as long as women and also women as healthy as men in late life. But for that, we need to understand where the differences come from," said Lu.

This study adds to the growing body of evidence that suggests sex-specific differences should be considered in the development of personalized medicine. As senior author Linda Partridge pointed out, "Sex can be a decisive factor for the effectiveness of anti-aging drugs. Understanding the processes that are sex-specific and determine response to therapeutics will improve the development of personalized treatments"

KINTU HANNINGTON

ADVANCEMENTS IN THE MEDICAL FIELD.

Ninsiima Doreen

Mbarara University of Science and Technology.

A medical advance is the generation of information or discovery of knowledge that improves our understanding of medical science. Medical advancements result from the improvement of the diagnosis, treatment, and prevention of disease and body disorders.

The medical world will always celebrate Edward Jenner's smallpox vaccine discovery in 1846 which graduated into many other vaccines as utilized in the present day with the variety of COVID-19 vaccines being some of the latest developments.

In 1846, T.G Morton introduces the use of ether as an anesthetic, and Louis Pasteur in 1861 proves that bacteria cause disease, opening up diverse fields of medical research to protect human and animal life while prolonging life spans.

In 1895, medical imaging is discovered using x-rays, 1928 saw Alexander Fleming discover the medicinal capabilities of penicillium making penicillin. In 1954, the first successful kidney transplant is carried out, and in the 1960s the first experimental antivirals are developed and the 1970s graced medicine with stem and antibody therapies.

The 21st century dawned with the use of numerous artificial intelligence techniques to ease medical diagnosis and simple medical procedures ranging from gene therapies to fiber lasers in surgical rooms and the development of medical devices. Since artificial intelligence has taken place in nearly every area of health care.

Artificial intelligence involves the development of computer logarithm systems, and machine learning applications able to perform tasks that normally require human intelligence. Integration of the practice of medicine increases the potential for precise detection, diagnosis, treating disease, and managing acute disorders making AI an invaluable tool in fast data collection from the patient, monitoring learning abilities, and assessing skills of the medical personnel while easing the learning process easy and fast in real-time.

The use of AI in emerging technologies like virtual reality (VR) and augmented reality (AR) while applied in medical practice has greatly eased the medical training of interns and residents in hospitals. Away from the use of gross procedures on cadavers to take medical students through surgical procedures, the use of VR provides a clean yet clear precise working interface for users to practice skills at magnificent angles of all anatomical models of patients and specimens.

Virtual reality in medicine is highly complimented by imaging from X-ray machines and MRI scans. These images are important to replicate the 3D models of the patient's structures and thus do prior surgical preparations to minimize surprises during real-time operations and so increase patient safety and medical success.

Low-risk surgical testing environments can be achieved using augmented reality and virtual reality to reduce surgical equipment in use and staff. VR and AR allow access to real-time medical references and information that is useful in explaining certain abstract procedures to patients. If patients understand their medical conditions, it becomes easier for them to appreciate the medical intervention and the functionality prescribed for them.

VR can further be utilized in community health care education to help people understand how lifestyle conditions like obesity, high blood pressure, lung and kidney damage, and metabolic dysfunctions develop and how cancer tumors grow. VR is highly appreciated in pain relief as patients are distracted from their pain, especially in physical therapy (orthopedic) and rehabilitation.



ANTIMICROBIAL RESISTANCE

By **Ondara Mildred**
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Antimicrobial resistance (AMR) has been declared top 10 public health threats facing humanity by WHO. Antimicrobial Resistance (AMR) is a phenomenon that occurs when bacteria, viruses, fungi and parasites change over time and no longer respond to doses of medicines that were initially effective therefore, making infections harder to treat and increasing the risk of disease spread, severe illness and death.

As a result of drug resistance, antibiotics and other antimicrobial medicines become ineffective and infections become much difficult or impossible to treat.

The emergence and spread of pathogens that have acquired new resistance mechanisms continues to threaten our ability to treat common infections. Most alarming of all being the rapid global spread of multi- and pan-resistant bacteria (also known as “superbugs”) that cause infections that are not treatable with existing antimicrobial medicines.

AMR occurs naturally over time, usually through genetic changes. Antimicrobial resistant organisms are found in people, animals, food, plants and the surrounding environment. They can spread from person to person or between people and animals, including food of animal origin. The main drivers of antimicrobial resistance include the misuse and overuse of antimicrobials; lack of access to clean water, sanitation and hygiene for both humans and animals; poor infection and disease prevention and control in health-care facilities and farms; poor access to quality,

affordable medicines, vaccines and diagnostics; lack of awareness and knowledge; and lack of enforcement of legislation.

High burden of infectious diseases, poverty, weak governance and health systems, and low awareness in many low-income and middle-income countries remain major challenges in the fight against AMR. Efforts to address AMR globally must take into consideration these peculiar challenges. Low-income and middle-income countries must strengthen their health systems in ways that address these systems issues, with a focus on developing regulatory strategies against unauthorized antimicrobial use, antimicrobial stewardship and treatment guidelines for common infections, along with sustainable public awareness campaigns aimed at changing health-seeking behavior. These efforts should be based on evidence—on each component of the PESTELI framework—tailored to the context in each setting.

Increased investment in research and development of vaccines, newer drugs and improvement in water, sanitation and hygiene to prevent common infections, together with the promotion of diagnostic tests to timely detect and treat infections, are essential to curb the current trends of AMR.

The world antimicrobial awareness week should be upheld by sharing stories about resistant bacteria, honoring community antimicrobial heroes, “going blue”, working with schools to train younger generations, and spreading the message are just a few examples.

REVOLUTIONIZING DRUG DISCOVERY WITH A COMPUTER-BASED PLATFORM

Researchers at The University of Texas at Dallas (UTD) and Novartis Pharmaceuticals Corp. have developed a computer-based platform for drug discovery that could make the process more effective, efficient, and less costly. The researchers presented their findings at the 36th Conference on Neural Information Processing Systems, which was held on 28th Nov through 9th Dec, 2022 in New Orleans. The platform, which is based on topological data analysis, allows for the virtual screening of thousands of potential drug candidates and narrows the selection down to those that are most fit for laboratory and clinical testing. This process, called virtual screening, is not new, but the approach developed by the UTD and Novartis team significantly outperforms other state-of-the-art methods on large data sets.

Typically, the early stages of drug discovery involve identifying a biological target, such as a protein associated with a disease, and then screening libraries of thousands of potential chemical compounds that could be effective or modified to affect the target. The most promising candidates are then subjected to the lengthy and expensive process of laboratory and clinical testing and regulatory approval. This process can take up to 15 years and cost billions of dollars. The

new platform aims to streamline the process by identifying the most promising compounds at the beginning, saving time and resources by avoiding testing “dead ends.”

The team framed the virtual screening process as a new type of topology-based graph ranking problem, using a branch of mathematics called topological data analysis. They characterized each molecular compound based on the shape of its underlying physical substructure and a series of physical and chemical properties of its components, creating a unique “topological fingerprint” for each compound. This fingerprint is used to rank the compound based on how well it fits the desired properties.

The next step for the researchers is to generalize the method to molecular property prediction, including scoring compounds on their solubility in water. Solubility can be crucial to a drug’s effectiveness in the human body. The UTD and Novartis team are supported by grants from the National Science Foundation, the Simons Foundation, and the Office of Naval Research

KINTU HANNINGTON

THE PHARMACEUTICAL TRAGEDY THAT WAS THALIDOMIDE

*Nuwagaba Heidi**BPHA III*

INTRODUCTION

Thalidomide can be described as the archetypal drug of our era. It still remains one of the most notorious and feared drugs in the world. It was a sedative drug first synthesized in 1953 that created one of the most dramatic and tragic disasters in the history of medicine. (Kim and Scialli) Since 1958, the drug has been widely praised, advertised, and prescribed because it is unusually safe, largely because it is nearly impossible to overdose and thus commit suicide while using it. Thalidomide was exceptionally effective in, among other conditions, the treatment of morning sickness in pregnancy. Then, in 1961–62, it was found to cause terrible malformations in unborn children. The drug caused limb deformities but also affected the ear, eye, heart, kidney, nerves, genitals, and other internal organs; however, limbs were affected in almost every case.

The drug was eventually taken off the market in late 1961. The incidence of severe birth defects decreased rapidly in the time that followed. However, since being discovered to be effective as a treatment for leprosy and multiple myeloma in the 2000s, it has since been returned to the market under strict supervision and monitoring. However, in some rural areas of the world that lack extensive medical surveillance initiatives, thalidomide treatment of pregnant women with leprosy has continued to cause malformations. (Kim and Scialli)

THE HISTORICAL BACKGROUND OF THALIDOMIDE

The company Chemie Grünenthal was the first to market thalidomide (*N*-[phthalimido] glutarimide) in 1957. It was advertised as having sedative, hypnotic, and antiemetic actions. It was also thought to have no toxic side effects. Thalidomide was also widely used to treat morning sickness in pregnant women. (Stather) It was marketed as having no harmful side effects in humans as it was not lethal in overdose experiments in rodents and had no morphological effect on the offspring of rodents. It was not until much later that it was realized that thalidomide exhibits species differences in its action and function, for reasons that remain unclear.

Grünenthal aggressively marketed "K-17" (the in-house code-name for the drug) for multiple uses. Indeed, for a short while, this "wonder drug" seemed to be the answer to the anxieties of the post-war modern condition, especially for women. Under its dozens of brand names, such as Asmaval (for asthma), Tensival (for hypertension), Valgraine (for migraine), Distaval (its most common name in Britain), Kevadon (in North America), Sof-tenon (in West Germany), and Entero-Sediv (for dysentery), to name just a few, it rapidly brought Grünenthal and other distributors very substantial profits. (Stather)

Promotional materials advertised thalidomide products as being "completely non poisonous", "astonishingly safe", "non-toxic", "fully harmless" and as a "completely safe, nontoxic sedative" for both adults, including pregnant women, and children. Instead, it led to a range of serious complications, including peripheral neuritis in many hundreds of adult patients and, more widely and notoriously known, the use of thalidomide by pregnant mothers, which led to the birth of horribly deformed babies.

By 1961, thalidomide had been distributed in 46 countries around the world, including the UK, Ireland, Germany, Sweden, Australia, Japan, Brazil, and Canada. Between 1957 and 1960, an unusually high increase in children being born with severe,

rarely seen limb deformities and internal organ problems was observed in Germany, Australia, and Britain.

This initially confused and concerned physicians. It was not until 1961 that a German doctor named Lenz expressed his suspicions that the terrible malformations that were being witnessed were linked to the ingestion of thalidomide by the mothers during their pregnancies. Support for Lenz's argument came soon after, independently, from William McBride, a physician in Australia. Due to the important link discovered by Lenz and McBride between thalidomide and malformed babies, the drug was withdrawn from the market in late 1961, although this was too late to prevent the damage that had already been done to an estimated 10,000 children worldwide. Following the withdrawal of thalidomide from sale in late 1961, the incidence of severe birth defects decreased rapidly, although this happened at different times in different countries. (Kim and Scialli)

It is vital to note that important lessons were learned from the thalidomide tragedy, notably:

Up until the thalidomide tragedy, it was simply assumed the placenta would prevent drugs from reaching the embryo or fetus. (Kim and Scialli)

The tragedy forever altered the way drug testing is conducted. It led to the establishment of strict toxicology testing for all drugs currently used in adults and children, and truly pioneered the toxicology field as we know it today. (Kim and Scialli)

In addition, the thalidomide tragedy highlighted species differences that existed in the action, effect, and side effects caused by drugs. Thalidomide has little or no effect upon the forming rodent embryo, yet it is highly teratogenic in non-human primates and rabbits. Why thalidomide has little or no effect on early rodent embryos remains unknown. (Kim and Scialli)

Such findings highlighted the need for a better understanding of the molecular and cellular basis of teratogenesis as well as the need to use species-specific models of development when testing new drugs and additional testing methods to ensure drug safety. Following the withdrawal of thalidomide, new legislation was introduced in many countries with regards to the testing of new drugs and their approval for use in humans, especially those that could come into contact with pregnant women. (Kim and Scialli)

THE PHARMACOLOGY OF THALIDOMIDE

Thalidomide is a glutamic acid derivative (*l*-phthalimidoglutarimide). It is a sedative-hypnotic drug, and its effects on the nervous system are still not fully understood. It is odorless, tasteless, and white in color and has a melting point of 271 °C. Thalidomide possesses a chiral center with an asymmetric carbon atom surrounded by a left-sided phthalimide ring and a right-sided glutarimide ring.

Thalidomide can exist in two different isomeric forms, *S* (-) and *R* (+), which can interchange spontaneously in body fluids. A racemate mixture of the two thalidomide isomers is used clinically. Each isomer is believed to have different properties: *S* (-) could be teratogenic, and *R* (+) is a sedative. As the two isomers can rapidly interchange at physiological pH, it is not possible to isolate and treat with just the sedative form of the drug. (Vargesson)

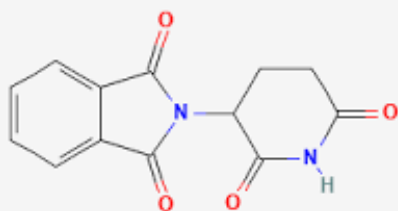


Fig 1: Structure of thalidomide.

Thalidomide has a low solubility in water yet is highly unstable and has a half-life of between 5 and 12 hours. It can rapidly hydrolyze into active by-products in aqueous medium at physiological pH, which varies with temperature, and this is also how the drug is thought to be primarily eliminated from the body. It can also be actively metabolized by the cytochrome P450 enzyme pathway, which produces a range of by-products, including anti-angiogenic by-products, and is species dependent. The breakdown of thalidomide results in at least 20 products, one or more of which is thought to be the active metabolite responsible for the detrimental effects of thalidomide. (Vargesson)

In addition, synthetic analogs of the drug have been made that are more potent than the original parent molecule, for example lenalidomide, which is used to treat multiple myeloma. Indeed, by making substitutions of amino groups or replacing them with fluorination groups, greater biological activity can be conferred on the analogs. Over 100 analogs of thalidomide can be made in this way, highlighting the complexity of thalidomide while also underscoring the many potential therapeutic actions of this drug. (Kim and Scialli)

THALIDOMIDE'S THERAPEUTIC ACTIONS

Anti-inflammatory and immunomodulatory actions

Thalidomide inhibits tumor necrosis factor (TNF) production in monocytes and macrophages by degrading TNF-mRNA. TNF regulates and controls the inflammatory response by inducing the production of a wide range of cytokines in response to injury or stimuli, including interleukins and interferon-. Thalidomide is currently used to target these effectors in inflammatory diseases, including leprosy and Crohn's disease, where the inflammatory response is overactive. (Kim and Scialli)

Anti-angiogenic actions

Thalidomide was demonstrated to block angiogenesis (the formation of new blood vessels) in a rat cornea assay, which led to the hypothesis that the drug's anti-angiogenic effect might be how thalidomide caused limb defects. Since this discovery, the drug has been researched as a potential anti-tumor agent. For these reasons, thalidomide is enjoying a renaissance and is used around the world for many clinical applications; indeed, it can be a lifesaver. (Kim and Scialli)

Mechanism of action of thalidomide

One may ask, "How does thalidomide cause widespread, and sometimes catastrophic, damage to the forming embryo?"

Over 30 hypotheses about thalidomide's mechanism of action have been proposed since the thalidomide tragedy was first described in 1961. Models proposed to explain thalidomide-induced defects include DNA mutagenesis, targeting chondrogenesis, inhibiting growth factor signaling, nerve toxicity, induction of cell death through the generation of reactive oxygen species, and inhibition of angiogenesis. Indeed, recent work has uncovered that thalidomide primarily targets rapidly forming, immature angiogenic blood vessels in the developing limb and embryo.

Thalidomide prevents limb outgrowth by inhibiting angiogenesis

Thalidomide breaks down into a wide range of metabolites with anti-inflammatory, immunomodulatory, and anti-angiogenic actions. Application of thalidomide breakdown products and analogs, with either anti-inflammatory or anti-angiogenic actions, identified that only an anti-angiogenic analog, CPS49, caused limb defects in embryos. None of the other by-products tested had any effect on development, even at very high concentrations. (Lenz et al.)

CPS49 is an analog structurally based upon the anti-angiogenic breakdown product of thalidomide, 5'-OH thalidomide. Further analysis of CPS49 action and function in chick and zebrafish embryos demonstrated that CPS49 rapidly affects, within 2 hours, immature, unstable, highly angiogenic vessels (which do not possess a protective smooth muscle coating), which are those that are migrating into previously avascular tissues. (Lenz) CPS49 causes the loss of immature, newly formed vessels within 2 hours, resulting in the cell death of surrounding mesenchymal tissue by 6 hours and the loss of the major signaling pathways controlling limb outgrowth by 6 hours. Indeed, *fgf8* expression in the AER and *fgf10* and *Shh* expression in the underlying mesenchyme were completely absent within 24 hours of exposure; these genes are essential for limb outgrowth and patterning. Loss of *fgf8* expression is also seen in the developing limbs of rabbit fetuses exposed to thalidomide.

In contrast, in mature and stable vessels that possess a smooth muscle coat, such as those in the head and body, vessels are unaffected; however, such vessels can be temporarily prevented from undergoing new angiogenesis, but as they are stable and quiescent, the effect is transient until drug activity is eliminated (6–12 hours). (Kim and Scialli)

These findings confirm that thalidomide's anti-angiogenic actions have different consequences depending on the developmental stage and timing of exposure. In the embryo, where lots of angiogenesis is required, early drug exposure is devastating, but in the adult, where vascular patterns are established and stable and high amounts of angiogenesis are not normally required, the drug can be therapeutic by inhibiting angiogenesis, which could be therapeutic for conditions such as hereditary hemorrhagic telangiectasia (HHT), sickle cell disease, and cancer

THALIDOMIDE TODAY

Since being discovered to be effective as a treatment for leprosy in 1965, the drug is now used around the world again, including the USA. Thalidomide is used primarily to treat erythema nodosum leprosum (ENL), a complication of leprosy, a chronic skin and nerve infection caused by *Mycobacterium leprae*, and is also used as part of the treatment regime for multiple myeloma, where the bone marrow overproduces white blood cells. The drug is also used to treat many other conditions, including Crohn's disease, HIV, arthritis, and some cancers. (Stather) Clearly, thalidomide is a very useful drug in the clinic.

Toxicity and risk assessment

Thalidomide and its analog, lenalidomide, continue to pose a significant risk to the unborn, developing child. For this reason, the use of thalidomide and its derivatives is strictly regulated and requires contraceptives to be taken when being used as a treatment. Patients prescribed thalidomide are usually those with severe, debilitating conditions for which other normal treatments have been unsuccessful.

A patient using thalidomide as an anti-tumor agent would be unlikely to be in a position to become pregnant; however, in the case of leprosy and other inflammatory disorders, misuse or misinformed use during pregnancy remains a high risk. Indeed, in South America and Africa, where thalidomide is widely used as a treatment for ENL, there have been multiple recent cases of babies being born with thalidomide embryopathy, some to women who were prescribed the drug for ENL and had either not been warned or not fully understood the warnings of taking the drug during pregnancy, and others to women who had not taken sufficient contraceptive precautions and had fallen pregnant while taking thalidomide.

As thalidomide and its analogs remain a risk to the unborn child, Celgene, which holds the license to market and distribute thalidomide and some of its analogs today, has developed the STEPS (System for Thalidomide Education and Prescribing Safety) program as a regulatory guide for the controlled use of thalidomide. The program is based around the following points:

1. Education of physicians, pharmacists, and patients on thalidomide and its risks
2. Contraceptive counseling from a physician or other medical professional for a patient prescribed thalidomide
3. Pregnancy testing (suggested every 2 weeks) for women of childbearing age taking thalidomide
4. Informed consent of patients (copies to patient, physician and pharmacist)
5. Managed distribution
6. Mandatory outcomes registry survey (Kim and Scialli)

However, long-term thalidomide use has side effects in patients that include constipation and rashes. Perhaps the most infamous side effect from thalidomide use is peripheral neuropathy, where nerve damage occurs and causes pain, typically in the extremities. This side effect has been described since thalidomide was originally marketed and remains a problem today. How the drug causes peripheral neuropathy remains a mystery. However, patients are advised to stop taking thalidomide if they develop neuropathic symptoms.

FUTURE RESEARCH INTO THALIDOMIDE

As a result of the thalidomide tragedy of the 1960s, the following lessons were learned:

Pharmaceutical products should be systematically tested for developmental effects prior to marketing.

There are differences in species sensitivity and manifestations of developmental toxicity. Use of a second species or more thoroughgoing interpretation of results from a single species (taking

pharmacokinetics into consideration) are important considerations in drug testing.

Because thalidomide is useful in the treatment of serious diseases, it is likely that this product will continue to be used in therapeutics until safer alternatives become available. Prevention of inadvertent exposure of pregnant women to this drug is a continuing challenge, particularly in parts of the world where access to the drug is less restricted than in the United States. The development of thalidomide analogs that retain the therapeutic benefits of the drug without its teratogenic liability is a second challenge.

The goal of a safe thalidomide analog may be elusive if the therapeutic mechanisms of action and the teratogenic mechanisms of action are closely related or even identical. Research into mechanisms of action remains a priority for a better understanding of whether and how safer alternatives can be developed. Toward this end, significant advances over the last two decades in molecular techniques and alternative test species have provided unique methodologies to test hypotheses on thalidomide's mechanisms of action.

Technologies such as the *in vitro* whole embryo culture test and zebrafish have been used to gain insight into mechanisms of action. For example, the use of advanced molecular techniques and an alternative test species (the zebrafish) for facile phenotypic evaluations has been used to understand mechanisms. (Kim and Scialli) Within the last 10-15 years, advances in gene expression analysis (pathway analysis, SNP) and omics technologies have enabled the rapid collection of information to further our understanding of embryonic development and the perturbation of key developmental pathways.

Hopefully, technological advances will also provide opportunities to investigate the less frequently encountered endpoints associated with thalidomide (e.g., autism, mental retardation, ocular anomalies, Duane syndrome), on which the literature is limited.

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ANTIMICROBIAL RESISTANCE AND STEWARDSHIP

By **Muyimba Anthony**
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Antimicrobial resistance (AMR) is a major growing public threat to global health being identified as one of the biggest challenges in this century. AMR refers to the ability of microorganisms such as bacteria, fungi, viruses and parasites to resist the effects of Antimicrobial drugs that were previously effective in treating infections.

The overuse and abuse of antibiotics and other antimicrobial medicines in humans and animals has made the AMR problem worse. Since their discovery in the 1940s, antibiotics in particular have been wisely employed, leading to the bacterial development of resistance. Health care expenses, mortality, and morbidity have all grown as a result of the urgency of these bacteria-resistant strains.

AMR not only makes treating infectious diseases challenging, but in many cases makes infections wholly incurable. For example, infections brought on by the drug-resistant strain of tuberculosis bacteria, which causes the disease, are highly challenging to treat and can take years to overcome.

With reference to the many reports availed by the World Health Organization (WHO), which globally estimates that over 700,000 people die each year from drug-resistant infections, infections gives an insight into how serious a threat AMR is and the necessary steps to combat it. Thus, if no action is taken, this figure could rise up to 10 million deaths annually by 2025, surpassing the number of deaths from cancer; therefore, AMR is a major public issue that needs urgent attention and action.

Antimicrobial stewardship is a strategy that aims to optimize the use of antibiotics in order to preserve their effectiveness and reduce the development of AMR. Antibiotic stewardship involves a range of activities and interventions, among which are the following:

Enhanced surveillance involves the collection of data on the use of antibiotics and the rate of AMR to help identify areas where urgent intervention is needed and track the impact of stewardship programs.

Improving prescribing practices where health care professionals can play a key role in reducing the development of AMR by prescribing antibiotics only when necessary and using appropriate guidelines, for instance using the narrowest spectrum antibiotic possible and prescribing the right dose and duration. And avoiding the unnecessary use of antibiotics for viral infections.

Effective and proper awareness and education of the health care professionals and patients on the importance of preventing infections achieved through practicing good hygiene, getting vaccinated, and the appropriate use of antibiotics, which can help promote effective treatment and reduce unnecessary use.

Amending, developing, and implementing guidelines and policies for antibiotic use can help promote their effective use and standardize prescribing practices. Policymakers should also invest in the research of new antibiotics and other antimicrobial drugs, as well as in the development of alternative treatments that don't promote the development of resistance. This can be achieved through the international collaborations needed to address the problem of AMR.

Nevertheless, a proper review of antibiotic prescribing patterns and feedback provided to health care professionals can help provide opportunities for improvement and promote more appropriate use of antibiotics.

Overall, AMR is a great threat that requires immediate action and intervention to reduce the loss of many lives and high healthcare costs. Through antibiotic stewardship, an important strategy for combating AMR, and effective use of antibiotics through improved monitoring, prescribing practices, tracking use and resistance, and educating health professionals and patients, we can ensure effective treatment of infections for generations to come.



MTrac SYSTEM IMPROVES HEALTHCARE DELIVERY AND ACCESS TO ESSENTIAL MEDICATIONS

By Kintu Hannington

One recent pharmacy breakthrough in Uganda is the development of a mobile phone-based system for managing and tracking medicine supplies. The system, known as mTrac, was developed by the Ugandan Ministry of Health and UNICEF, in collaboration with the technology company mHealth.

The mTrac system allows health workers to report on medicine stock levels and other data using their mobile phones, which is then transmitted to a central database. This enables real-time monitoring of medicine availability and helps to ensure that essential medications are always in stock and available to patients.

The mTrac system has been successful in improving the availability of medicine in Uganda, particularly in remote and underserved areas. A study published in the journal *Health Affairs* found that the use of mTrac resulted in a significant increase in the availability of essential medications, including antiretroviral drugs for HIV/AIDS, antimalarials, and vaccines.

The mTrac system is an innovative example of how technology can be used to improve healthcare delivery and access to essential medications, and it has the potential to be implemented in other countries facing similar challenges.



MUPSA Leaders amongst other pharmacy students after a meeting with the leadership of the Pharmaceutical Society of Uganda.

THE 3RD UGANDA PHARMACEUTICAL SYMPOSIUM.

By **Chelimo Betony**
BPHA IV, Makerere University

A year ago, students from all over the country training in the noble profession of Pharmacy convened for the 3rd Uganda Pharmaceutical Symposium. This auspicious event was organized by the 2022/23 executive committee of the Uganda Pharmaceutical Students' Association (UPSA) under the leadership of Ms. Mutesi Immaculate. The event was largely a success and had representation from all three pharmacy students' associations in Uganda viz; MUPSA (Makerere University), MbUPSA (Mbarara University) and KIUPSA (Kampala International University). International delegates were also present; the associations of pharmacy students in Rwanda and Burundi also sent delegations to grace the occasion.

MUPSA was fortunate to host the symposium last year, the precious one having been hosted by MbUPSA. In light of this fortune, the symposium was hosted at Makerere University. Coincidence also had it that the UPSA President also happened to be a MUPSA member. This event hosted within the premises of the "Harvard of Africa" left those in attendance different individuals as they picked so much from the three days starting March 16 to March 18, 2023.

To begin with, talks were given by senior members of the profession on a myriad of topics. These topics were mainly aligned to the theme of the symposium which was, "Multi Disciplinary action in the fight against AMR in the post-COVID-19 era." It goes without saying the pertinence of the theme. The speakers also made mention of the various developments in the practice of pharmacy in Uganda and around the globe, trends in the pharmacy profession and specialties in the profession, among others. These speeches left the pharmacy students having learnt much.

More to it were the panel discussions on various topics that similarly centered around the theme of the symposium. Moderators for these discussions were health education students from different universities as the symposium was a student-centered event. The panelists were a combination of knowledgeable experienced professionals within the topics of discussion as well as recent graduates within the pharmacy profession. Notable among these was Mr. Agaba Innocent, the president of UPSA for the time period 2021/22.

Putting the technicalities aside, the next generation pharmacists had their brains and teamwork skills put to task in a quiz activity that mainly focused on pharmaceutical and biomedical disciplines. The quiz, however, was not limited to these. Pharmacists are all-round and the quiz had the job of proving this. Participants also answered questions within entertainment and current affairs. Much to the amazement of the quiz judges, the participants aced the questions in the latter two sections better than in the academic section.

"All work and no play makes Jack a dull boy," the adage goes. Nobody understands this better than the next generation pharmacists and it was for this reason that the third day of the symposium was dedicated to having fun. A beach bash was slated for that day, it being a Saturday. The drug lords and queens spent the day reveling by the sandy shores of Lake Victoria. Playing games, swimming, listening to music and taking photos were the major activities of the day. The students also got to network with one another, interact, make new friends and create new memories.

It would be deceitful to claim that anyone can fully narrate the overall experience at the symposium, for so much happened, and to everyone, the impact was different. All in all, the symposium was largely a success, amid a few shortcomings. Much gratitude is owed to all delegates who graced the symposium with their presence, as well as the UPSA executive who organized the auspicious event, and most importantly, the generous sponsors who gave in willingly to see to it that the symposium turned out a success.



Delegates at the 3rd Uganda Pharmaceutical Symposium

25TH MPJ—ARTICLES

BPharm 20/U: A Tale of Triumphs, Trials, and Timeless Bonds

By Naluyange Caroline
Vice President, MUPSA (2023-24)

Reminiscing on the road that has been trodden thus far, one has no option but marvel. The journey that was set to begin in August 2020 commenced in February 2021, ultimately setting in place a cascade of bumpy ride experiences that have shaped the BPharm 20/U class.

Joining the prestigious Makerere University in the midst of the COVID-19 pandemic meant that the academic voyage was never going to be like any other before. The compensation for lost time saw us through end to end semesters sans holidays. Even the few holidays seldom exceeded a week long. Even more amazing, the end to end semesters were always three months long until the third year.

Online classes via zoom was a norm in the biomedical years (1&2). This definitely put class solidarity to the test. Nonetheless, a strong class solidarity was later brewed in the third year, yielding a Pharmily that is set to last the test of time.

This, our cohort has grown from glory to glory, gracing various events in large numbers and emerging victors in various quizzes organized by MUPSA. It thus remains for us to keep in friendship and solidarity through the times.

Not many can boast of the diversity we share as a class; for so unique is every member and yet there is so much we share in common. The academicians, the ones here for the license, the entrepreneurs, the politicians, the leaders, the mood brighteners (read comedians), the future lecturers, the fashionistas, the socialites, the tech wizards, to name but a few. The cohort boasts of a special unity in diversity.

In spite of the trials and tribulations which have punctuated our stay at the hill, there too have been innumerable joys and laughter; pleasure shared and memories made, etched in history for millennia to come. Even as this journey comes to the anchor point, we will still run this race for eternity because the love, memories and happiness we share have no finishing line.

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