International Symposium on Infectious Agent Transmission Model Building – Focusing on Assessment of Risk to Communities

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SUMMARY: The Susceptible Infected and Recovery (SIR) Model proposed by Robert May in the UK is the basis of the present mathematical model building of infectious disease epidemics. Need for model building incorporating more social and other relevant factors has been recognized. An important example is the introduction of idea of the scale-free distribution of links among the people. More refined models by taking into account the nature of a pathogen, geo-sociological factors, lifestyles of the people, etc., have been developed. For example, Koopman proposed a model for prediction of epidemic expansion based on actual epidemiological data. Eubank proposed a model assessing the bio-terror attack using a model city where every day activity is going on. The present workshop, participated by experts from the US, the UK and Japan, is the first meeting of the proposed series of conference on this issue.

Why mathematical model?

Outbreak of infectious diseases is mostly unpredictable. Continued surveillance and early detection of emerging epidemic are basics of its prevention. Nations have to be prepared for any emergent epidemics. For this, it is essential to know possible consequence of coming plagues. Epidemiological studies of the past cases are useful. However, such studies have limitations. For example, we have experienced no bio-terror attacks in the modern cities. We cannot make assessment by experiments of bio-terrorism for obvious reasons. A mathematical modeling is an alternative approach. Recent progress in computer science has made such an approach more realistic.

Mathematical models developed so far

The Susceptible Infected and Recovery (SIR) model proposed by Robert May (1) is now generally supported and used as a prototype of the mathematical models (Fig. 1). The model is based on the assumption of direct transmission of a pathogen from man to man. However, more parameters, such as geo-sociological elements, lifestyles of different people, climate, transportation system, water supply, etc., have to be incorporated. Several models incorporating such diverse factors have been developed.

Koopman proposed an approach that could be more realistic by incorporating medical and epidemiological data (2). More recently, Eubank (3) proposed a model assessing the bio-terror attack in a model city by using parameters of geodemography of the city, people's household, people's twenty-four-hour activities, etc.

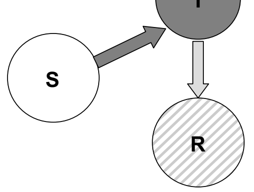

Fig. 1. Traditional modeling

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Present meeting

With the above background, the present symposium was held at the National Institute of Infectious Diseases (NIID), Japan in February 2005 aiming at the review of the ongoing activities in the related field and discussion on the future perspectives (Table 1).

Eubank, Virginia Bioinforrmatics Institute and Modeling Infectious Disease Agent Study (MIDAS), USA, presented a model of propagation of small pox in a city. Koopman, University of Michigan, USA, proposed an influenza virus spread model, which incorporated the parameters, such as social structures and vaccination options. Yasuda, Josai University, Japan, and Suzuki, NIID, presented a simulation of spread

Table 1. International symposium on trends in transmission models for infectious diseases - 2005: modeling biology focusing to social risk assessment

Program

Opening remarks: Kazuo Suzuki, National Institute of Infectious Diseases, Japan

1. Models for a Science of Infection Transmission
   James S. Koopman, University of Michigan, USA
2. Mathematical Models of the Evolution and Spread of Infections
   Angela McLean, Zoology Department, Oxford University, UK
3. Network Based Models of Infectious Disease Spread
   Stephen Eubank, Virginia Bioinformatics Institute and MIDAS, USA
4. Modeling on Social Spread from Immunity
   Hidenori Yasuda, Josai University, Japan
5. Sensing and Network
   Mami Furukubo, Hitachi Software Engineering, Japan
6. Effectiveness of Vaccination Strategies for Infectious Diseases According to Human Contact Networks
   Fumihiko Takeuchi, Juntendo University, Japan
7. Social Interaction Models
   Takashi Iba, Keio University, Japan
8. Simulation of Human Network
   Kenji Yamamoto, International Medical Center of Japan, Japan

Closing remarks: Takeshi Kurata, National Institute of Infectious Diseases, Japan

Commentators: Hiroshi Yoshikura, National Institute of Infectious Diseases, Japan, and others

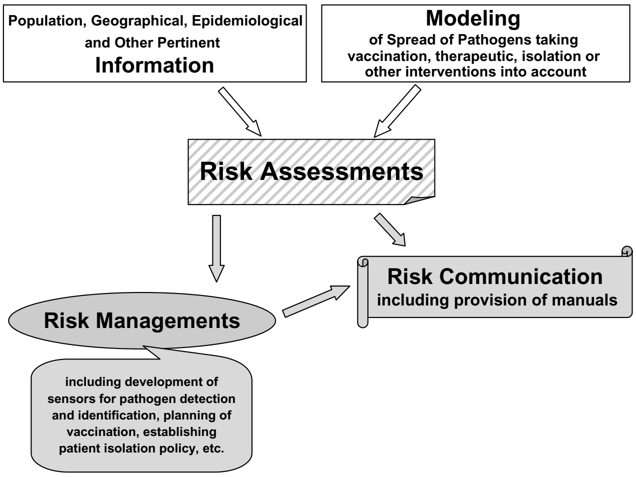

Fig. 2. Transmission models for risk assessment.

of influenza virus incorporating the parameters of immune state of the population and examined the effect of classroom closure on the persistence and spread in a community. Takeuchi presented a mathematical analysis of propagation in a community where man-to-man linking number follows a scale-free distribution. Yamamoto, International Medical Center of Japan, presented a data of hospital infection, frequency of which could be predicted by a mathematical model. McLean presented a model of HIV transmission that is under the effect of frequent mutation. Iba, Keio University, Japan, presented a social interaction model, which could strongly affect man to man spread of pathogens. Kokubo presented a recently developed a pathogen sensor device coupled with reporting and data collection for sensing outbreaks. Commentators were Kurata, Director-General of NIID and Yoshikura, Emeritus member of NIID. The latter commentator discussed influence of social link structure among the homosexuals on the exponential spread of HIV in Japan. Based on discussion in this meeting, reduction of risks of infectious diseases by transmission modeling for infectious agent will be proposed (Fig. 2).

ACKNOWLEDGMENTS

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2. Eubank, S., Guclu, H., Anil Kumar, V. S., Marathe, M., Srinivasan, A., Toroczkai, Z. and Wang, N. (2004): Modelling disease outbreaks in realistic urban social networks. Nature, 429, 180-184.
3. Koopman, J. S. (2005): Infection transmission science and models. Jpn. J. Infect. Dis., 58, S3-S8.