School of Mathematical and Statistical Sciences
Arizona State University

M E M O R A N D U M

DATE: 06/12/2023

TO: Faculty and Students

FROM: Professor(s) Chair/Co-Chairs of Defense for the PhD Committee Members

Abba Gumel
Queen Tollett
in Applied Mathematics

Carl Gardner
John Fricks
John Nagy
Sharon Crook

DEFENSE ANNOUNCEMENT

Candidate: Queen Tollett

Defense Date: Monday, June 26, 2023

Defense Time: 1:00 PM

Virtual Meeting Link: https://asu.zoom.us/j/9844726390 Live: Wexler Hall (Tempe) WXLR 206

Title: Mathematics of Transmission Dynamics and Control of HIV/AIDS in an MSM Population

Please share this information with colleagues and other students, especially those studying in similar fields. Faculty and students are encouraged to attend. The defending candidate will give a 40 minute talk, after which the committee members will ask questions. There may be time for questions from those in attendance. But, guests are primarily invited to attend as observers and will be excused when the committee begins its deliberations or if the committee wishes to question the candidate privately.

ABSTRACT
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Abstract

The human immunodeficiency virus (HIV) pandemic, which causes the syndrome of opportunistic infections that characterize the late stage HIV disease, known as the acquired immunodeficiency syndrome (AIDS), remains a major public health challenge to many parts of the world. This dissertation contributes in providing deeper qualitative insights into the transmission dynamics and control of the HIV/AIDS disease in an MSM community. A new mathematical model (which is relatively basic), which incorporates some of the pertinent aspects of HIV epidemiology and immunology and fitted using the yearly new case data of the MSM population from the State of Arizona, was designed and used to assess the population-level impact of awareness of HIV infection status and condom-based intervention, on the transmission dynamics and control of HIV/AIDS in an MSM community. Conditions for the existence and asymptotic stability of the various equilibria of the model were derived. The numerical simulations showed that the prospects for the effective control and/or elimination of HIV/AIDS in the MSM community in the United States are very promising using a condom-based intervention, provided the condom efficacy is high and the compliance is moderate enough. The model was extended in Chapter 3 to account for the effect of risk-structure, staged-progression property of HIV disease, and the use of pre-exposure prophylaxis (PrEP) on the spread and control of the disease. The model was shown to undergo a PrEP-induced *backward bifurcation* when the associated control reproduction number is less than one. It was shown that when the compliance in PrEP usage is 50%(80%) then about 19.1%(34.2%) of the yearly new HIV/AIDS cases recorded at the peak will have been prevented, in comparison to the worst-case scenario where PrEP-based intervention is not implemented in the MSM community. It was also shown that the HIV pandemic elimination is possible from the MSM community even for the scenario when the effective contact rate is increased by 5-fold from its baseline value, if low-risk individuals take at least 15 years before they change their risky behavior and transition to the high-risk group (regardless of the value of the transition rate from high-risk to low-risk susceptible population).