



Taking Control of Your Digital Library

How Modern Citation Managers Do More Than Just Referencing

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Physicians are constantly navigating the overwhelming body of medical literature available on the Internet. Although early citation managers were capable of limited searching of index databases and tedious bibliography production, modern versions of citation managers such as EndNote, Zotero, and Mendeley are powerful web-based tools for searching, organizing, and sharing medical literature. Effortless point-and-click functions provide physicians with the ability to develop robust digital libraries filled with literature relevant to their fields of interest. In addition to easily creating manuscript bibliographies, various citation managers allow physicians to readily access medical literature, share references for teaching purposes, collaborate with colleagues, and even participate in social networking. If physicians are willing to invest the time to familiarize themselves with modern citation managers, they will reap great benefits in the future.

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Navigating and organizing the massive body of literature published in medical journals can be overwhelming. Physicians have moved past filing cabinets full of torn-out medical articles and shelves overflowing with print journals to embrace digital storage of medical literature. Unfortunately, the advent of computer-based storage has deteriorated into hard drives full of poorly organized full-text articles lacking a system to retrieve and use data for tasks such as bibliography creation. As the organization of medical literature becomes even more daunting, with some 25,000 peer-reviewed journals publishing some 2.5 million articles per year,¹ development of various digital citation managers has eased the tedium of data organization by providing searchable, customizable article collections. Early versions of commercial citation managers such as EndNote

and Reference Manager were pioneering programs in the realm of reference software. Today, the advent of Web 2.0² programs (a new generation of websites that allow for collaboration and interaction) has brought with it new web-based citation managers such as Zotero and Mendeley. These new citation managers not only organize references, but also allow physicians to store literature, participate in scientific collaboration, and even take part in social networking.³

Time-consuming methods for searching, cataloging, and citing scientific literature made early referencing exhausting. Traditionally, the paradigm followed in directing a literature search was a Sisyphean task. Mead and Berryman⁴ described the traditional process, which began with MEDLINE, which led to a reference management program, which, in turn, led to a word-processing program, which, in turn, led back to MEDLINE to start the cycle again. These licensed software programs, such as early versions of EndNote, provided researchers with non-web-based personal libraries centered primarily on local desktops. Metadata were stored in reference format using rudimentary software programs, without the ability to use the data further. Although these programs were capable of creating bibliographies, they had limitations when it came to more advanced functions. Scientists were unable to easily retrieve and share the information stored on

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their desktops or collaborate with other experts in their fields. As funding in research and development continued to expand over the past 50 years, the proliferation of scientific publications made it essential to devise an instrument to conveniently search, store, retrieve, and share literature.

Today, digital citation managers have gone above and beyond the task of simple metadata storage and bibliography creation. Modern citation managers are versatile web-based programs capable of meeting the needs of a more Internet-savvy generation of physicians. As the influence of Web 2.0 has grown and new mobile medical technology has evolved, so have the capabilities of web-based citation managers in providing point-and-click bibliography creation, manuscript organization, and distribution of medical literature. The latest of these managers allow physicians to effortlessly use mobile web platforms to search for references using various external databases and scientific websites to add references into personal digital libraries. Once assembled, digital libraries can be used not only to create bibliographies, but also to access reference material for patient care, facilitate literature distribution to colleagues, and assist in social networking. Even the earliest citation managers such as EndNote have evolved to provide a web-based version that allows access to references anywhere. Through a number of relatively simple digital interfaces yielding a steep learning curve, modern citation managers have proved themselves to be innovative tools for improving functionality and efficiency for physicians of all ages.

The distinct features of the various citation managers may vary depending on the featured program. Although a number of such managers exist, various programs are capable of different functions, from collecting citations to effortlessly importing them into word-processing programs. Gilmour and Cobus-Kuo⁵ describe a number of functions that we currently expect from effective citation managers (Table 1). Although physicians may not find all these functions necessary, the multiple available managers provide different options based on

individual need. The most effective ones provide the ability to search for scientific literature using reputable bibliographic databases (PubMed, EBSCO, Ovid, and others) or web browsers, store data for future retrieval, and aid in the production of scientific manuscripts. One citation manager may be more applicable to researchers seeking scientific collaboration and manuscript creation, whereas another may be more suited to a physician whose aim is to store literature for clinical reference. Although all physicians may not require the myriad of advanced referencing functions, the increasing number of modern citation managers provides a broad selection of programs based on personal preference.

Almost all modern citation managers can effortlessly search for and collect metadata. Current versions of Mendeley, Zotero, and EndNote have platforms that make it easy to create a digital library and retrieve stored literature. Point-and-click options make these programs user friendly, with little frustration in learning the operating system. Current versions of EndNote offer the freedom to directly search remote databases via its native search engine, which allows users to collect references and even download available full-text articles from databases such as PubMed and EBSCO. Unlike EndNote, programs such as Zotero and Mendeley cannot directly search all remote databases, but they are able to search and collect references from articles in digital medical journals, newspaper articles, and online databases. Mendeley makes importing and organizing metadata from PDFs particularly easy and, along with EndNote and EndNote Web, have integrated sophisticated PDF viewer functions to edit and annotate PDFs. Zotero offers the unique feature of an add-on icon to Firefox, and now the Safari web browser automatically identifies scientific papers being viewed and allows a user to input the citation into a digital library with a single click of the mouse. Additionally, if the full-text article cannot be downloaded using an index database, many citation managers offer the ability to quickly conduct an extensive online search to find and download the entire article. These citation managers offer multiple options for simple and expeditious data collection.

Effective organization and storage of medical literature through the use of citation managers is beneficial for both physicians and researchers. The task of collecting online references and consolidating files dispersed throughout personal computers is made simple through the use of modern citation managers. By creating a robust digital library, physicians have uninterrupted access to the medical literature that can enhance patient care. Preferred seminal papers and research articles can be accessed at the bedside for physicians to reference for patient care and can be used for patient and trainee education. Web-based citation managers

Table 1—Effective Citation Managers

Characteristics
1. Import citations from bibliographic databases and website.
2. Gather metadata from PDF files.
3. Allow organization of citation within reference manager database.
4. Allow annotation of citations.
5. Allow sharing of reference manager database or portions thereof with colleagues.
6. Allow data interchange with other reference manager products through standard metadata formats.
7. Produce formatted citations in a variety of styles.
8. Work with word processing software to facilitate in-text citation.

Adapted from Gilmour and Cobus-Kuo.⁵

allow physicians to access digital libraries at any time on a number of different electronic devices. Mendeley and EndNote save citation libraries to a local computer but can then be synced to multiple devices for convenient access. Mendeley also offers iPad and iPhone applications that make an entire digital library available on mobile tools. Zotero does not require installation on a local computer but, instead, is completely web based, which allows the program to be accessed conveniently by synchronizing digital libraries across multiple devices without being tied to a local computer. Another defining feature of these programs is their storage capabilities. Although the desktop edition of EndNote has unlimited storage space, EndNote Web can hold only 25,000 records. Furthermore, Zotero offers only 100 MB of space free of charge and Mendeley Web offers only 500 MB free.⁶ Individuals can purchase more memory for Zotero and Mendeley Web if needed.

The ability to effortlessly and accurately create formatted bibliographies in a number of citation styles with word-processing integration is a key feature of modern citation managers. The earliest forms of reference management required medical researchers to tediously and manually adapt metadata into various bibliographical styles. Unfortunately, manually inputting data is not only time consuming, but is subject to a high incidence of referencing errors. Some studies reveal journal referencing errors and quotation error rates in the *New England Journal of Medicine* and *Lancet* of 8% and 10%, respectively.⁷ The monotonous nature of manually inputting data, along with the referencing errors, made it evident that more efficient and accurate means for creating bibliographies were necessary. Newer web-based citation managers are able to interface with various bibliographic databases in addition to scientific websites to directly input metadata from PDFs into their digital library. While working in word-processing programs such as Microsoft Word, users are able to use, for example, EndNote's "Cite While You Write" function to insert citations directly into written text while instantaneously creating a complete bibliography. Reformatting these bibliographies into the various diverse citation styles within seconds is also an essential function, because scientific journals require different reference styles. The trend toward improved accuracy may be derived from use of these new citation managers and online resources compared with previous manual input methods.⁸ The ability to directly input citations from reference databases, websites, and even PDFs, along with style modification functions, has allowed researchers to effortlessly create bibliographies as they write with greater efficiency and accuracy.

An essential role of modern citation managers is the creation of well-developed systematic reviews. Unlike most traditional review articles, quality systematic

reviews use an explicit and systematic predefined methodology to minimize bias and to increase the precision of measurements of treatment effects.⁹ The validity of a systemic review relies on the studies' methods and reliability. Unfortunately, reviews can be biased because of the inclusion and exclusion of certain pieces of data. In accordance with the nature of systematic reviews, researchers are required to search, collect, and manage hundreds of articles relevant to the topic at hand. As articles are reviewed, researchers must track the results of their searches and identify which articles are to be included or discarded. Modern citation managers are invaluable to organize and access the myriad of articles evaluated in the creation of systematic reviews. The point-and-click function of Mendeley and Zotero, in addition to their ability to directly annotate and share data, makes these citation managers effective vehicles for publishing quality systematic reviews.

As mentioned, one of the most impressive functions of modern citation managers is the ability to share information. Commercial software and free web-based programs possess the point-and-click ability to send citations through e-mail from computers and even mobile phones. Selected programs even have the ability to e-mail full-text articles. Literature sharing through e-mail is beneficial in trainee-teaching situations when physicians would like to expand on clinical practice with evidence-based literature. House staff can greatly benefit from collecting these references and are able to develop their own digital libraries for reference if they encounter similar medical cases in the future. In addition to e-mail, Zotero and Mendeley offer more sophisticated media for reference sharing through the creation of private and public interest groups. Creators can invite others to join their group to share references and discuss issues pertinent to areas of interest. Thousands of public groups exist, and users are able to browse multiple scientific disciplines to stay current with the literature that other members post and discuss. This integrates the principles of social media with scientific study and collaboration.

Additionally, private groups can be organized by individuals of similar interest to share literature without providing open access to all members. Mendeley limits the number of users who can join a private group, whereas Zotero allows more groups. EndNote libraries stored on local computers can be shared with collaborators but require the extra step of synchronizing the data to the web-based version. Another unique vehicle for sharing and collaborating is Mendeley's social media function, which allows members to create personal profiles, similar to those featured in other social media forums such as Facebook and LinkedIn. This function allows users to search for other members who share similar interests and possibly develop a basis for future collaboration.

Although modern citation managers are powerful tools in research, teaching, and patient care, they have limitations. Commercial products such as EndNote and RefWorks cost money. Even free web-based services offer fee-based features. Because of this, collaboration can be difficult using these fee-based programs, because all collaborators must purchase the software to share data. Additionally, although these programs are able to integrate metadata into a reference format in the majority of cases, sometimes citation managers have difficulty distinguishing identifying information, thus, requiring the user to insert data manually. Finally, despite attempts to make digital interfaces as simple as possible, many physicians who have difficulty adapting to advances in medical technology may be resistant to integrating these tools into regular practice. It was found that perceptual problems associated with organizational hierarchies, technology, and the information stored therein impeded the introduction of digital library access via the Internet.¹⁰ Unfortunately, some physicians may find mastering the programs to be frustrating, leading them to abandon further use.

Modern citation managers are powerful tools capable of performing above and beyond the mere creation of manuscript bibliographies. Today's Web 2.0 citation managers are able to easily build digital libraries, create accurate bibliographies, and swiftly share information. The ability of citation managers to improve efficiency in the realms of research, education, and patient care through mobile web-based programs represents the ever-evolving face of medicine. As both commercial and noncommercial citation managers continue to evolve and compete for users, the programs will inevitably become even more user friendly and efficient. The various functions of modern current citation managers can be overwhelming to physicians; however, signifi-

cant benefits can be gained by investing the time and effort needed to master these impressive programs.

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