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Connections

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CMPT QUARTERLY ON-LINE NEWSLETTER

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IN THIS ISSUE

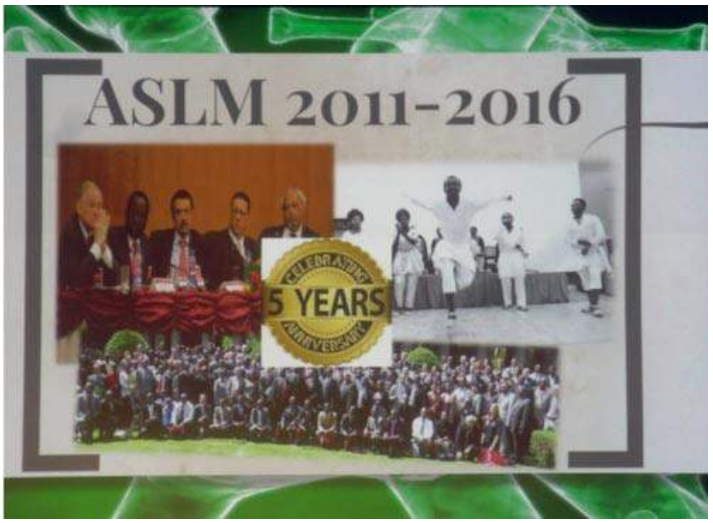
Dr. Michael Noble visits the African Society for Laboratory Medicine

In December 3-8, 2016, Dr. Noble got the opportunity to visit the African Society for Laboratory Medicine (ASLM) conference in Cape Town, South Africa. ASLM was first created only 5 years ago, and hosts a conference every 3 years.

In the early 2000s, Dr. Noble representing both CMPT and POLQM had the opportunity to work with the Clinical and Laboratory Standards Institute (CLSI) and the President's Emergency Plan for AIDS Relief (PEPFAR) in developing a program to help laboratories in eastern Africa (Tanzania) learn and implement better laboratory quality management.

The program included a series of workshops and a stepwise approach to ISO 15189 (Medical laboratories – requirements for quality and competence). The process was slow at start, but much improved with implementing an intermediate-stay mentor program. Over the years the concepts of quality started to catch on with improved documentation, active quality indicators, and internal audits.

Table Mountain - Cape Town, South Africa



By 2014, all the regional laboratories reached the required levels of confidence in their markedly improved quality and competence. All of them applied for accreditation by internationally authorized accreditation assessment bodies and all seven laboratories met the required level of achievement and earned their accreditation certificate.

Modern medical laboratories first started to appear in Europe and North America around 1850. When studied, as late as the 1940s, their reliability and accuracy, as measured by external assessment and proficiency testing, was basic, at best. But over the following 75 years, laboratories have improved hugely. Most learning was done on-the-job and first hand and was slow and often incomplete. By contrast, laboratories in Africa have had the benefit of mentors, money, and motivation and have started to achieve comparable levels of success in only 15 years.

So congratulations to African medical laboratories and to the ASLM.

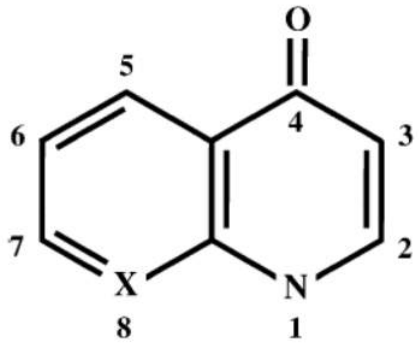
We look forward to the opportunity to be a part of the ongoing story of progress and improvement.

Quinolone Resistance

By Dr. John Galbraith

Quinolones are a class of antibiotic with broad-spectrum antibacterial activity. They are well absorbed orally and have good tissue penetration making them popular agents for the treatment of a wide variety of infections. They are synthetic agents rather than natural products. The first member of the class, nalidixic acid, was discovered during the synthesis and purification of chloroquine in 1962.[1] The clinical role of nalidixic acid has been limited by its minimal serum levels and its narrow gram negative spectrum.

The core structure of the quinolone nucleus is depicted below: [2]



Second generation agents were developed by the addition of a fluoride atom at position 6 of the quinolone molecule, creating fluoroquinolones (FQ) with broadened antimicrobial spectrum including *Pseudomonas* species and some gram positive organisms. Fluoroquinolones were developed in the 1980s and included norfloxacin, ofloxacin, and ciprofloxacin. Further modifications in the 1990s led to the development of third generation FQ agents: levofloxacin and moxifloxacin, with improved *Streptococcus pneumoniae* coverage and fourth generation agents: trovafloxacin, with enhanced anaerobic activity.[2,3]

Mechanism of Action

Quinolones are direct inhibitors of bacterial DNA synthesis; [4-7] they specifically inhibit the action of two enzymes essential for bacterial DNA replication: DNA gyrase (topoisomerase II) and topoisomerase IV. DNA gyrase is a tetramer of two A and two B subunits, encoded by the genes *gyr*A and *gyr*B respectively. DNA gyrase introduces negative DNA supercoils, removes positive and negative supercoils, and links and unlinks chromosomal material. Topoisomerase IV has two C subunits and two E subunits, encoded by the genes *par*C and *par*E, and it too can remove positive and negative supercoils, but is primarily involved in the separation of daughter chromosomes.

The process of supercoiling is essential for the large amount of bacterial DNA to be packed into the cell. The degree of supercoiling (how twisted the DNA is) is not fixed and there is continuous remodeling which is under the control of enzymes that work in opposition to supercoil DNA either positively or negatively.

Quinolones form a ternary complex of drug-enzyme-DNA that is trapped, disrupting DNA replication and triggering cell death mechanisms. For most gram negative bacteria, DNA gyrase is the primary quinolone target whereas for most gram positive bacteria, topoisomerase IV is the primary target, with DNA gyrase being secondary.

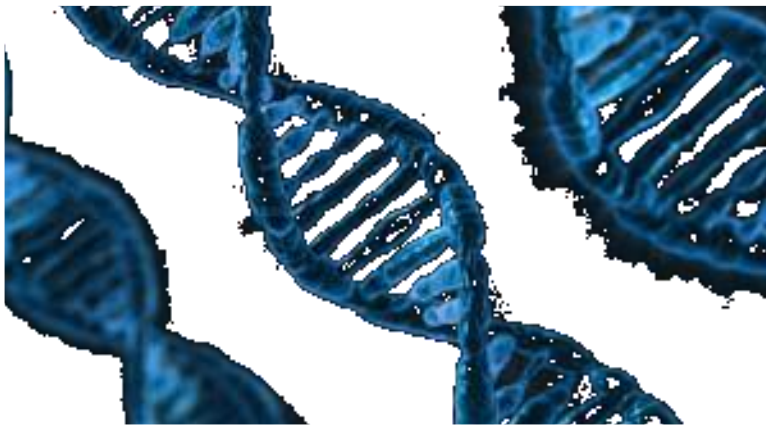
FQ are bactericidal and exhibit a post-antibiotic effect following bacterial exposure to inhibitory concentrations. The antibacterial effect continues for approximately two to three hours after the bacteria are exposed to these agents, even at sub-inhibitory concentrations.

Spectrum and Clinical Uses

The most commonly prescribed FQ are ciprofloxacin, levofloxacin, and moxifloxacin. They are most active against aerobic gram negative bacteria including *Enterobacteriaceae, Haemophilus* species*, Neisseria* species*,* and *Moraxella catarrhalis*. Ciprofloxacin remains the most potent FQ against *Pseudomonas aeruginosa* and *Acinetobacter baumannii.* FQ also have some activity against staphylococci (but MRSA are typically resistant) and enterococci. Levofloxacin and moxifloxacin have enhanced activity against *Streptococcus pneumoniae*. FQ have activity against a wide variety of gram positive bacilli including *Bacillus* species*, Corynebacterium* species, *Erysipelothrix* species, and *Nocardia* species*.*

FQ are active against the so called "atypical" agents, including *Chlamydophila pneumoniae*, *Legionella pneumophila,* and *Mycoplasma pneumoniae*. They are also active against some genital pathogens, including *Chlamydia trachomatis, Ureaplasma urealyticum,* and *Mycoplasma hominis,* and against *Mycobacterium tuberculosis* and some non-tuberculous mycobacteria, including *M. fortuitum, M. kansasii,* and *M. chelonae*.

Given the broad spectrum of activity and excellent oral bioavailability, FQ have been widely used (and over used) for a variety of infections including: urinary tract infections, prostatitis, sexually transmitted diseases, infectious diarrhea, respiratory tract infections, bone and joint infections, and skin and soft tissue infections.[3,8]



Unfortunately, the axiom "The more you use an antibiotic the quicker you lose it" certainly applies to FQ as rapid dissemination in use has been associated with emerging resistance.[9]

Mechanisms of Acquired Resistance

Resistance to quinolones may result either following mutations in chromosomal genes or after acquiring resistance genes on plasmids.[3,7,9,10]

Chromosomally mediated resistance may occur by two broad mechanisms:

Altered target, with mutations in genes *gyr*A, *gyr*B, *par*C and *par*E that encode the subunits of DNA gyrase and topoisomerase IV. The region where mutations arise in these genes is a short DNA sequence known as the quinolone resistance determining region (QRDR). The mutations in the QRDR result in altering the target protein structure and subsequently the FQ-binding affinity of the enzyme leading to resistance.

Altered permeation, with mutations in genes that regulate efflux pumps or result in loss of outer membrane porins.

Plasmid-mediated quinolone resistance (PMQR) may occur via:

Target protection, with acquisition of a resistance gene, *qnr*, which encodes for a protein that protects DNA gyrase and topoisomerase IV from quinolone inhibition. Several variants of such quinolone resistant genes, *qnr*, have been identified.[11,12] The mechanism of Qnr protective effect is not completely understood although it is thought that binding of the Qnr protein to the target enzyme physically prevents the interaction with the antibiotic.[13]

Drug inactivation, with a quinolone modifying enzyme able to acetylate ciprofloxacin. This enzyme is encoded by a *cr* variant of an aminoglycoside acetyltransferase.[14]

Efflux pumps encoded by *qep*A and *oqx*AB genes, they can pump quinolones out of the cell.[15,16]

The plasmid-mediated mechanisms are almost always associated with resistance to other antibiotics. FQ resistance occurring together with other antimicrobial resistance elements on plasmids allows mutual resistance promotion and the spread of organisms that are difficult to treat.[12] It is important to note that "resistance" in the context of PMQR refers to any increase in MIC (a biological definition) rather than an increase above a susceptibility breakpoint (a clinical definition).

In vitro laboratory testing

Nalidixic acid was initially used by clinical laboratories as a surrogate agent to detect *Salmonella* with FQ resistance due to target site mutations (*gyr*A and *par*C). However, the situation has become more complex with the discovery of PMQR. Strains with PMQR may be difficult to detect because the resulting MIC elevations are typically more modest than those associated with QRDR mutations and do not confer resistance to nalidixic acid.[17,18] Low-level FQ resistance is associated with poorer clinical outcomes.[18,19] Moreover, FQ treatment of bacteria with low level resistance may promote the development of high level resistance.[18,20] CLSI and EUCAST recently lowered their susceptibility breakpoints for *Salmonella,* but surveillance data and pharmacokinetic/pharmacodynamic analyses suggest the FQ breakpoints for other *Enterobacteriaceae* may still be too high.[18,19]

Adverse Reactions and FDA warning labels

Several FQ have been removed from the market due to rare but very serious adverse reactions. grepafloxacin was removed from the market following fatal cardiovascular events and cases of torsades de pointes (specific form of polymorphic ventricular tachycardia); trovafloxacin was removed from the market due to reports of liver failure, while gatifloxacin was withdrawn from the market because it was found to be associated with symptomatic hypoglycemia and hyperglycemia.[3]

Common adverse effects associated with FQ include gastrointestinal and central nervous system toxicities. Other adverse effects include: rashes and other allergic reactions, tendinitis and tendon rupture, QT prolongation, hypoglycemia and hyperglycemia, hematologic toxicity, and retinal detachment.[3,21]

FQ should not be given together with other drugs known to prolong the QT interval as these interactions may increase the risk of torsades de pointes and sudden death.

FQ labelling has for many years had warnings about the risks for tendonitis, tendon rupture, central nervous system effects, peripheral neuropathy, myasthenia gravis exacerbation, QT prolongation and torsades de pointes, photosensitivity, and hypersensitivity.

More recently the FDA added black box warnings and took the unprecedented step of recommending against FQ for some common infections. An FDA panel advised that serious side effects associated with FQ generally outweigh the benefits for patients with sinusitis, acute exacerbation of chronic bronchitis (AECB), and uncomplicated urinary tract infections. For patients with these conditions, FQ should be reserved for those who do not have alternative treatment options.[22]

One of the FDA panel members was quoted "Very rare side effects will be magnified when we abuse an antibiotic millions of times."[22]

The plasmid-mediated mechanisms are almost always associated with resistance to other antibiotics. FQ resistance occurring together with other antimicrobial resistance elements on plasmids allows mutual resistance promotion and the spread of organisms that are difficult to treat.

Conclusions

FQ, especially later generation ones, have a very wide spectrum of activity. Their excellent bioavailability and seemingly favourable tolerability led to widespread use and, like other antimicrobials, misuse. Not surprisingly resistance predictably followed. Resistance is mediated by both chromosomal and plasmid gene mutations with resultant altered DNA targets and/or reduced drug permeation. Unfortunately, clinical laboratories are challenged to detect low level resistance which is associated with poorer clinical outcomes. It also appears that continued treatment of bacteria with low level FQ resistance promotes the development of high level FQ resistance.

Another ominous development associated with quinolone use has been the occurrence of some serious adverse reactions leading to the removal of several agents from the market. Black box warnings about the risks of serious side effects accompany the agents that remain on the market. The FDA took the unusual step of advising that serious side effects associated with FQ generally outweigh the benefits for treating sinusitis, AECB and uncomplicated urinary tract infections in patients who have other treatment options.

Hopefully, emerging antimicrobial stewardship programs will improve FQ utilization and thereby preserve and protect this class of antimicrobials. It also hoped that research and development within this class will yield new FQ with better safety profiles and with expanded spectrum against the emerging multidrug resistant microorganisms.

We would like to thank Dr. John Galbraith for his contribution to our newsletter.

Dr. Galbraith is a microbiologist and infectious diseases specialist with the Vancouver Island Health Authority, Victoria, BC; and a member of the Clinical Microbiology Proficiency Testing (CMPT) Microbiology Subcommittee.

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Biosecurity Plan

A Biosecurity Plan must be developed by any facility that handles or stores human or animal pathogens or toxins as these pose a risk to personnel, the community, and the environment. "The purpose of a biosecurity program is to prevent the loss, theft, misuse, diversion, or intentional release of biological assets."

The biosecurity plan needs to be developed based on a biosecurity risk assessment. This biosecurity risk assessment is and evaluation of the probability of an *intentional* event, such as the theft of assets and the consequences of that event. The biosecurity risk assessment will be specific for each facility.

Elements of a Biosecurity Plan

Every biosecurity plan must address the following elements:

1. **Physical Security**: physical and security controls must be put on place to restrict access of unauthorized individuals to a facility, part of a facility, or assets to protect them from damage, theft, or misuse. The complexity of these controls will depend on the level of risk determined by the facility's biosecurity risk assessment.

Physical and security controls may include key access to facility, additional level of control for laboratory areas, locked freezers where organisms are stored, etc. It is important that the facility maintains a record for keys, codes, combinations, etc. that limit or restrict access to containment zones, infectious material, or toxins.

Facilities must also have a protocol for the entry of non-authorized individuals such as trainees, maintenance staff, etc. who require temporary access are important considerations when evaluating access control.

2. **Personnel Suitability and Reliability**: potential employees which will be granted access to pathogens, toxins or other regulated infectious material need to be screened to evaluate their integrity and reliability; this may include background checks and HPTA Security Clearances.

3. **Pathogen and Toxin Accountability and Inventory Control:** pathogens, toxins, and other regulated infectious material in long-term storage need to be tracked and documented within the organization and when transported within or to a different organization. This requirement does not apply to material that is in use such as cultures or ongoing experiments/tests.

   A robust pathogen and toxin inventory and accountability system will include a designated individuals responsible for the maintenance of the inventory; documentation of all transfers, inactivation, and disposal of material; proper labelling for long term storage and accountability; accountability measures to protect pathogens and toxins when transported from one location to another.

4. **Incident and Emergency Response**: an incident is an event that has the potential to cause harm to personnel, the community, or the environment. "Incidents involving pathogens, toxins, other regulated infectious material, infected animals, or failure of containment systems or control systems be immediately reported to the appropriate internal authority, and in some cases, to the PHAC."

   Examples of biosecurity incidents are: any loss or compromise of keys, passwords, combinations, remote access equipment; unauthorized access or attempts to access restricted access areas; any suspicious persons or activities; any discrepancy in the inventory.

5. **Information Management and Security**: specific measures must be put in place to assure sensitive information is protected from unauthorized access, keeping it confidential and making it accessible only to those who need it.

Training of the personnel is essential for the success of the biosecurity plan. Personnel need to be knowledgeable about the hazards and threats associated with the pathogens and toxins present in their work environment, and of the measures and protocols that can prevent accidental exposure to, or release of, pathogens and toxins, and maintain the security of assets.

It is important that the biosecurity plan is regularly reviewed and continually improved so that it remains relevant, applicable, and effective.

Reference: Canadian Biosafety Guideline: Developing a Comprehensive Biosecurity Plan

CMPT's Grading Guideline

At CMPT, we take a number of measures to ensure that laboratories understand that we take our responsibility for proficiency testing (also known as External Quality Assessment) as both core and critical:

- We ensure that we maintain our quality and performance as top of mind through our accreditation to the international standard ISO/IEC17043:2010 (Competency assessment: Conformity assessment -- General requirements for proficiency testing)
- We continue to ensure that our quality system meets the requirements of ISO9001:2008/2015 (Quality Management Systems – Requirements)
- We regularly monitor laboratory opinion of our services and practices through electronic surveys, and we publish all our results in our Annual Report.

One expectation we strive to keep is to ensure that our approach to grading challenges is consistent. Participants deserve and have the right to demand that grading is done thoughtfully and consistently. This can be a challenge for organizations as old as CMPT where committee members change over time, microbial identities change and, importantly, clinical interpretations change.

For the longest time grading consistency was monitored only by "corporate memory" by participants that had a long experience with CMPT and knew and understood our approach to grading. However, by 2014, it was felt that a grading guideline needed to be formulated, to help the committee grade in a consistent way. The CMPT Grading Guideline is a continual "work in progress" balancing between maintaining a consistent approach and recognizing that laboratory approach and interpretation of laboratory results change with time. Laboratory structural changes that have resulted from mergers and consolidation have changed approaches to laboratory testing. Methodologies, such as MALDI TOF MS, while not found in all laboratories has an impact on how bacteria are selected and tested for identity. Today's very appropriate concerns about antibiotic resistance and the importance of antibiotic stewardship impact on our approach to susceptibility testing and reporting.

All these factors being taken into consideration should not impact CMPT's responsibility towards evaluation and grading of results.

The committee's efforts to maintain consistency are underscored by the Grading Guidelines Guiding Principles:

PRINCIPLES OF GRADING CMPT CHALLENGES

1. **ABOVE ALL ELSE** the role of CMPT is to ensure that laboratories are meeting the expectations of a quality informed report.

   a. Acceptable reports on samples should be seen as consistent with good clinical practice, including accurate information that is sufficient for interpretation and appropriate clinical decision making.

   b. Reports that contain errant information, or are missing clinically appropriate information or notes should NOT be assessed as acceptable.

2. CMPT participants should perceive grading as IMPARTIAL and FAIR.

   a. CMPT should grade samples ONLY when there is 80 percent agreement within the reference laboratory group and at least 50 percent of participating laboratories were able to provide an acceptable report. In the absence of two-tiered consensus, the challenge must not be graded (i.e. ungraded result)

3. CMPT grading should be perceived as consistent with CMPT prior practise **AND** current appropriate medical laboratory practices.

   a. Use of the CMPT Grading Guideline should drive grading practices.

      i. While precedence should be always considered **first**, in the presence of changing technologies, or changing perspective of clinical awareness and expectation, grading can and should alter.

      ii. Where the CMPT committee has flexible alternatives, they should be considered to determine if they are appropriate in a particular situation.

   b. To the extent possible, changes in interpretation and perspective should be taken into consideration when the challenge is being selected BEFORE it is sent to participants.

      i. Prior decision can be made to have the sample sent as an UNGRADED EDUCATIONAL CHALLENGE.

4. CMPT participants have the right to challenge CMPT grading and expect a fair re-evaluation of grading

In quality parlance, CMPT is a Quality Partner which means that it exists, first and foremost, to assist laboratories to stay on track with their quality efforts. If there are no errors detected by CMPT, it is probable that the laboratory is not making errors that impact on patient care. But if CMPT does detect an unacceptable performance, it is possible that this same error is occurring in clinical samples, and the laboratory has an obligation to check.

CMPT goes to great strides to ensure that its challenge selection, preparation and grading is confidential, as well as, transparent, consistent and fair while current and relevant, and true to our Quality Mission Statement: Innovation – Education – Quality Assessment – Continual Improvement.

Professional Development Course

Our Professional Development course keeps attracting more people.

This year we have extended the invitation to microbiology residents; we have already some residents registered for the course.

We are also very excited that our course was chosen as a continuing education tool for laboratory technologists in Ethiopia through a building capacity project supervised by Dr. Makeda Semret from McGill University in Montreal, QC.

We look forward to offering this useful tool to more interested groups.

Video Challenges

As part of the February 2017 Clinical Microbiology survey, CMPT will send its first Video Challenge. CMPT has been using its Paper Challenge as a way to evaluate extra-analytical processes in the total laboratory testing.

This year, CMPT introduces the Video Challenge as a new format to present scenarios where different types of laboratory errors may occur.

The advantages of the Video Challenge are many and among them, the error is not obviously stated, participants need to recognize it. Also, the scenario is not limited to a few sentences that can be misinterpreted or interpreted differently by the laboratories.

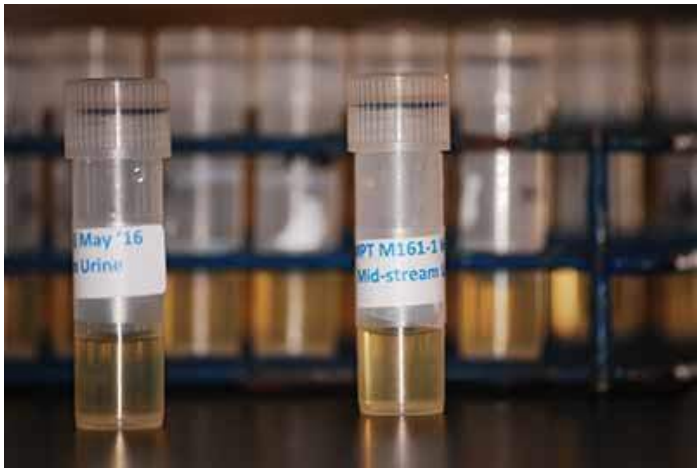
We hope that this format will allow for more flexibility, and that it is useful for our participants as a teaching and learning tool.

CMPT is committed to continual improvement and we continue to explore new ways of testing the laboratory process through means that allow for the education of the laboratory staff.

Ordering Information - PT Year 2017-2018

The due date to order PT programs for the year 2017-2018 is March 24th, 2017. Please place your order before that date.

Order forms can be found here: http://cmpt.ca/eqa-programs-ordering-information/



Upcoming Events

APRIL 2017

27th European Congress of Clinical Microbiology and Infectious Diseases
April 22 - 25, 2017 Vienna, Austria
More info: http://www.eccmid.org/

MAY 2017

2017 AMMI Canada - CACMID
May 3 - 6, 2017 Toronto, Canada
More info: http://www.cacmid.ca/2016/04/toronto2017/

LABCON 2017
May 26 - 28, 2017 Banff, Canada
More info: https://labcon.csmls.org/

JUNE 2017

ASM Microbe / ICAAC 2017
June 1 - 5, 2017 New Orleans, US
More info: http://www.asm.org/index.php/asm-microbe-2017

OCTOBER 2017

POLQM - 2017 Quality Management Conference for Medical Laboratories
October 1 - 3, 2017 Vancouver, Canada
More info coming soon.

ABOUT CONNECTIONS

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