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SIR INTEGRATED MODEL BASED ON RUNGE-KUTTA FOR POLIO VACCINATION ANALYSIS

(Model Integrasi SIR Berdasarkan Runge-Kutta bagi Analisis Vaksinasi Polio)

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ABSTRACT

Polio was one of the most lethal acute viral infectious diseases in the 20th century. A great deal of success has been achieved since the implementation of the polio vaccination strategy in 1988, and wild polio cases have decreased by more than 99%. However, in recent years, during the COVID-19 pandemic, vaccination strategies have encountered difficulties and challenges. At this stage, we are faced with the question of whether vaccination strategies should be continued. To determine the effect of vaccination strategies on the spread of polio at this stage, this paper proposes to use the SIR model based on world data collected in 2021 to simulate the 30-days transmission process of polio with and without vaccination. In addition, the results of this model also provide us with a reference disease response plan. The simulation results show that the vaccinated polio transmission model performs better than the uninoculated polio transmission model in terms of average estimated infection case, reproduction number, and infection rate, etc. At this stage, polio will not become an endemic disease if it occurs in vaccination areas. Nevertheless, if the case occurs in an unvaccinated area, the disease may develop into an endemic disease, and we must take immediate action (increase social distance, isolation,etc.) to effectively control its spread.

Keywords: poliomyelitis; vaccination strategy; Runge-Kutta; SIR; model

ABSTRAK

Polio adalah salah satu penyakit berjangkit virus akut yang paling berbahaya pada abad ke-20. Banyak kejayaan telah dicapai sejak pelaksanaan strategi vaksinasi polio pada tahun 1988, dan kes polio liar telah menurun lebih daripada 99%. Walau bagaimanapun, dalam beberapa tahun kebelakangan ini, semasa pandemik COVID-19, strategi vaksinasi telah menghadapi kesukaran dan cabaran. Pada peringkat ini, kita berhadapan dengan persoalan sama ada strategi vaksinasi perlu diteruskan. Untuk menentukan kesan strategi vaksinasi terhadap penyebaran polio pada peringkat ini, kertas kerja ini mencadangkan untuk menggunakan model SIR berdasarkan data dunia yang dikumpul pada tahun 2021 untuk mensimulasikan proses penularan 30 hari polio dengan dan tanpa vaksinasi. Di samping itu, hasil model ini juga memberikan rujukan untuk pelan tindak balas penyakit. Hasil simulasi menunjukkan bahawa model transmisi polio yang divaksin berprestasi lebih baik daripada model transmisi polio yang tidak divaksin dari segi anggaran purata kes jangkitan, bilangan pembiakan, dan kadar jangkitan, dsb. Pada peringkat ini, polio tidak akan menjadi penyakit endemik jika ia berlaku dalam kawasan vaksinasi. Namun begitu, jika kes itu berlaku di kawasan yang tidak divaksin, penyakit itu mungkin berkembang menjadi penyakit endemik, dan kita mesti mengambil tindakan segera (meningkatkan jarak sosial, pengasingan, dll.) untuk mengawal penyebarannya dengan berkesan.

Kata kunci: poliomielitis; strategi vaksinasi; Runge-Kutta; SIR; model

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