A COMPUTER-BASED SURVEILLANCE SYSTEM FOR HUMAN IMMUNODEFICIENCY VIRUS INFECTION IN SINGAPORE

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ABSTRACT

The first case of the human immunodeficiency virus (HIV) infection was detected in Singapore in 1985 and the first case of the acquired immunodeficiency syndrome (AIDS) in 1986. Since then, the number of infections had increased. By the end of 1993, there were 222 residents with HIV infection, including 75 cases of AIDS. In view of the rapidly increasing magnitude of HIV infection, a microcomputer-based surveillance system was designed and developed in 1992 to better monitor epidemiological trends of HIV infection in Singapore.

***Objective** – The objective was to define a composite model of a successful HIV and AIDS registry that included: (a) patient data forms, (b) patient's contact data forms, (c) data analysis, and (d) report generation.*

***Methodology** – An IBM-compatible desk-top microcomputer was used for the project. The main software used for computer programming and data analysis were DBase IV (Version 1.5) and Epi Info (Version 5.0), respectively. Security features were incorporated into the programme to ensure confidentiality of information and that only authorised personnel could gain access to the programme.*

***Main Findings** – The system functioned as the National HIV Notification Registry and was able to track notifications, analyse data and enabled prompt dissemination of information. The system was also linked to another database system for tuberculosis to enhance surveillance of both HIV infection and tuberculosis.*

***Conclusion** – The authors believe that this system would enhance surveillance and provide timely information for national AIDS control programmes. However, the effectiveness of this computer-based surveillance system is dependent on an established notification structure with notifications of sufficient completeness for both HIV infection and AIDS.*

Keywords: *acquired immunodeficiency syndrome (AIDS), human immunodeficiency virus (HIV), surveillance, computer, Singapore.*

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INTRODUCTION

The first cases of the acquired immunodeficiency syndrome (AIDS) were reported in the United States in 1981[1]. Since then, there has been a progressive increase in the number of cases worldwide. By the end of 1993, a total of 851,628 cases of AIDS were reported to the World Health Organisation (WHO)[2]. The majority of these cases was reported from the Americas (51%) and Africa (35%). WHO estimated that more than 14 million adults and one million children have been infected by the human immunodeficiency virus (HIV).

The first case of HIV infection was detected in Singapore in May 1985 and the first case of AIDS in September 1986[3]. By the end of 1993, there were 222 Singaporeans with HIV infection, including 75 cases of AIDS. Prior to 1990, the majority of cases reported had acquired HIV infection through homosexual and bisexual transmissions[4]. However, after 1990, an increasing proportion of patients was reported to have had heterosexual exposure with persons at risk for HIV infection[5,6].

The notification of HIV infection and AIDS in Singapore is mandatory by law. Notifications are confidential and are received from government and private hospital doctors, medical practitioners as well as government and private medical laboratories. All notifications are reported to the Epidemiology Unit (EU), Communicable Disease Centre (CDC), Ministry of Health, and cases are then individually investigated and counselled. All patients had a positive ELISA screening test which was confirmed by a Western Blot test. Diagnosis of AIDS was made in accordance with established classification systems[7,8], Information on biodata, risk factors, clinical status and relevant laboratory investigations associated with HIV transmission were recorded in a standard epidemiological surveillance form which was pre-coded.

In view of the increasing magnitude of HIV infection in Singapore, a microcomputer-based surveillance system was designed and developed by the EU, CDC, in 1992 to better monitor trends of HIV infection in Singapore. In this article, we present the details of the development of this system and its application in Singapore.

MATERIALS AND METHODS

The objective was to define a composite model of a successful HIV and AIDS registry that included: (a) patient data forms, (b) patient's contact data forms, (c) data analysis, and (d) report generation.

Computer hardware and software

An IBM-compatible personal desk-top computer with a 80386 33-MHz microprocessor and colour monitor was used for the project. The computer had a 120 megabyte (MB) harddisk, one 1.2 MB 5.25-inch and one 1.44 MB 3.5-inch floppy disk drives. It had a base memory of 640 kilobytes with 4 MB extended memory and ports for connecting a parallel printer. A Hewlett-Packard laserjet printer (HP II) was used to print all tables in reports.

IBM-compatible software, or the operating instructions for the computer, loaded into the harddisk, was of four types:

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1. operating system (MS-DOS 5.0, Microsoft Corporation)
2. word-processing (WordPerfect 5.1, WordPerfect Corporation)
3. data-base (Dbase IV Version 1.5, Borland International, Inc.)
4. data analysis (Epi Info Version 5.0, Centers for Disease Control, United States)[9]

Interview form

All notified patients were seen by epidemiology supervisors of the EU and information on their biodata, clinical status, immune status, and risk factors associated with HIV transmission were recorded in a standard epidemiological surveillance form. The two-sided single page form contained 40 pre-coded variables (that is, questions or observations).

Database Management

An 87 kilobyte database programme was written with Dbase IV to capture information from completed interview forms. A user-friendly customised colour screen was created to allow easy entry of data by the epidemiology supervisors (Fig 1). A two-level security feature using passwords was incorporated into the programme to ensure confidentiality of information and that only authorised personnel could gain access to the programme.

The information of an individual patient and his/her contacts was captured on separate database record files and linked by the identity or passport number of the index patient (Fig 2). For convenience in tracing individual patients, indexes were created and updated continuously by the programme for the case serial number, identity or passport number and name. It also provided on-line error checking and consistency checking of the variables entered. A help file consisting of pre-coded variables was also available to assist the supervisor during data entry. In addition, there was a memo field in each record so that any additional remarks could be recorded. Data could be added, modified, updated or deleted using the menu screen. A security password was incorporated to ensure that no record could be deleted without authorisation.

After data entry had been completed, the database file would be routed and saved on a 1.2 MB 5.25-inch floppy diskette which was secured after use. The programme also ensured that a back-up file was saved during exit procedures during which the user would be prompted to backup the database file on another floppy disk.

Data Analysis and Output

Data analysis was carried out using customised programmes which were written with Epi Info and incorporated into the DBase IV programme. The information required was generated from a user-friendly screen designed within DBase IV. The DBase IV database file was read by Epi Info during analysis and the output text file was then passed back to Dbase IV for printing. A shareware programme called 'list.com' was used for viewing the prepared file before printing.

A name list of notified HIV/AIDS patients or AIDS deaths could be prepared (Fig 3). In addition, it was also possible to generate a table listing numbers of notifications or HIV infection or AIDS by year and sex, age groups, mode of transmission, and other variables (Fig 4). The completed report is automatically routed to and saved in a text file on the harddisk. This text file could then be viewed on screen or routed to the printer. In addition to lists and tables, the analysed data could be viewed in the form of histograms, pie-charts and line-graphs. To provide a more finished product, the text file could be imported into word-processing software, WordPerfect 5.1, for printing.

The programme also had features to enable query functions of a combination of variables (Fig 5). A combination of up to 10 variables could be queried at any one time. In addition, a separate programme was written on DBase IV for survival analysis based on the Kaplan-Meier product-limit method. Survival analysis could be readily executed from the user-friendly main menu of the HIV registry. Analysis could be carried out for HIV patients, AIDS patients or those patients receiving anti-retroviral therapy.

Other features

The National HIV Notification Registry was linked to the National Tuberculosis Notification Registry, another database written with DBase IV and sited at the CDC. This enabled on-line matching of biodata of patients in both databases to allow for identification of patients with both HIV infection and tuberculosis. Furthermore, HIV patients who were followed up at the CDC for counselling and treatment could be tracked and a list of defaulters generated by the system.

DISCUSSION

Public health surveillance of HIV infection and AIDS is the collection, analysis and dissemination of data of sufficient accuracy and completeness regarding the prevalence and

Fig 1 – HIV registry menu screen

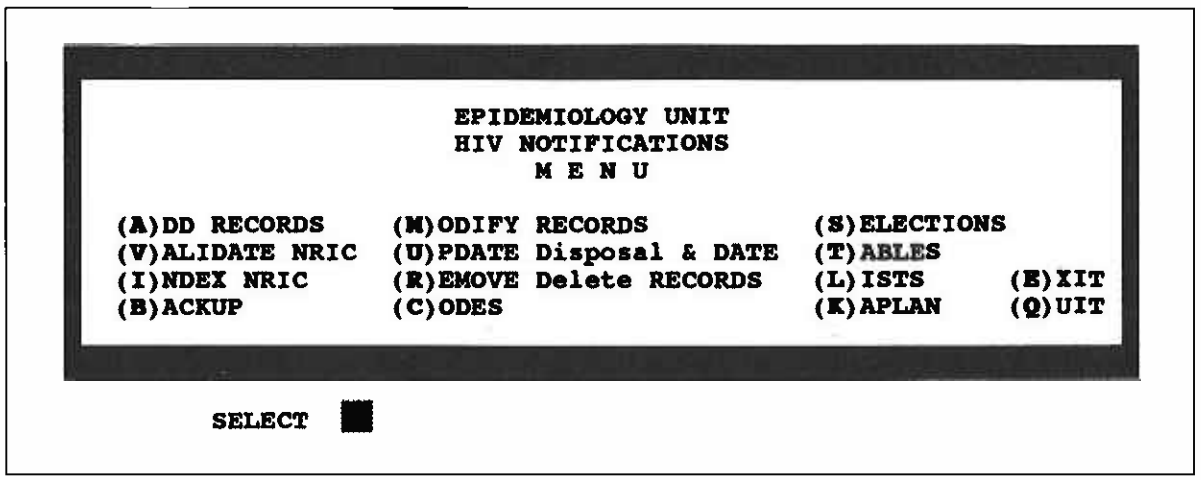


Fig 2 - Customised database entry screen

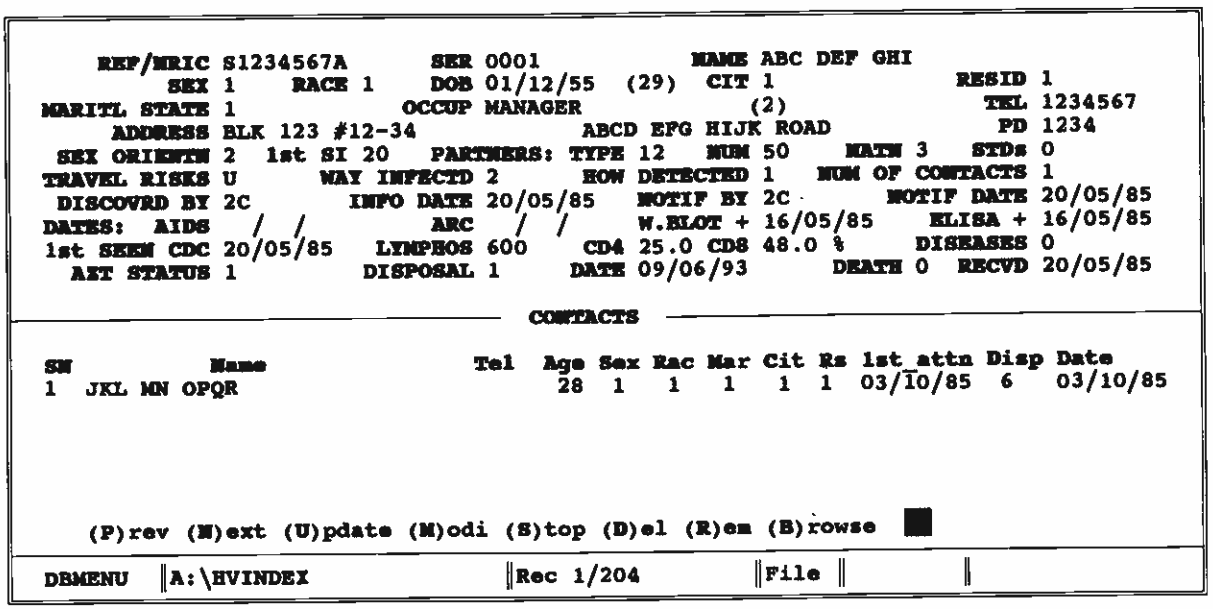


Fig 3 – Cutomised list selection screen

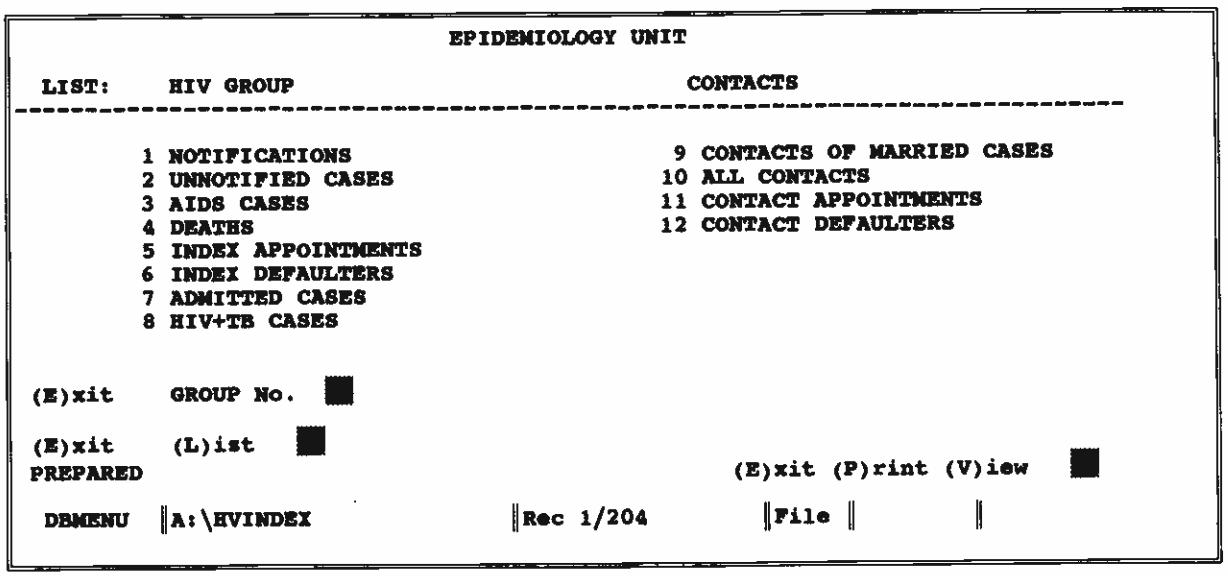


Fig 4 – Customised table selection screen

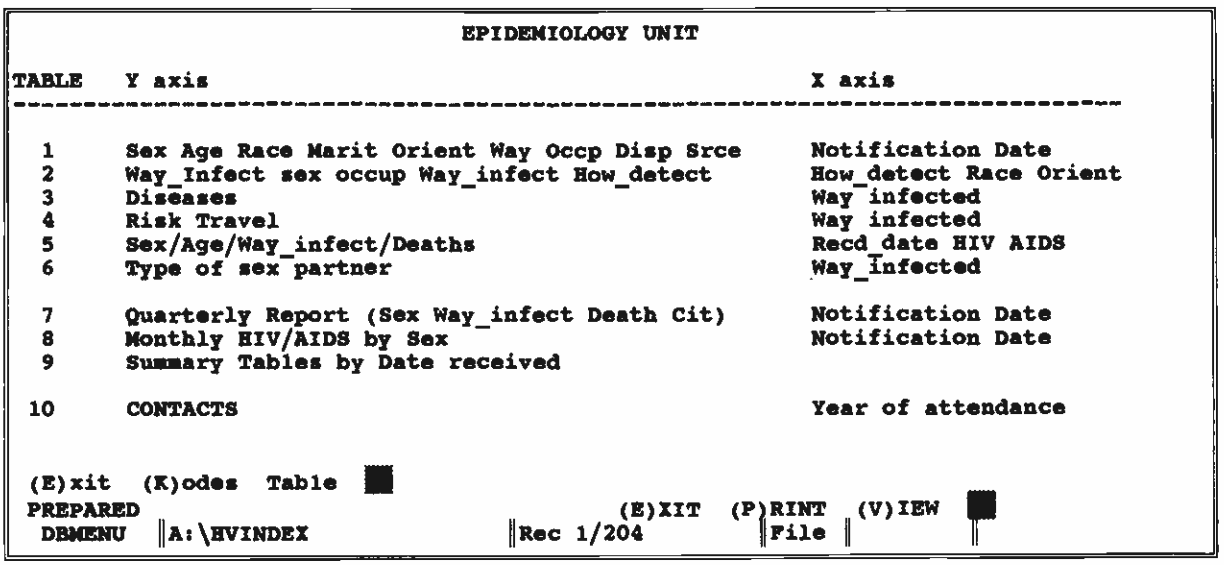
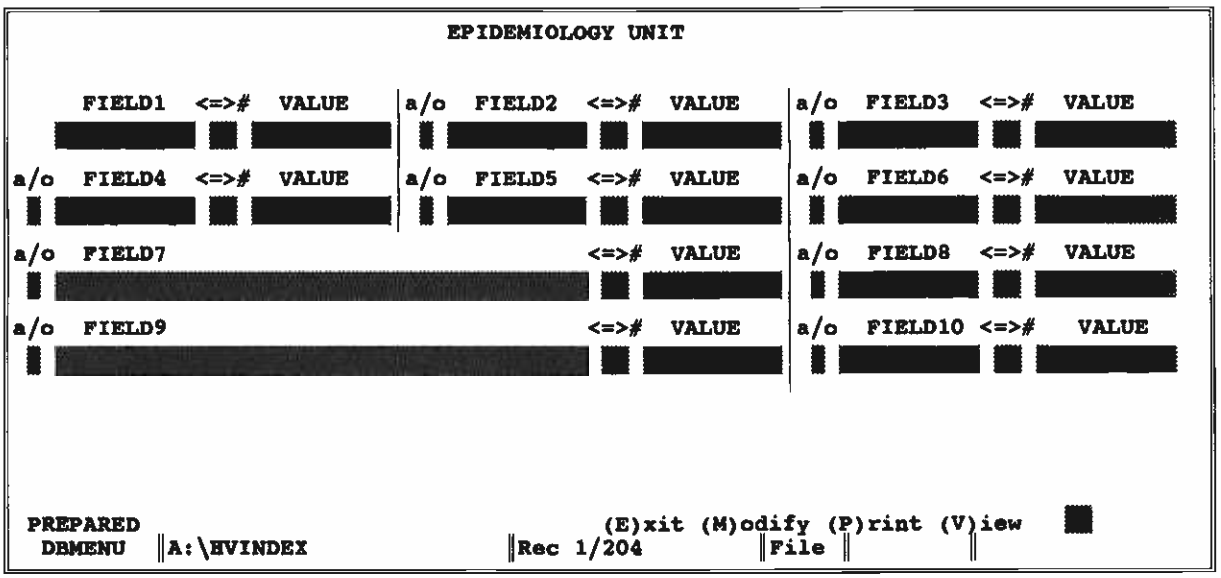


Fig 5 – Customised user-defined query selection screen



transmission patterns of infection. It has to be pertinent to prevention and control programmes and activities. Although the use of mathematical modelling for AIDS epidemiology has been widely reported, there are few practical computer programmes, such as "Epi Model"[10], which have been developed for use for short-term HIV and AIDS case-load projections. The accuracy of such projections is determined by the quality of AIDS surveillance data. Also, there has been virtually no information in the literature on the use of comprehensive computer-based programmes, including analytical capabilities, for the routine surveillance of HIV infection and AIDS.

In order to better monitor the changing trend of HIV infection in Singapore, a microcomputer-based surveillance system was developed to track notifications and to enable timely analysis and dissemination of information. The system enabled all HIV infections to be tracked from the time a case was notified to the point of death of that case. It monitored the individual characteristics of patients, the modes of HIV transmission and the progression from HIV infection to AIDS and death. These permitted rapid analysis of data to evaluate any change of trends over time. To overcome concerns of confidentiality associated with the disease, security features were incorporated into the system to ensure that only authorised personnel were allowed access.

The HIV registry surveillance system was designed to be flexible, and modifications could be made to both database and analytical programmes to suit national needs. This was made more convenient by designing the output of lists in modular form so that changes could be easily made if necessary. The programme files for tables and graphs written in Epi Info for analysis could also be altered to reflect the type of analysis desired. The system was also linked to another database system for tuberculosis to enhance surveillance of both HIV infection and tuberculosis.

As the HIV epidemic continues and the number of infections and AIDS cases are expected to increase, the authors believe that this system would enhance surveillance and provide timely information for national AIDS control programmes. However, the effectiveness of this computer-based surveillance system is dependent on an established notification structure with notifications of sufficient completeness for both HIV infection and AIDS.

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