A global approach to the management of EMR (Electronic Medical Records) of patients with HIV/AIDS in Sub-Saharan Africa: the experience of DREAM Software

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Abstract

Background

Operating within the framework of national health systems of several sub-Saharan African countries, the DREAM Project aims to introduce the essential components of an integrated strategy for the prevention and treatment of HIV/AIDS. The project is intended to serve as a model for wide-ranging scale-up in the response of the epidemic. The objective of this study is to describe the work carried out by the DREAM Project towards the realisation of a software programme for the management of data pertaining to people with HIV and AIDS.

Method

Starting out from previous experiences in the management of electronic medical records (EMR), the aim is to propose an innovative solution, a global approach which gathers the diverse activities connected to the DREAM Project – from treatment to research – into one system. The decision to design special software, through a participative, user-centred approach, has led to the creation of a tool which is strongly geared towards the needs of the end users. At the same time, it contains all the potential of a modern tool of epidemiological analysis.
Results

DREAM Software, together with the computerised support system of DREAM in its entirety, has played a significant role in the expansion of the project, responding to one of its fundamental needs: its scalability. The possibility of guaranteeing levels of excellence in treatment and the opportunity of having biomedical data both for the refining of therapies as well as for research, have made the project one of the most significant experiences in the treatment of HIV and AIDS in Africa.

Conclusion

Sub-Saharan Africa is the region hardest hit by HIV and AIDS in the world. However, the resources and responses adopted so far to confront the epidemic have at times been rather minimalist. The DREAM project has faced the battle against the epidemic by equipping itself with qualitative standards comparable to Western ones. The experience of DREAM Software has revealed that it is indeed possible to guarantee levels of excellence in developing countries also in the sphere of ICT (information and communication technology), thus making intervention even more effective and contributing to bridging the digital divide.
Background

Drug Resources Enhancement against AIDS and Malnutrition (DREAM) was created by the Community of Sant’Egidio to fight AIDS in sub-Saharan Africa. The project takes a holistic approach, combining Highly Active Anti-Retroviral Therapy (HAART) with the treatment of malnutrition, tuberculosis, malaria and sexually transmitted diseases. It also strongly emphasizes health education at all levels. DREAM aims to achieve its goals in line with the gold standard for HIV treatment and care.

DREAM was launched in Mozambique in March 2002, following two years of groundwork. However, the idea for the project was born in 1998 when the Sant’Egidio Community – a Christian movement founded in Rome in the late 1960s that has a strong base in Africa – decided to fight the devastating impact of HIV/AIDS.

What DREAM is about

Within the framework of national health systems, the DREAM Project aims to introduce the essential components of an integrated strategy for the prevention and treatment of HIV/AIDS. The project is intended to serve as a model for the wide-ranging scale-up of the response to the epidemic. Its main objective is
achieved through the establishment of services providing diagnosis and comprehensive treatment.

The prevention of HIV transmission in the general population and of mother-to-child transmission through Community Care and Home Care services (CCHC) and Mother and Child Prevention and Care (MCPC), respectively, are additional key components of the programme.

Since adherence to ARVs and treatment follow-up are essential for the effective use of HAART in large-scale public health settings, DREAM provides the treatment package free to all patients. This is a crucial element; for many patients, even the cost of transport may prevent them from adhering to treatment. By eliminating the cost of treatment, high adherence rates have been achieved [14,24].

**Typology of patients, modality of intervention (MCPC, CCHC)**

DREAM realized early on that it was not feasible to offer treatment indiscriminately to all people with HIV. In order to use limited resources most efficiently [27,29], the project gives preference to carefully selected groups of patients:

- **Pregnant women**, to prevent mother-to-child transmission and ensure the mothers’ survival.
• **Skilled workers**, especially in the health sector, such as doctors, nurses, laboratory technicians and other personnel. Today more than 170 employees in the health sector where are receiving treatment.

• **Employees of certain businesses**, because DREAM favours collaboration with business entities that offer antiretroviral treatment to their employees and their families in order to avoid the loss of skilled personnel. This decision aims to preserve the economic and productive fabric of the country. Collaboration generally consists of financial co-sponsoring of treatment of employees of respective companies. In some cases, doctors employed by the firms are trained in providing HIV treatment. This enables the doctors to manage free-of-charge clinics - in premises made available by the same companies - where antiretroviral treatment is provided. The doctors are further supported in this initiative by, for example, free access to laboratory testing.

However, patients who do not fulfil these criteria but live within the catchment area of the centres are eligible to access all services offered.
Basic concepts and programme expansion

DREAM has chosen to invest in intensive short-term personnel training, followed by more prolonged in-service training with the support of expert personnel at the workplace.

Subsequently, community intervention models have been developed, such as outpatient care, community and home-based care. These do not require extensive resources and can be set up quickly. As a backup, a small number of high technology centres capable of supporting large areas (e.g. molecular biology laboratories) have been set up too. A third step has been to invest heavily in the provision of access to treatment and clinical and laboratory monitoring for patients in remote locations. Centres within a 150km radius of cities have been equipped so that they can offer the same qualitative level of treatment and monitoring as those closer to the cities. Apart from the provision of equipment, the transport of blood samples and periodic supervision by DREAM staff are organized. The fourth step consists of the effective use of computer resources to guarantee both the best possible organization of work and even long-distance monitoring of various aspects of the programme. An efficient computer system also allows for additional support to clinical and diagnostic operations through the use of internet technologies. This may include second opinions from specialized European centres, tele-medicine, tele-diagnostics and long-distance training. The elements of this comprehensive
model may be duplicated to treat conditions other than AIDS, such as tuberculosis. Hence, the model may potentially serve as a blueprint for the development of a broader response by health systems to HIV in resource-limited settings.

The scalability of the programme has allowed for its rapid expansion: the programme has now spread to 10 countries of Sub-Saharan Africa, with 21 centres and 12 molecular biology laboratories that are already operational (Figure 1).

**Methods. DREAM Software: an overview**

**Basic concepts**

DREAM Software was born of the need to computerise the management of the clinical files of DREAM patients. This need envelops two main objectives:

i. Optimising access of the patients to the clinic so as to guarantee the highest possible number of daily visits;

ii. Having at one’s disposal a database with information about the clinical history of individual patients and about the overall running of the DREAM centre, which comes in useful to refine therapies and for the sound running of the centres.
The first objective of DREAM, and consequently for DREAMS (DREAM Software), is to guarantee a standard of quality comparable with that of developed countries.

DREAM Software was developed in *MICROSOFT VISUAL BASIC FOR APPLICATIONS*.

It has been recognised [8,10] that developing computer projects for application in the health services sphere is a very complex activity, which must necessarily take into account the perspective of the end user, who is involved in the iterative process for the development of software tools [37,43]. DREAM Software was created and developed to respond to the needs which emerged in the field and has been elaborated with experience. Hence the end users were extensively involved, and they gave a fundamental contribution to the creation of the tool which they themselves would be using.

Moreover, the expansion of DREAM to several countries (with different languages) introduced a further level of complexity, that of sharing data [38, 42]. In this sense, DREAM Software was also born of the need to introduce uniformity in the gathering of data by different centres in different countries, for the monitoring of centres and for the refining of therapies. Often, in fact, integrating data coming from heterogeneous sources is a problem which may require a somewhat complex solution [8, 34]. The need to collect and share data for subsequent analysis required a solution to the communication problems...
often encountered in African countries. Below, the typical architecture of
DREAM centres will be illustrated and subsequently the solutions adopted to
solve the problems of communication and information-sharing will be
presented.

**Architecture of centres**

The DREAM database and Software are found on a computer server in every
DREAM centre. For security reasons, access to the database can take place only
indirectly through the DREAM Software: users (the coordinator, doctors, nurses
and operators) do not have the privileges to accede directly to the database.
This precaution serves to prevent a malicious (or inexpert) user from damaging
the database or from deliberately spreading sensitive information. Moreover,
the sharing of the same software on the server simplifies the configuration of
the computers used. The architecture of a DREAM centre is illustrated in Figure
2.

As may be seen, each and every service within the DREAM centres (the
examination room, the pharmacy and so on), has a computer, which is linked to
the server and to the rest of the computers through a LAN, giving individual
operators the possibility of following the patient for his/her entire course of
treatment in the centre, with the most updated data always at hand, without
having to refer to files on paper.
Communication between the various centres is guaranteed by an Internet connection, and through satellite in those places where it has proved impossible to get connected through an already existing cable network. Communication has turned out to be of considerable importance for two fundamental reasons, namely the centralised compilation of data and communication/consultation with specialised personnel. Through Internet communication (instant messaging or VoIP), each operator can communicate with the personnel of other African or European centres. This has allowed for extensive use (furthermore, without any additional cost save that of the Internet connection) of tele-consultation, which is very useful when the doctor feels the need to interact with colleagues about more complex clinical cases.

**Difficulties in the setting and proposed solutions**

When situated in a complex environment like the African reality, such a structure is naturally subject to different kinds of problems: power surges, disruption in network connections, both LAN and Internet and low bandwidth. Years of experience in this field have led to the identification of simple solutions to these problems. Clearly, a distinction needs to be drawn between the big centres, found in large cities where the problem is usually just of an economic/financial nature, and rural centres where the challenges are of a technical nature. The most pressing problem was undoubtedly that of power
current; we can list three types of solutions of increasing complexity: i) using a UPS, ii) using a system of (rechargeable) batteries and of inverters, iii) using solar panels and batteries. The first method is obviously effective only in those cases where the power supply is present but erratic, and the dimensions of the UPS may be measured on the basis of the estimated quality of the connection. The second system is used in centres which are open only on some days, and it is possible to recharge the batteries in backup/support centres. The last is the latest method and allows for the continual use of our centres.

The problem of LAN quality is fundamentally linked to the quality of the planning and implementation of the installation process. By consulting engineers, it has been possible to equip local technicians with the necessary know-how to create installations of quality comparable to western structures.

As for Internet connection, especially regarding bandwidths that are not always adequate, the matter is tackled in different ways. Careful enquiries made to local Internet service providers (ISP) have allowed many centres to have good quality Internet access at an accessible price. In cases where this was not an option, the problem has been resolved by using satellite connections, usually installed in our laboratories. For all the rural centres that are not connected to the Internet, it has been possible to transfer requests for tests via flash disk from the centre to the laboratory. The same applies to the transfer of backup of the centres. Once the backup reaches the laboratory, the software allows for the
sending of all the backup of the satellite centres to a centralised server.

Another important point: the size of files sent is reduced, to make them as robust as possible, so as not to be vulnerable to possible loss of data. To realise this, an incremental backup system with especially strong redundancy was designed.

Testifying to the quality of the networks (electrical as well as computer) of DREAM centres, VoIP communication systems have been introduced (at times supplied by the operators), which have allowed for the reduction in intercontinental tele-consultation costs.

**Installation of software**

The installation system designed for the DREAM centres was intended to be as simple as possible. A standard installation requires two CDs (or one DVD, or a flash pen) which contain all the software in zipped files (including SQL Server, Office and other support software) and a code (which may be generated by using a programme found in the CD) containing all the information about the way the required installations function. Installation via CD takes places exclusively on the server; once the server is configured, clients are installed by gaining access to a file shared by the server itself. In this way, the software may be installed in a DREAM centre (or a new client added) even without the presence of a computer technician.
Assigning an ID to the patient

The first issue encountered in the management of clinical files is the identification of the patient. In countries where DREAM is at work, patients often do not have a medical card with one identification number that is used across the national health system. Hence, an ad hoc ID was created, differentiated by treatment centre, which identifies the patient in the database; a card with this number is given to the patient who shows it each time he/she comes to the DREAM centre.

Provision has been made for the use of, should such exist, an ID previously assigned by a treatment centre of the national health system. This ID is added to the identification which is anyhow assigned to the patient when he/she starts treatment in a DREAM centre.

Each DREAM centre has a clear identification code composed of two letters. A patient ID is made up of these two letters plus a number composed of six figures.

The system of assigning IDs is therefore homogenous, making it possible to determine, in a simple manner, the treatment centre of a given patient from his/her ID. The uniformity of data in different treatment centres has allowed for the merging of the various databases in order to conduct
statistical/epidemiological analyses about patients in the different countries hosting DREAM.

The DB

A large part of the work on DREAM Software has been dedicated to the design of a relational database for the management of data contained in clinical files. The database consists of 42 tables, which contain data relative to the topics presented in Table I. This is an important resource both for the management of the clinical data of patients, as well as for the possibility it gives to analyse information found therein, from clinical and organisational perspectives.

As has already been acknowledged [1, 6, 40], creating a dictionary of terms used is of crucial importance for the management of the database. In particular, there was a felt need for encoding with regard to the more important information – pathologies and drugs although not exclusively – as this has the capacity of making such information usable in an epidemiological context while maintaining a friendly approach towards clinical users. ICD X and ATC codifications in particular were used. The transcoding dictionaries compile 2,700 items for pathologies in the following languages: English, French, Portuguese and Italian. This feature is all the more useful in the case of DREAM, where the presence of many centres spread across different countries makes the homogenisation of terminology necessary. In the DREAM Software,
pre-codified data is consequently used for the specification of symptoms, of
diagnosis and of drugs, to avoid the possibility of inserting free text which
would lead to non-homogeneity of data.
The registration of test results coming from laboratories (which have specific
software for the administration of tests) has been automised too, to prevent
mistakes in copying values [44]. In fact, it has been noted that the quality of
data (accuracy and completeness) is fundamental, among other things, to
enable the integration of a support tool with decisions in the system [31]. We
thus undertook to use an established terminology, in order to create structured
records that could be used towards this end. On the other hand, the input of the
patients in supplying information about themselves has been recognised as
very useful in several cases [32]. Consequently, the Software provides the
option to add notes in fields for free text, apart from the codified data to be
filled for each patient, so that news (possibly supplied by the patients
themselves), which cannot be committed to memory in any other way, may be
recorded there.
It has been noted [10] that the preservation of data relating to electronic health
records (EHRs) is a critical issue, even if at times operators may adopt an
attitude of mistrust with regard to computerized systems for patient
management [35]. The security of data is consequently a fundamental aspect of
the programme, bearing in mind that frequently data pertaining to DREAM
patients on treatment is the only clinical data which exists about them. Hence, the database is equipped with a sophisticated system of backup and recovery which guarantees the reliability of the system and the persistence of data. This matter is tackled by using two parallel systems. First, an automatic procedure is created, which generates two backups of the database. The first backup is incremental and is used for the centralized database, which we will come to presently. The second is a full backup and serves to restore the database in case of failure. Usually, this backup is not in the same machine hosting the DB server; it is copied on another machine. Another security system provides for the periodic backup of the entire folder (together with the settings) of the SQL Server and of the DREAM software. In this way, should the restoration of data prove insufficient to resolve the malfunction, it will be possible to replicate the server (SQL+software) on another machine. Further, since the system handles sensitive, private information about the patients on treatment, we have sought to make the data secure on various levels, preventing its malicious diffusion or loss due to technical malfunctions. Despite the fact that in many African countries, specific norms governing privacy do not exist, the data is handled according to Western standards. In particular, any transfer of data from one centre to another, from laboratories to centres to transmit test results, or from the centre databases to the central database, is carried out in such a way so as not to reveal any personal data
(pertaining to births, marriages and deaths, or other social details) of the patients, which is stored exclusively in the database of the reference centres. Further, the data is encrypted using symmetrical keys.

In the initial phase of the project, the database was developed with Microsoft Access. Subsequently, to improve the services and to enhance the security of data, the database was re-designed and developed with Microsoft SQL Server 2000.

A centralised DB for epidemiological investigations

As already mentioned, a fundamental aspect of DREAM Software is that it links tools for epidemiological investigation to the automatic management of the clinical files of patients. Having a database with the clinical data of patients on treatment provides the opportunity to use such data to conduct large-scale epidemiological investigations. This has necessitated the creation of a centralized database, in which to merge the data of the various databases of the DREAM centres. For the scope of keeping this database updated, an incremental backup procedure has been put in place, which periodically (according to the settings) sends new data to the central database. A copy of this centralised database is then used for the analysis of data, through the use of specific tools.
Software – the main features

In this section, some of the main characteristics of the DREAM Software are illustrated and the operational impact of the programme in the centres is highlighted.

The architecture of the DREAM Software is the client/server type. It was decided not to develop a web-based software (as per the recent trend) since this would have entailed increased investment for the server, both in terms of the cost of the hardware as well as difficulties in managing it. Further, there would have been no consistent savings in acquiring “thin” client computers (terminals), as it is difficult to repair them in the countries where DREAM works.

Figure 3 illustrates the window of access to the programme, from where it is also possible to choose which database to use, if there is more than one.

In Figure 4, the main screen of the programme is illustrated.

Access to the programme (and through it, to the database), is task-based. Each user profile accedes to the functionalities of the programme pertaining to him/her, and to those alone.

The system is however flexible, in the sense that the administrator of the system may assign added functionalities to the basic profile (for example, of a nurse). The user management module is illustrated in Figure 5.
The differentiated access to the software translates into differentiated access to data. This functionality is very important because it forestalls damage to the integrity of the data, or the loss of the same data due to incorrect use of the programme.

From the perspective of policies of access, there is no hierarchy among the user profiles; rather each profile is assigned with basic functionalities which may however be extended by the administrator.

Making specific queries for each task is fundamental for the efficient use of the database. These queries allow for the reading of data from the particular perspective of the user profile accessing the programme.

The identification of the user also allows for the tracking of operations on the database, and especially errors and warnings. This last aspect is very important because it allows for the verification, even long-distance, of the quality of work undertaken, through the consultation of the log tables [39, 41].

The Interface

DREAM Software is equipped with a graphical user interface, which allows for interaction with its modules on a simple and immediate basis. This is an important feature for which the involvement of end users in the development process proved to be of great importance.
The navigation bar, illustrated in Figure 6, is always present in the various windows of the programme.

This bar allows the user to speed up certain frequent operations.

By clicking on the icon featuring a house, one may easily return to the main menu. The icon symbolising a question mark activates online assistance; the symbol depicting two people (next to which there is the name of the user who gained access) allows for the change of user and re-launches the access window. The bar also visualises certain information: the database to which we are connected, the date of the latest access to the programme and the language used by the programme.

By clicking on the button, we can change the language of the programme. It is always possible to change the language used without restarting the programme, and to do so in an entirely user-friendly way. This functionality is very important because DREAM is present in many countries where different languages are used. Further, it could be that people speaking different languages work in the same centre, due to the presence of foreign voluntary personnel. Therefore it is of crucial importance that the language used may be changed without having to restart, or worse to reinstall the programme.

One may accede to diverse modules of the programme through tabs, used to organize the various components on the screen in a rational manner. By clicking on the tab, the relative file appears in the forefront.
DREAM Software uses tabs to permit the swift visualisation of a large quantity of information on the screen at the same time. For example, thanks to the tabs, the section of the programme pertaining to the selected patient’s clinical file allows for easy consultation of all relative data, from the file of vital statistics to the tests, examinations, appointments and other information (see Figure 7).

Organisation of the centre with DREAMS

Rationalisation of the patient flow

The use of such sophisticated software for the management of patients has led to improved rationalisation of the access of patients to the centre. The flow of patients in the DREAM centre is organised in a schematic manner, as described in Figure 8.

As mentioned above, each room is equipped with a computer configured for the use of the DREAM Software. The patient first goes through registration. If the person in question is already a patient, the staff member doing the registration opens his/her file and directs him/her to the next room (for example, EXAMINATION if the patient must see the doctor, or else PHARMACY, if the patient just needs to pick up some medicines).

Each staff member, in his or her room, may access the records pertaining to the patient, with his/her clinical history and prescriptions of drugs and tests. All
query operations of the clinical files, and of the modification or insertion of data, are made directly with the software, thus avoiding time wasting by filling in paper forms to then insert the data later on.

The software has grown in parallel with the development of the project. Consequently, the various modules found were created as the needs/demands of the centres emerged. As the number of patients grew and the complexity of treatment increased, it became clear that rationalisation of the patient flux was a crucial point. The software has enabled the increased effectiveness of the subdivision of tasks of the staff of the centres, leading to a clear picture of the patient journey from the moment he/she enters the centre up until the completion of all appointments. In this way, the patient journey has been streamlined over time, and the software has gone along with these changes.

Planning the work: the coordinator

An important role in the management of the centre is undertaken by the profile of the coordinator who, thanks to the APPOINTMENTS module, is able to rationalise the workload of the centre. Figure 9 shows the APPOINTMENTS file.

Through this module, it is possible to query the database, getting information about appointments scheduled for a determined period of time (for example, a
day or a week), with the possibility of distinguishing appointments by type (examination, delivery of drugs, food integration and so on).

Through simple operations, the coordinator of the centre may therefore discover the number of appointments over a certain period of time, and may organise the work of the centre in an efficient manner. Moreover, he/she may give directions to appointed workers about how to assign appointments to patients, to avoid a lack of homogeneity in the distribution of appointments, which could create bottlenecks.

Further, the module of the coordinator is equipped with a series of reminders about possible critical situations of patients (like the imminence of delivery of a woman in MCPC). These tools, the importance of which has been recognised, allow for more careful monitoring of the overall situation of patients in our care.

**The pharmacy**

Thanks to DREAM Software, the prescription and delivery of drugs is completely automatic. The doctor may prescribe a drug to a patient through the apposite module and his/her prescription may be accessed by the pharmacist, who will then see to the consignment of the drugs.

The computerisation of the prescription and delivery of drugs has permitted the rationalisation of an important resource in the management of DREAM, namely
medicines, keeping waste at a minimum and contributing to the success of therapy. Moreover, it has been demonstrated that careful management of the pharmacy may help to evaluate adherence to therapies [3,4].

For instance, the system for the management of drugs provides for checks on the returns, that is, the medicines which patients received as their treatment and which remain unused at the end of the treatment period. This monitoring has enabled the continuous observation of adherence to therapy, giving workers the possibility to intervene, where necessary, to correct possible problematic behaviour of patients in taking their medicines.

Further, giving treatment is made much simpler by the presence of icons representing the different times of the day (morning, afternoon, evening, night). In this way, even patients who are unable to read may take their medicines correctly (Figure 10).

In addition, the system computerises the calculations of the quantity of drugs to be taken, according to the drug chosen and the length of the period of treatment, reducing to the minimum the possibility of errors in the prescription and delivery of drugs.
Results and discussion

In this section, we present some results obtained through DREAM Software, related to its use in the centres of the DREAM programme.

In the years between 2002 and 2006, the DREAM programme grew considerably, in terms of both centres and patients on treatment [Figure 11]. This expansion put the DREAM Software to the test and it has proved to be a reliable tool even when it comes to handling a large quantity of data.

The experience of DREAM Software is directly linked to the history of the DREAM programme. It was born of the needs met in the field, from the awareness that the complexity of treatment of people with HIV and AIDS calls for a high standard of quality to achieve success. On the other hand, DREAM is not a programme scheduled to come to a close. The need for scalable solutions therefore emerges, not least from the point of view of technologies used. Thus, we have sought to identify all the possible IT solutions which could make the programme more efficient and effective, but which could at the same time be easily replicated and interoperable.

The expansion of DREAM in different countries has made the management of its software an important issue for a number of reasons, ranging from language to different ways of thinking about the same problems.
What’s more, the necessity of integrating and sharing data has brought to research continuous improvements in communications, to make the sharing of data and experiences faster and more economical.

Anyhow, we have sought to transform a need imposed by contingency (that of having efficient management of clinical files and useful tools for the communication and sharing of data) into an opportunity. The personnel of the DREAM project have gained experience in the use of ICT, and have had the opportunity to raise problems and questions, which have proved useful for the remodelling of the software, providing the scope for the redesigning of the interfaces and proposing new functionalities that are useful in their daily work.

Different metrics have been proposed in order to estimate the quality of an EMR system [33,36], notwithstanding the fact that it is complicated to separate the contribution of such a system from other factors. In the future, we anyhow propose to analyse aspects linked to the utility of software in a systematic manner.

Further, DREAM Software has proved to be a tool of crucial importance for epidemiological research. The fact that the treatment of people infected by HIV and AIDS is not yet widespread in Sub-Saharan Africa poses problems for the management of therapies (the response to drugs, social factors, and so on), since the sickness is different from that found in western countries, both due to the strain of the virus and to the socio-economic conditions involved. The
possibility of having such an extensive compilation of (standardised) data has therefore allowed for the refining of strategies and guidelines for therapies [15,17,19,20,22,23,25,28], in such a way as to guarantee a continued evolution of the management of care and treatment, making it ever more effective. On the other hand, the fact that it has become possible to monitor each activity of the centres through the software (from examinations to tests, from the delivery of drugs to nutritional integration), allows for the assiduous and precise assessment of the quality of services offered and the extent of resources employed. The management of drugs, for example, has constituted a critical aspect since the costs of medicines weigh heavily on the overall budget of the project.

Moreover, through the data collected, it is possible to give information to the national health services, which comes in useful for monitoring the epidemic. This is especially so when one bears in mind that DREAM is frequently a significant presence in the context of HIV/AIDS treatment, in those countries where it is at work. Tools in DREAM Software, which are capable of synthesising data collected, have allowed for the streamlining of procedures for the production of reports. This feature is not a negligible one, because in projects like DREAM, a huge amount of resources are often employed for bureaucratic types of activity, such as providing national Governments or donors with updated reports about the situation of patients receiving care, the
entity of resources used, or the general activities of the centres. Thus, streamlining these procedures translates into dedicating more resources (human and economic) to care and treatment, and concentrating on the success of the programme.

Conclusions

The work we have presented illustrates a very important and sensitive aspect of the DREAM programme: the computer management of the data of patients. The attention paid to the requests of the end users, the coverage of every aspect of care and treatment, the possibility of having homogenous data from different countries, are only some of the significant features which have made this computer system an indispensable tool for the management of treatment and for epidemiological research. All this has been achieved in places where minimal solutions, which are a far cry from Western standards, are often those proposed. In DREAM treatment centres, a computer with the DREAM Software is available for all staff members; each follows the patient as per his/her specific competence and tasks and while doing so, has all the updated data of the said patient at his/her disposal. Not only does this make procedures more efficient and the work of the centre more streamlined, it has also served to guarantee the
quality of data, with each staff member able to verify the said data from his/her own station.

Together with the centralised compilation of data for epidemiological analysis, this means that the joint efforts of the doctors, researchers and computer experts hasten the consideration of possible proposals regarding the upgrading or correction of the software or the procedures of use, thus gradually improving the quality of the system. [DV2]

In future, it would be interesting to embed a decision support system into the software, so as to be able to put to better use the great quantity of data available for each patient.

Finally, the experience of DREAM overall, and of DREAM Software in particular, has shown how the catastrophe of HIV and AIDS in Africa also holds an opportunity: that of equipping the continent, in response to this emergency, with the necessary and appropriate technologies to overcome old and new problems: the digital divide, the poor possibilities of communications, the sprawling distances and poor logistics. The repercussions of the implementation of such technologies actually go well beyond the specific context of the epidemic. There are strong possibilities for the development of formation too, since it would be possible, for example, to have long-distance formation with centres of excellence in Europe and elsewhere in the world. And this is a chief point of strategic priority [30].
List of abbreviations


Competing interests

The authors declare that they have no competing interests.

Authors’ contributions

AN conceived of and designed the study and drafted the manuscript; GMB made the interviews to gather the end users’ expectations about the software, contributed to implement the software, contributed to draft the manuscript; MB interpreted the data and revised the article; FDPM made the interviews to gather the end users’ expectations about the software and revised the article; PG interpreted the data, contributed to implement the software and revised the article; MP made the interviews to gather the end users’ expectations about the software, contributed to implement the software and contributed to draft the manuscript; GP interpreted the data and revised the article; LP conceived of and designed the study and revised the manuscript. All authors read and approved the final manuscript.
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27. Marazzi MC, Germano P, Liotta G, Buonuomo E, Guidotti G, Palombi L:


Figures

Figure 1. Expansion of DREAM centres

Figure 2. Architecture of a DREAM centre

Figure 3. Form to access programme

Figure 4. Main menu of the programme

Figure 5. User management module

Figure 6. Navigation bar

Figure 7. Navigation of Tabs

Figure 8. Patient flow in the DREAM centres

Figure 9. File for the management of appointments

Figure 10. Prescription and drugs delivery

Figure 11. Evolution of DREAM from 2002 to 2006
## Tables

Table I. Typology of data represented in the database

<table>
<thead>
<tr>
<th>Topic</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Statistics</td>
<td>Information relating to statistical and social data of patients</td>
</tr>
<tr>
<td>Examinations</td>
<td>Data about examinations of patients with relative clinical parameters</td>
</tr>
<tr>
<td>Tests</td>
<td>Data about tests</td>
</tr>
<tr>
<td>Symptoms and</td>
<td>Codification of symptoms and of diagnosis,</td>
</tr>
<tr>
<td>diagnosis</td>
<td>dictionary of data ICD X</td>
</tr>
<tr>
<td>Drugs</td>
<td>Codification of drugs, prescriptions and delivery of drugs, dictionary of data (ATC)</td>
</tr>
<tr>
<td>Home care</td>
<td>Data about home visits to patients who enjoy this service</td>
</tr>
<tr>
<td><strong>Software users</strong></td>
<td>Data managing access to the software</td>
</tr>
<tr>
<td>-------------------</td>
<td>--------------------------------------</td>
</tr>
<tr>
<td><strong>Log errors and warnings</strong></td>
<td>Codification of messages of log errors or warnings used in the software.</td>
</tr>
</tbody>
</table>
Figure 4

- Reception
- Patients
- Appointments
- Pregnancies
- Blood Samples
- Drugs supply
- Home Care
- Medicine management
- Evidence
- Configuration

Close Application
Figure 5
Figure 10

### TARV drugs prescription

<table>
<thead>
<tr>
<th></th>
<th>Pharmacology form</th>
<th>Form that can be delive</th>
<th>Days</th>
<th>Fr.</th>
<th>Qty</th>
<th>SO</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lamivudine150/Zidovudine 300/Nevirap tablets</td>
<td></td>
<td></td>
<td>217</td>
<td>7</td>
<td>434</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### non-TARV drugs prescription

<table>
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<th></th>
<th>Pharmacology form</th>
<th>Form that can be delive</th>
<th>Days</th>
<th>Fr.</th>
<th>Qty</th>
<th>SO</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sal Feroso</td>
<td></td>
<td></td>
<td>30</td>
<td>7</td>
<td>30</td>
<td></td>
<td></td>
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</tbody>
</table>

### Prescriptions

<table>
<thead>
<tr>
<th>Date</th>
<th>Medicines</th>
<th>Days</th>
<th>Until</th>
<th>ARV</th>
<th>Prescribed</th>
<th>Frequency</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>06/11/2007</td>
<td>Lamivudine150/Zidovudine 30C</td>
<td>217</td>
<td>10/08/2008</td>
<td>ARV</td>
<td>434</td>
<td></td>
<td></td>
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### Delivered medicines

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<th>Quantity</th>
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<th>Labels</th>
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<tr>
<td>Lamivudine150/Zidovudine 30C</td>
<td>434</td>
<td>06/11/2007</td>
<td>1</td>
</tr>
<tr>
<td>Sal Feroso</td>
<td>30</td>
<td>06/11/2007</td>
<td></td>
</tr>
<tr>
<td>Lamivudine150/Zidovudine 30C</td>
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<tr>
<td>Lamivudine150/Zidovudine 30C</td>
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<td>09/10/2007</td>
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</tr>
<tr>
<td>Lamivudine150/Zidovudine 30C</td>
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<td>18/09/2007</td>
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<tr>
<td>Lamivudine150/Zidovudine 30C</td>
<td>54</td>
<td>13/08/2007</td>
<td></td>
</tr>
<tr>
<td>Lamivudine150/Zidovudine 30C</td>
<td>28</td>
<td>30/07/2007</td>
<td></td>
</tr>
<tr>
<td>Lamivudine150/Zidovudine 30C</td>
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<td>28/06/2007</td>
<td></td>
</tr>
<tr>
<td>Pidocycline 30C</td>
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<td>12/06/2007</td>
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</table>

### Appointments

<table>
<thead>
<tr>
<th>Date</th>
<th>Appointment</th>
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</thead>
<tbody>
<tr>
<td>10/09/2008</td>
<td>EXAMINATION</td>
</tr>
<tr>
<td>09/05/2008</td>
<td>SAMPLE</td>
</tr>
<tr>
<td>04/02/2008</td>
<td>CHECK</td>
</tr>
<tr>
<td>24/12/2007</td>
<td>FOOD INTEGRATION</td>
</tr>
<tr>
<td>06/11/2007</td>
<td>MEDICINES</td>
</tr>
</tbody>
</table>