CASE STUDY

DEVELOPMENT AND IMPLEMENTATION OF AN HIV/AIDS TRIALS MANAGEMENT SYSTEM: A GEOGRAPHICAL INFORMATION SYSTEMS APPROACH

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Introduction. Researchers, practitioners and policymakers make decisions at all levels – from local to international. Accessible, integrated and up-to-date evidence is essential for successful and responsive decision-making. A current trials register of randomised and clinically controlled trials of HIV/AIDS interventions can provide invaluable information to decision-making processes. Using the newly emerging geographical information systems (GIS) technology, we have developed a tool which assists such decisions.

Objective. To demonstrate how the tool provides consistent, quantitative information in an accessible format, making it a key tool in evidence-based decision-making.
Methods. We identified all HIV/AIDS trials in relation to publications for the period 1980 - 2007, using both electronic and manual search methods. To facilitate searching the trials register, studies were coded by using a comprehensive but user-friendly coding sheet. We captured the geographical co-ordinates for each trial and used the ArcGIS 9 mapping software to design and develop a geodatabase of trials.

Results. The geodatabase delivered the complete requirements for a data-driven information system, featuring the following functions: (*i*) a clear display of the spatial distribution of HIV/AIDS trials around the world; (*ii*) identification of and access to information about any particular trial on a map; and (*iii*) a global resource of potential information on the safety and efficacy of prevention and treatment measures.

Conclusions. The building of a functioning HIV/AIDS trials management system can provide policymakers, researchers and practitioners with accessible, integrated and up-to-date evidence that is essential to successful and dynamic decision-making.

In 2005, the World Health Organization (WHO) launched the International Clinical Trials Registry Platform (ICTRP) project to set international norms and standards for clinical trial registration and reporting. Registering trials at inception in an international registry and making them publicly accessible offers many benefits, including: (*i*) guarding against the threat of suppressing negative findings and exaggerating positive ones;[1] (*ii*) preventing duplication of effort by improving transparency;[2,3] (*iii*) avoiding misleading conclusions being drawn from forms of care that are most likely to benefit patients;[4] and (*iv*) identifying research gaps that should be addressed in future trials. Registries of clinical trials also provide an important mechanism by which members of the public can learn of ongoing and completed trials and that may positively influence their participation in such trials as an opportunity to contribute to research.[5]

In support of a comprehensive approach to public registration and reporting of clinical trials, the International Committee of Medical Journal Editors (ICMJE) stipulated that all trials commencing enrolment after 1 July 2005 would be published in ICMJE member journals only if they had been registered with an appropriate repository.[5] A number of publicly accessible registries of clinical trials are currently available to meet various specific needs,[6] the two major ones being ClinicalTrials.gov, run by the USA's National Library of Medicine, and the metaRegister of Controlled Trials (mRCT), established by Current Controlled Trials.[7] ClinicalTrials.gov provides information

about registered trials including: a summary of the purpose of the study; eligibility criteria; trial location; study design; trial phase; disease or condition; and drug or therapy under study. Trials registered on the mRCT receive a unique number (the International Standard Randomized Controlled Trial Number (ISRCTN)), which helps to eliminate double registering and allows a trial to be tracked and identified throughout its life cycle.[8] In addition to the ISRCTN, mRCT lists the following information about each trial: title; sponsor; disease or condition under study; hypothesis and objectives; eligibility; current status; and contact information.[5]

In this paper, we present the methods employed by the Cochrane HIV/AIDS Review Group (CRG) in developing an HIV/AIDS trials management system (HTMS), coupling GIS technology and a relational database management system to locate HIV/AIDS randomised clinical trials (RCTs) and controlled clinical trials (CCTs) throughout the world.

A GIS is a system of computer software and hardware, data and personnel that makes it possible to enter, manipulate, analyse, and present spatially referenced information, i.e. information tied to a locus on the earth's surface.[9] Several authors have described the applications of GIS in the area of public health.[10-14] In the past decade, however, the scope of GIS and health policy and practice has risen to prominence, and researchers, practitioners and policymakers are recognising that the GIS tool can facilitate efficient and effective decision-making. This paper presents the features of the HTMS and demonstrates, with an example of the application, how the system can support decisionmakers.

METHODS

IDENTIFICATION OF TRIALS

The HTMS consists of two components: the first involves the identification of HIV/AIDS trials from electronic bibliographic database sources which include PubMed/MEDLINE, EMBASE, and AIDSearch, as well as from 'hand searching' non-indexed journals and conference proceedings. The included studies are all RCTs and CCTs evaluating the efficacy or effectiveness of preventing or treating HIV/AIDS and related conditions. Trials which assess interventions that may have an effect on HIV transmission (e.g. condom use) are included, but those trials assessing interventions specific to other sexually transmitted infections are excluded, as are trials which only assess safety (so-called phase I trials).

All identified trials are imported into a study-based register in MeerKat, an in-house bibliographic management software package built in Microsoft Access and developed by the international organisation, the Cochrane Collaboration (CC).[15] Owing to the relational nature of the database, different fields can be related to each other, allowing references, studies, reviews and authors to be interlinked. To facilitate searching in the trials register, the studies are coded, using a comprehensive and user-friendly coding sheet. Table I lists the required data elements for the coding sheet.

The study name is a unique text assigned to each trial, and is usually the last name of the first author followed by the publication year, e.g. Brown 2006. For any subsequent publications by the same author in the same year, the trial is assigned the study name Brown1 2006, Brown2 2006, etc. The status of the study gives an indication of whether the trial is closed, ongoing, planned or was stopped early. Study design types include RCT, CCT or systematic review (a study type which compiles and pools the data of RCT results of a particular intervention). The register status reveals whether a particular trial is pending, accepted or rejected. Other data elements such as intervention, outcomes and the ISRCTN are also captured. Free fields are available to capture additional information when specific elements of trials are being studied, such as aspects of the methodological quality.

TABLE I. DATA ELEMENTS FOR THE CODING SHEET

Study			
Study name			
Status of study			
Closed	Open/Ongoing	Planned	Stopped early
Design			
RCT	CCT	Systematic review	
Register status			
Pending	Accepted	Rejected	
Intervention			
Treatment	Prevention		
Outcomes			
Morbidity	Mortality/Survival	Transmission (MTCT)	
Geographical co-ordinates			
Latitude	Longitude		
ISRCTN			

To facilitate the mapping process, we capture the location of the trial in terms of latitude and longitude. For multi-centre trials, the geographical co-ordinates of each centre are recorded. The coding sheet mirrors the user-friendly input screens of the register (Fig. 1). Fields contain drop-down lists from which items have to be selected, to avoid typing errors.

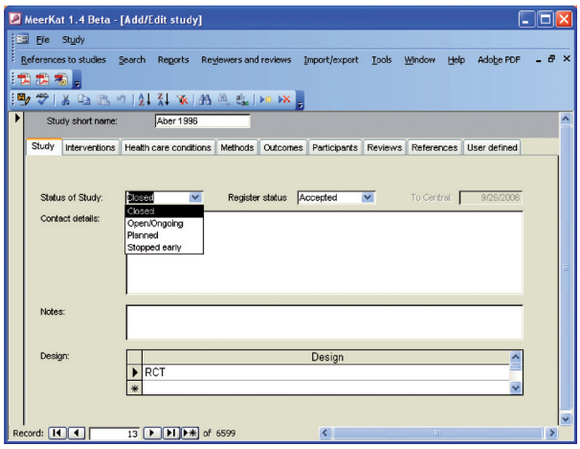

Fig. 1. Input screen of the register.

INTEGRATION OF THE REGISTER INTO GIS

The second component involves implementing the GIS platform of the HTMS. Using the Environmental Systems Research Institute family of software known as ArcGIS 9, we created a new geodatabase in ArcCatalog, which involved integrating the trials register in MeerKat (Microsoft Access) with a series of GIS map layers. The datasets included continents and countries' boundaries. The longitude and latitude of each study identifies the X and Y spatial co-ordinates in geographical space. This allowed us to map the geographical location of each study.

RESULTS

To date, the database contains 7 382 records relating to publications in the years 1980 - 2007, and is being updated quarterly, continually coded and regularly quality-controlled by random checks of the data. The architecture of the HTMS is shown in Fig. 2.[16]

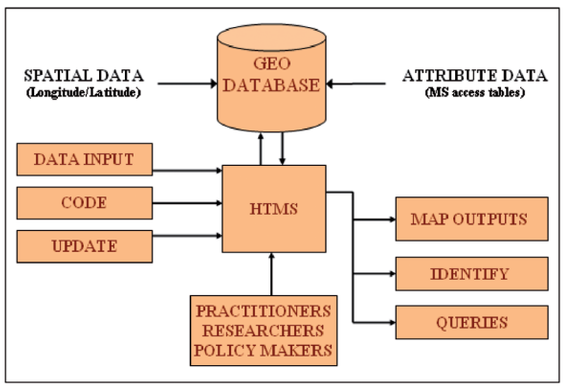

Fig. 2. Architecture of the HTMS.

SPATIAL DISTRIBUTION OF TRIALS

The spatial distribution of HIV/AIDS trials across the world is clearly displayed. For example, spatially distributing a convenience sample of 53 trials from the year 2003 showed that 50 of these were RCTs and 3 were CCTs (Fig. 3). Further analysis carried out by compiling a report (Fig. 4) or chart (Fig. 5) indicated the number of trials conducted on each continent.

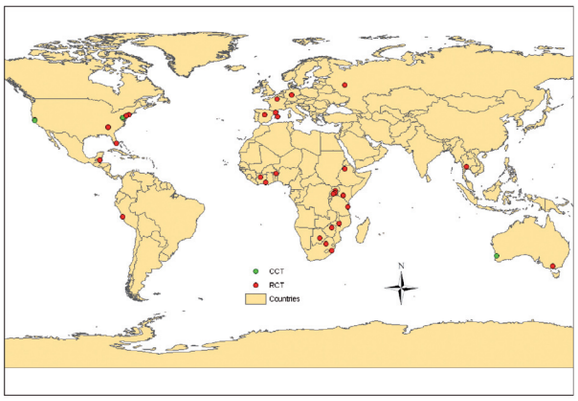

Fig. 3. Spatial distribution of 50 RCTs and 3 CCTs from the year 2003.

CONTINENT	NoOfTrial
Asia	1
North America	22
Europe	6
Africa	20
South America	2
Oceania	0
Australia	2
Antarctica	0

Fig. 4. Report output.

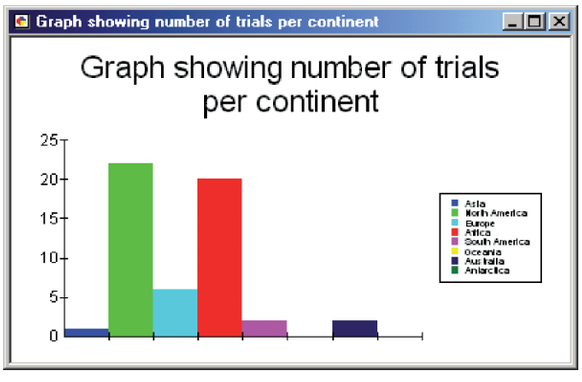

Fig. 5. Graph output.

IDENTIFICATION OF TRIALS

The system provides a foundation and suite of tools for monitoring and tracking ongoing, completed and published trials and their characteristics. When the user clicks on a particular trial, the resulting window displays all attributes of the trial, as shown in Fig. 6.

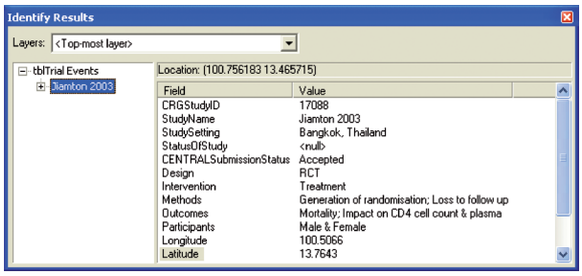

Fig. 6. Table of attributes.

QUERYING THE HTMS

The **Find** button facilitates searching the HTMS. Because the trials are coded in different ways, as shown in Table I, locating treatment trials can be done by typing 'treatment' in the **Find** search box, selecting 'tbltrials' from the **In** drop-down menu list, selecting 'intervention' from the **In fields** drop-down menu list, and finally clicking on Find. The **Find** dialogue box will then list all intervention trials, as shown in Fig. 7, and, on double-clicking, that selected will be highlighted on the active map.

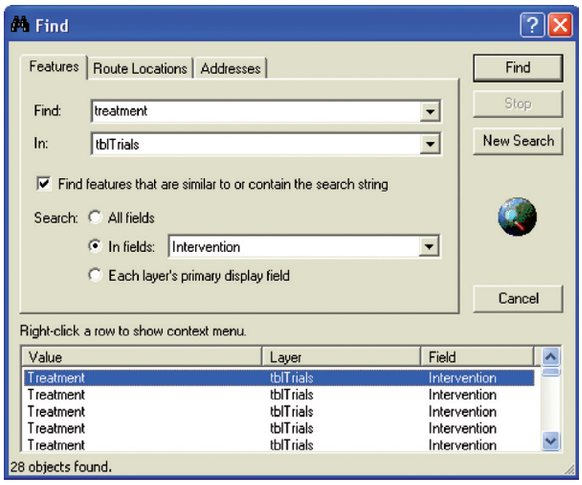

Fig. 7. Querying the HTMS.

DISCUSSION AND CONCLUSION

The need for comprehensive, up-to-date and easily accessible trials registers has been recognised for years. In the last two years, we have designed and implemented a system which offers an infrastructure of support to researchers, practitioners and policymakers, with up-to- date and reliable trials that satisfies the right of all children and adults to have access to all the available evidence regarding HIV/AIDS trials. The geodatabase developed in this work is a comprehensive source of clinical information obtained by searching electronic bibliographic sources as well as hand searching non-indexed journals and conference proceedings. The compilation of the HTMS serves the purpose of continual identification and data warehousing of HIV/AIDS trials across the world.

In addition, the HTMS is a landmark initiative in tracking and monitoring HIV/AIDS RCTs and CCTs in global health research endeavours. Instead of depending solely on information in text format, the visual synthesis of information into a picture and the overlay of quantitative graphics allow users of the system to realise the spatial distribution of the trials across the world in a clear manner. The system presented here can be used for trials characterisation and also serve as a valuable source of information for researchers as they initiate and design their studies. Another strength of the system is its ability to act as a research tool for analysing trends in the conduct of trials around the globe. For example, since sub-Saharan Africa carries the heaviest burden of the HIV/AIDS pandemic, researchers can follow in a timely and detailed way the location of trials conducted in this region, which can provide both an historical tracking system as well as identifying gaps where HIV/AIDS prevalence is high but clinical intervention research is lacking.

As much as the HTMS has several success factors, it also has its share of limitations. The HTMS is only as good as the data it contains; it is currently being updated and maintained by a single person, with support from a number of trial coders. Populating the HTMS is a labour-intensive process and entails a conscientious effort which includes downloading records from electronic bibliographic sources, followed by the necessary formatting, configuration and de-duplication of records prior to importing them into the register. The challenge is to continually monitor and improve the quality of the records and ensure that they are coded in the correct coding categories as shown in Table I. The currency of the information in the trials bank is of great importance, and the accuracy and completeness of the data are critical so that the maps communicate effectively and inform the broad range of users who may view them without misinformation.

The register put together by ClinicalTrials.gov (http://www.clinicaltrials.gov/ct/action/GetStudy) also offers a geographical perspective of clinical trials and allows website visitors to click on a region to display studies with locations in that region. However, ClinicalTrials.gov lists trials that are currently under way, meaning that the register is a prospective one whilst the HTMS is retrospective and contains all HIV/AIDS RCTs and CCTs since 1980, including the human T-lymphotropic virus type III (HTLV III) trials, as HIV was commonly referred to before 1985. The African Clinical Trials Portal (http://www.africaclinicaltrials.org/) is yet another comprehensive online resource for easily accessible information on malaria, HIV/AIDS and TB clinical trials in Africa. The portal is a one-stop resource that allows users to access clinical trial information using a database of pre-licensure clinical trials of malaria, HIV/AIDS and TB drugs, vaccines and microbicides that are currently under way in Africa.

Similarly to ClinicalTrials.gov, the African Clinical Trials Portal is a prospective register where data manipulation

at the user end is restricted. To our knowledge, the HTMS is the first retrospective compilation of HIV/AIDS trials around the world. As the information technology revolution (including online systems), the World Wide Web, and other electronic information systems continue to expand both the volume and accessibility of information,[17] the next component of this project will involve translating the desktop HTMS into a web-based HTMS to publicly make available all the clinical trials information. Within the web-based system, multiple users from different locations will only require their existing web browser to view geographical data and access the trials-related data, without the requirements or costs of installing GIS software packages.

With the implementation of the international HTMS, the need to communicate HIV/AIDS trials-related data to researchers, practitioners and policymakers has begun to be achieved as it proves to be an effective information-gathering and management tool. Our plans to make the data available online will increase the accessibility of the information. Ultimately, we hope that policymakers and researchers will find the HTMS a transparent means of capturing trial information so that all trial results are available to all parties involved – including consumers and their carers. In the future, the use of GIS technology could be regarded as a means of facilitating access to evidence-based health care data and contributing to policy development.

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