Better Access to Information about Clinical Trials
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Access to information about clinical trials is important to researchers, health care professionals, and patients. Many have argued for the establishment of clinical trials registries, citing their substantial benefits. Although some registries do exist, it has been difficult to create comprehensive, easily accessible systems. This paper briefly reviews existing registries, discusses the challenges in building registries, and reviews some of their benefits. The paper concludes with a description of a new, extensive Web-based registry called ClinicalTrials.gov (http://clinicaltrials.gov/), which was developed at the National Institutes of Health (NIH) by the National Library of Medicine as a result of recent legislation calling for a comprehensive, publicly accessible registry of clinical trials.

The first version of the system became available in late February 2000 and contains information about approximately 5000 trials. The first release contains primarily NIH-sponsored trials, and new trials are regularly added to the system. Subsequent versions will contain information about trials sponsored by other federal agencies and by the private sector. The system was developed in accordance with basic informatics principles, including adherence to standards, usability considerations, and iterative testing and evaluation.

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manuscripts describing clinical trials to include standard registration numbers from trial registries.

Several years ago, patient advocacy groups and others argued that information about clinical trials should be readily available to members of the public and that such availability should be required by law. Earlier legislation had resulted in the establishment of a database of information on AIDS clinical trials (15), and now the goal was to make information about clinical trials on a much broader range of diseases available through one easily accessible system. In late 1997, a section of the FDA Modernization Act required the creation of a database of information about clinical trials. Specifically, the law called for the following:

A registry of clinical trials (whether federally or privately funded) of experimental treatments for serious or life-threatening diseases and conditions . . . which provides a description of the purpose of each experimental drug, either with the consent of the protocol sponsor, or when a trial to test effectiveness begins. Information provided shall consist of eligibility criteria for participation in the clinical trials, a description of the location of trial sites, and a point of contact for those wanting to enroll in the trial, and shall be in a form that can be readily understood by members of the public (16).

In late 1998, the National Library of Medicine (NLM) at the National Institutes of Health (NIH) undertook the development of this system, and in February 2000 we announced the first version of a new World Wide Web-based system called ClinicalTrials.gov (http://clinicaltrials.gov/) (17, 18). The first version contains primarily NIH-supported trials, and subsequent versions will contain data from trials supported by other federal agencies and by the private sector.

Existing Clinical Trials Registries

Because of the legislation that resulted in the development of ClinicalTrials.gov, it has now become possible to design and develop a broad, comprehensive registry. Although this has been difficult to do in the past, several individual registries have been developed over the years. In 1989, Easterbrook (19) surveyed approximately 60 organizations in 13 countries. She found that a total of 24 registries existed, including two early registries (the international registry of thrombosis and haemostasis trials, the Oxford perinatal trial registry) and several other registries focused on AIDS or cancer. Persons interested in information on AIDS and cancer have had access to clinical trials information for some time through two government-supported systems, AIDS Clinical Trials Information Service (ACTIS) and CancerNet (20, 21). Tonks (22) reports that many individual registries currently exist and are supported by a variety of individuals and groups around the world. She notes, however, that “Recorded details vary dramatically among registers. There is no guarantee that a register is complete, accurate, or comprehensive . . . The existing network of registers is therefore valueless to anyone but a small group of cognoscenti, and only of limited value to them.”

Recently, a group of British publishers created the Current Controlled Trials Web site, which maintains links to approximately 50 on-line registries and contains a “metaRegister” of trials submitted by six groups in Canada and the United Kingdom (22, 23). The Cochrane Collaboration, which conducts meta-analyses and creates systematic reviews of the trials literature, also maintains a register of controlled clinical trials (24). In the past few years, some medical schools and hospitals have begun to establish Web sites that list the clinical trials being conducted at their institutions, and some commercial organizations now also provide listings of clinical trials.

Challenges in Developing Trials Registries

Clinical trials registries are expensive to develop and to maintain. They require resources from all who are involved, including the developer of the registry, the trial sponsors, the review and regulatory bodies, and the investigators themselves. The currency of the information in a prospective registry is of paramount importance, and the accuracy and completeness of the data are critical. It can be difficult to identify exactly where and how many trials are being conducted at any given time, and when data are collected from a wide range of sources, there will be concerns about duplication. Standards for collecting and disseminating the information are necessary if the data are to be widely shared and easily interpreted.

Confidentiality issues may also arise. Investigators or the companies that employ them may consider information about the trial they are conducting to be proprietary and may feel that participation in a trials registry will compromise the competitive value of the information.

There will also be technical challenges in the develop-
ment of a clinical trials registry. If the goal is to create a system that is accessible to a broad range of constituents, then appropriate technology must be chosen and implemented. Tonks (22) points out that although many individual trial registries exist, they are often built with stand-alone software and are inaccessible even to researchers. Since it is an ongoing challenge to keep the data in a clinical trials registry current, it is critical that methods be put in place to ensure that the registry will be kept up-to-date.

**Benefits of Clinical Trials Registries**

The International Collaborative Group on Clinical Trials Registries has pointed out that the goal of trials registries is to “facilitate access to information by interested investigators and patients. This objective arises from an ethical and scientific goal, i.e. to accelerate dissemination of trial data, making the results available sooner, and enabling patients to benefit earlier from what is learned” (25). Many researchers have pointed out that the existence of clinical trials registries would address and help solve the problems associated with publication bias (6, 7, 24, 26, 27). Such bias can arise for at least two reasons. Investigators are more likely to prepare reports for publication about clinical research studies with positive, statistically significant results than those with negative or inconclusive results (10, 28). This is sometimes referred to as the “file-drawer” phenomenon (29). Studies with negative results are presumed to be uninteresting and may therefore never be published. Dickersin and Manheimer note, “There is now strong evidence that published studies are a biased sample of all studies undertaken” (24). This bias potentially leads to an over-estimation of the efficacy of a particular intervention (6). Rennie (26) points out another, perhaps more deliberate reason for publication bias. The favorable results of some studies are published in various forms in multiple journals, thereby giving the impression that a particular intervention is more promising than the facts would warrant.

Comprehensive clinical trials registries would assist researchers who are conducting meta-analyses of trial results to create systematic reviews of the literature on treatments for a particular disease (30, 31). These reviews can bring the results of clinical trials to the bedside more quickly than would otherwise be the case because they usually synthesize and evaluate a large body of evidence (32, 33). Instead of depending solely on published reports, reviewers with access to a comprehensive registry would be able to collect information on all trials that have been done, regardless of whether the results were positive, negative, or inconclusive.

Comprehensive trials registries can also serve as valuable sources of information for researchers as they initiate and design their studies. Such registries might help them avoid unnecessary duplication of effort (which is distinct from appropriate replication). If a study has already been conducted and has conclusively shown positive or negative results, then it is wasteful and in some cases dangerous to repeat it. A comprehensive registry might also reveal areas of fruitful future investigation. For example, if few studies have been conducted in certain disease areas or for certain drugs or combinations of drugs, then investigators and funding organizations might consider these as important opportunities for research (22, 27).

Although it is not often mentioned, another substantial benefit of a publicly accessible clinical trials registry is that it may aid in the recruitment of eligible patients to clinical trials (19). Mansour (34) points out that fewer than 3% of patients with cancer participate in clinical trials. He and others give some possible reasons for this, including physician and patient reluctance to participate (34–38). As more information about ongoing and completed clinical trials is collected and critically evaluated, it should serve to educate both clinicians and patients about the risks and the benefits of clinical trials. **Table 1** summarizes some of the challenges and benefits involved in developing clinical trials registries.

**Table 1. Clinical Trials Registries**

<table>
<thead>
<tr>
<th>Challenges</th>
<th>Benefits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Require extensive resources to create and maintain</td>
<td>Serve as resources for patients, physicians, and researchers</td>
</tr>
<tr>
<td>Require agreement on standard data elements</td>
<td>Help patients find trials for which they may be eligible</td>
</tr>
<tr>
<td>Require managing data from multiple sources</td>
<td>Assist in accrual of patients</td>
</tr>
<tr>
<td>Must be regularly updated and must be accurate and complete</td>
<td>Help physicians identify treatments under study</td>
</tr>
<tr>
<td>Raise proprietary concerns</td>
<td>Help in the initiation and design of new trials</td>
</tr>
<tr>
<td>Involve technical challenges</td>
<td>Help solve publication bias in clinical trials reporting</td>
</tr>
<tr>
<td></td>
<td>Facilitate meta-analyses and systematic reviews</td>
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</tbody>
</table>

**Designing a Clinical Trials Registry**

Because the advantages of clinical trials registries are so great and because several forces now demand their
Table 2. Information Given in the ClinicalTrials.gov Record Display

<table>
<thead>
<tr>
<th>Title</th>
<th>Recruitment status</th>
<th>Sponsor</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Description of the purpose of the trial</td>
<td>Condition, intervention, phase (in table format)</td>
<td>MEDLINEplus related topics</td>
<td>Study type</td>
</tr>
<tr>
<td>Official title</td>
<td>Ages and sexes eligible for study</td>
<td>Description of inclusion and exclusion criteria</td>
<td>Location and contact information</td>
</tr>
<tr>
<td>Date last updated</td>
<td>Recruitment status at specific trial locations</td>
<td>More information</td>
<td>Links to more information (e.g., related Web sites)</td>
</tr>
<tr>
<td>Date recruitment status verified</td>
<td>Publications relevant to the study (if available)</td>
<td>Study identification numbers (submitted by data providers)</td>
<td>National Library of Medicine identifier (e.g., NCT00001789)</td>
</tr>
<tr>
<td>Date study started</td>
<td>Date recruitment status verified</td>
<td>Date last updated</td>
<td>Date last updated</td>
</tr>
</tbody>
</table>

Table 2 illustrates the type of information that is displayed whenever a user retrieves a record from the database.

For anyone contemplating the development of a clinical trials registry, the first question to be addressed is whether the information. Principal investigators themselves, of course, design and implement clinical trials protocols, and they are the primary sources of the data. However, sponsors, review boards, or regulatory bodies might also assist in capturing the data and delivering it to the registry. Boissel and Haugh (9) surveyed 281 ethics review boards in seven European countries. Of the 115 boards that replied, 70% said that they would be willing to submit data to a centralized clinical trials registry, particularly if the laws in their countries were changed to mandate registration of clinical trials information.

The broad scope of the legislation that resulted in the new Web-based ClinicalTrials.gov system has required a carefully planned approach to a project that will be an ongoing, long-term effort. However, because a first version needed to be developed relatively quickly, it made sense to develop the system in phases, incorporating NIH-supported trials first and adding trials supported by other federal agencies and by the private sector later. In designing the system, we have been guided by several important informatics principles, including adherence to standards and iterative testing and evaluation, and have emphasized ease of use (41, 42).

Standard data elements, standard methods for labeling and transmitting the data, use of standard vocabularies, and use of standard Web technologies have all played a role in the design of the system. Discussions among the joint NIH and FDA working group about the standard data elements to be included were informed by earlier published work as well as by the results of discussions at several public meetings. Table 2 illustrates the type of information that is displayed whenever a user retrieves a record from the database.

Twenty-one NIH institutes and centers are currently contributing data to the centralized system at the NLM. Records from all participating sources are combined in the database and are presented in a consistent way to users. This consistency is possible only because of the standard data elements that make up all records. Certain elements, such as the disease or condition name, are expressed in standard controlled vocabularies, thereby allowing better searching and browsing capabilities. The terminology component of the system uses knowledge from NLM’s Unified Medical Language System (43) to assist in resolving user queries. For example, if a user queries ClinicalTrials.gov for trials related to “heart attack,” the search will also include “myocardial infarction,” which is available as a synonym in...
the Unified Medical Language System. If a user misspells "glaucoma" as "glacoma," the system will offer spelling corrections.

Links to related information appear throughout the system. For example, if a trial is testing a new intervention for Alzheimer disease, a link from the record for that trial will allow users to access the topic on MEDLINEplus, NLM’s Web-based consumer health site. If the trial record includes references to the literature, a link is automatically made to MEDLINE through NLM’s PubMed system. Finally, each record is also assigned its own unique identifier, consisting of the prefix “NCT” followed by eight digits. This identifier will never be changed or reused and functions much like a MEDLINE identifier.

Testing and evaluation are always important, but they are particularly so when a system is being designed for broad use by people of many different backgrounds and technical skills. Because the primary intended audience includes patients and other members of the public, who may or may not be sophisticated Web users, we have designed the system to be as easy to use as possible and have also been concerned with accessibility. No training is required to search the system, and the results are easily understood. We conduct ongoing testing and evaluation with members of the public, health care professionals, and information specialists. Representatives from all of these groups tested prototypes of the system, and their comments have already led to many improvements and enhancements.

**DISCUSSION AND CONCLUSIONS**

It is too early to evaluate the impact of the ClinicalTrials.gov system, but it seems likely that as patients and their physicians have increased access to information about ongoing clinical trials, they will be in a better position to decide whether participation in a clinical trial is appropriate. Researchers may well see an increase in the number of patients who are interested in enrolling in their trials, and they may therefore also see the advantages of registering their trials in a comprehensive registry. Although some private companies may have concerns about the proprietary nature of their clinical trials data, this may be balanced by the benefits of having their trials listed.

In addition, the system may be helpful to practicing physicians. In some cases, a physician may be aware of trials being conducted by colleagues but not of those in progress at other institutions. The links to published references related to specific trials may help provide additional insights into the goals and possible outcomes of the trials. In some cases, the results of completed trials are available on the site, most often in the form of references to published articles. This means that not only has the work been peer reviewed but also that the methods have been more fully described. The International Collaborative Group on clinical trials registries points out that although registries have many advantages, they cannot substitute for full analysis and evaluation of the research data in a clinical trial. Investigators have a continuing obligation to publish their results (21).

Because more patients are accessing the Internet for health care information, it is likely that they will be able to benefit from a reliable source of information about clinical trials. It will, of course, continue to be important to interpret this information in the context of the patient’s overall medical care. ClinicalTrials.gov can help by providing “just-in-time” information about the particular condition or intervention under study (42), but the physician clearly plays a critical role in the application of such information. Evaluating possible participation in a clinical trial is best accomplished in a close partnership between patients and their physicians.

Clinical trials have the potential to improve people’s lives. Many thousands of trials are conducted each year in the United States and throughout the world, but it is often difficult to determine what specific trials are being conducted, where they are being conducted, who is doing the work, and what the results are. Registries of varying scope and size have been developed over the years, but none has been comprehensive in its coverage. There are, in addition, significant economic, organizational, and technical issues involved in developing large registries. Many have argued strongly for the establishment of clinical trials registries over the past several decades because researchers, physicians, and patients can all benefit by having ready access to information about clinical trials.

We have recently developed and made publicly available a clinical trials registry called ClinicalTrials.gov. The system has been designed to be comprehensive and currently contains approximately 5000 clinical trials covering a wide range of diseases and conditions. Although this represents just the beginning of an evolving long-term project, we hope that it may be viewed as an important step toward providing better access to clinical trials information.
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References