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USING CITATION ANALYSIS TO MEASURE THE RANGE OF INFORMATION USED IN INTERDISCIPLINARY RESEARCH: A TEST ON FORENSIC TOXICOLOGY IN CANADA

BY

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The undersigned certify that they have read, and recommend to the Faculty of Graduate Studies and Research for acceptance, a thesis entitled USING CITATION ANALYSIS TO MEASURE THE RANGE OF INFORMATION USED IN INTERDISCIPLINARY RESEARCH: A TEST ON FORENSIC TOXICOLOGY IN CANADA.

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Abstract

The purpose of this study was to develop a method of characterizing the citations in articles published by interdisciplinary researchers, in terms of age, format and subject of the citations, that could be applied to the management of research collections. A method developed for this purpose should identify a population of researchers known to be active in an interdisciplinary field so that all of their published research could be assessed. It should not exclude non-periodical information sources, and should include subject analysis of the citations. The subject classification system should be comprehensive enough to indicate the crossing of discipline boundaries and it should be easy to apply. A study sample was developed by identifying the names of authors active in forensic toxicology in Canada, between 1981 and 1987. The names were used to retrieve source articles and then the search results were narrowed to include only the source articles pertaining specifically to forensic toxicology. A system was developed to assess the subjects of the citations according to the Dewey Decimal Classification of the cited work. A 4 level classification system (core, quasi-core, IDR-1, and IDR-2) was developed. This system allowed an index of interdisciplinarity to be developed that could be used to compare the information use characteristics of individual authors to that seen in forensic toxicology as a whole. The applicability of this type of index to the management of research collections was assessed.

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I. Introduction

A. Background to the Study Problem

Interdisciplinary researchers use a variety of published sources of information in order to help them resolve research problems. The choice of published sources of information reflects the particular problem being solved, the researchers' personal interests, and the environments in which the researchers work. These published sources are identified in the citations in articles describing their research.

Research collections developed to serve the information needs of interdisciplinary researchers must be responsive to dynamic situations. Maintaining collections that are timely, stimulating, and useful in such environments can be a difficult task for information specialists. Traditional collection management practices that make use of opening-day lists, lists of highly-cited research periodicals, and community surveys, may not provide the information required to build, maintain, and evaluate these types of collections. A method of characterizing citations in articles written by interdisciplinary researchers that includes age distribution, published format, and subject would be a useful supplement to regular collection management practices, and would better enable information specialists to build research collections to serve interdisciplinary researchers.

B. Purpose of the Study

Citation analysis is a technique that can be used to supplement collection management practices. It serves to provide quantitative data from which qualitative decisions can be made (Smith 1981). It has been sucessfully applied in measuring the impact factors of periodicals (Garfield 1972), but can also be used to assess the importance of the date of publication, published format, and the subject of the citations in any particular research article. While methods for determining the importance of the date of publication and published format are fairly straight forward, those used for determining the importance of the subject of the citations are more difficult to apply.

The purpose of this study was to develop a method of characterizing and analysing the subject content of works cited in published articles that could be easily applied in the management of research collections. The method was tested on forensic toxicology in Canada. Forensic toxicology was selected because of its interdisciplinary nature, and the geographic limitation was used to reduce the study sample to a manageable size. The data-gathering method used the names of authors to identify research articles. Articles published by these authors between 1981 and 1987 then became the study sample.

A database was created and used to carry out the citation analysis. With the addition of a data element not recorded in the citations, a subject category assigned from the Dewey Decimal Classification (DDC), a citation classification system was developed. This system was then used to establish an index of citation interdisciplinarity. This index was used to compare the information use characteristics of individual authors to the characteristics seen in forensic toxicology as a whole. The index was used in this study to determine the range of subjects used by forensic toxicologists. Some inferences could then be drawn regarding the management of research collections that serve forensic toxicologists.

Authors will have different requirements for information from various subject areas depending on the emphasis of their research. The index developed was used to determine the differences in the subject requirements of these researchers in order to test the hypothesis that an author active in forensic toxicology will demonstrate a subject citation pattern that is different from the pattern demonstrated in forensic toxicology as a whole. The results of this test were used to gauge how well a researcher could be served by a research collection developed around the range of subjects used in forensic toxicology as a whole. From this, decisions may be made, on the basis of an individual collection, whether to emphasize collection development or specialized client services.

C. Related Literature

Interdisciplinary Research

The term interdisciplinary research (IDR) has received considerable media attention in recent years as a result of such widely publicized research efforts as the attempts to halt the desertification of the Sahel, the inquiries into the greenhouse effect, acid rain, global disarmament, the AIDS epidemic, and the scientific investigations of the Shroud of Turin. These research problems have mass public appeal because they affect directly the lives of people all over the world. However, research problems that emphasize global social concerns are only one aspect of IDR.

Definitions of IDR (Petrie 1976; Meeth 1978; Porter and Rossini 1984) and the early investigations into the process itself (Porter 1983; Chubin, Porter, and Rossini 1984; Porter and Chubin 1985), lead a reader to believe that the process of IDR is different from the process that takes place in a disciplinary setting. However, the plethora of alternate terms and descriptions found in the literature (Anbar 1973; Darden and Maull 1977; Klein 1986) indicates that there is a general state of confusion about IDR and its place in the progress of science.

The problem of defining IDR stems from the fact that philosophers of science seem unable to define the word discipline. Toulmin's (1972) treatise, Human understanding: The collective use and evolution of concepts, does not add to the understanding of the concept of a discipline. A discipline has been defined as a community that shares the belief of a single paradigm (Kuhn 1970, p. 175). However, paradigm is a word that is grossly over-used and misused in philosophy (Lamb and Easton 1984, p. 47) and by Kuhn in particular. On the other hand, the alternative of "matrix" or framework of "shared generalizations, values, models, and exemplars" (Weimer 1979, p. 207) is a static way of looking at disciplines.

In the past, disciplines have been seen to work in isolation from one another. The advances of present day philosophers of science (Weimer 1979; Lamb and Easton 1984) have only recently begun to undercut this assumption. In fact, many disciplines seem to share portions of their framework with other disciplines (Porter and Rossini 1984). This results in the impossible, according to the old view of disciplines, that is, that a discipline can be interdisciplinary. The unacceptability of this idea may well have led to the coining of the phrase IDR, and the belief that it was somehow a different type of research.

If, in fact, disciplines do share their frameworks, then the idea of IDR is not new to science. Most scientists do not recognize it as a special phenomenon. It is only that some 20th century research projects have made the crossing of discipline "boundaries" more obvious.

Recent research on the process of IDR is beginning to approach the subject with this in mind (Porter and Rossini 1984).

Research problems are determined, in most instances, by disciplinary concerns or the interests of society. Some problems require more "complex intellectual and even organizational solutions" than others (Porter and Rossini 1984). These problems are the realm of the presently accepted process of IDR. While scientists do not usually recognize this complexity as a problem, research managers often do. Therefore, the term IDR will likely remain in general use even though it has little intellectual meaning.

IDR is based on integrating ideas from a variety of areas of knowledge to solve research problems. Klein (1986) has divided IDR into five categories. These are:

1. The integration of discipline perspectives for shared topics, questions or themes.
2. The use of discipline perspectives to solve problems without any modification to the original disciplinary perspectives brought to bear on the problem.
3. The beginnings of new disciplines or specialities.
4. An enduring dependence on a borrowed method, concept or theory.
5. An increased consistency of subject matters, methods, and theories between fields.

(Klein 1986, p. 410)

In science, IDR is closely linked with the innovation process. The creativity of a scientific innovation is related to the diversity of the ideas, concepts and theories employed by the scientist developing it (Kasperson 1978). This is most evident in the fertile research fields that exist at the interface of scientific disciplines (Beveridge 1980, p.2). An example of this is the theoretical developments that have resulted where cytology, genetics, biochemistry, physical chemistry, and physics merge (Darden and Maull 1977).

Not all innovations in science are theoretical or revolutionary in nature. IDR plays an important role in the more common innovations resulting from the informal process of borrowing methods, tools, theories, and models from one discipline for application in another (Klein 1986). In some instances, this process will lead to the development of interfield theories (Darden and Maull 1977), and even the development of new disciplines such as biochemistry, biophysics, and cytogenetics. However, in most instances, the process is simply a means to an end within the borrowing discipline. An example of this that has gained prominence in the latter half of this century is the field of research known as toxicology.

Toxicology is the "study of the harmful actions of chemicals on biologic tissues" (Loomis 1974, p. iii). Its interdisciplinary nature is evident in that it borrows heavily from biology, chemistry, pathology, physiology, pharmacology, public health (Kissman and Wexler 1983), and sociology. It gives rise to the applied disciplines of environmental toxicology, which is the study of pollution, residues, and industrial hygiene; economic toxicology, or the development and testing of drugs, food additives, and pesticides; and forensic toxicology, or the analysis of the harmful effects of chemicals as it pertains to diagnosis, therapy, and jurisprudence (Loomis 1974, p. 9). These disciplines rely on scientific data generated from research and testing (Kissman and Wexler 1983), as well as on scientific methods and models. In certain instances, especially when results are applied to social situations, these disciplines will also rely on non-scientific information.

Information Use in Science

Access to a variety of information sources in research is essential (Vickery 1977; Kasperson 1978; Pachevsky 1982; Kissman and Wexler 1983; Bawden 1986). Reviews, collection browsing, and personal communications all help a researcher find a great variety of information sources. Serendipity may also lead a researcher to useful information.

Many researchers will systematically review indexing and abstracting services for current information on a subject of interest. Some make use of subject bibliographies. The majority of researchers follow up pertinent citations in the bibliographies of published research articles (Vickery 1977). Reviews provide broad overviews of the literature on subjects and help researchers to discern the differences between contributory and non-contributory research in fields related to their own. They are also excellent introductions to unfamiliar fields of research (Woodward 1977). However, they can be difficult to find through regular indexing services (Woodward 1977).

Current awareness programs are important updating services for many researchers. One example of this type of service is CAN/SDI, which is offered to researchers in Canada by the Canada Institute for Scientific and Technical Information (CISTI). Less sophisticated programs are offered by many local libraries. Regular use of libraries and the services they provide also serves to keep a researcher up to date with published information sources.

In addition to all of these ways of finding published information sources, most researchers have experienced accidently coming across important information sources while looking for something different (O'Dette 1969; Beveridge 1980; Bawden 1986). Such serendipitous information plays an important role in the IDR process.

Researchers retrieve useful published information sources by using personal or public research collections (Herner 1954). Personal collections can include a number of sources, such as the researcher's own subscriptions, reprints collected over the years, advanced texts on a subject, and copies of any proceedings they have attended. A public collection provides systematic access to published information sources that are more difficult for an individual to collect or are not specifically applicable to the individual's specialty.

How a researcher makes use of the published information sources retrieved is as varied as the researchers who exist. However, it should be noted that the usefulness of such information is not always immediate, and that something that is perceived by a researcher to be important does not always pertain directly to current research projects.

One aspect of published information sources used in IDR that is alluded to in the literature (Porter and Chubin 1985), is the wide range of formats drawn upon. For information that is closely related to the researcher's own field, periodicals or primary information sources are consulted. As a researcher requires information that is less familiar, other less current published information and secondary sources are consulted.

However, in a recent questionnaire survey of U.S. researchers working on interdisciplinary issues, close to 64% of respondents expressed the view that there is a serious deficiency in the information services provided for them (Bawden 1986). Indexing and abstracting services and research collections are not providing timely, stimulating, and useful information to these researchers. Information specialists must look more carefully at the type of information these researchers do find useful. Citation analysis is one method information specialists can use to gather information that will help begin to address this problem.

Citation Analysis and Collection Management

Citation analysis is the study of the relationship between a document and its citations (Smith 1981). It is a method that has been used by information specialists in numerous studies because it is unobtrusive and reproducible. Unlike some of the other methods of determining information use employed by information specialists, such as interviews or surveys, citation analysis is relatively precise and objective (Smith 1981).

However, there are assumptions underlying the basis of citation analysis that must always be taken into consideration. These assumptions are:

1. Citation to a document implies use of that document by the citing author.
2. Citation to a document reflects the merit of that document.
3. Citations are made to the best possible works.
4. A cited document is related in content to the citing document; if two documents are bibliographically coupled they are related in content and if two documents are cocited they are related in content.
5. All citations are equal.

(Smith 1981, pp. 87-89)

These assumptions may or may not be true depending upon the circumstances in which the citation analysis is applied.

Problems in interpreting the results of citation counts can arise because of the way the citations were treated in the analysis. This is especially true when applying results to collection management. Those who conduct citation analysis often exclude self-citations, negative citations, and citations to sources that are not periodicals (Smith 1981). These practices can bias results if the research discipline being studied is highly specialized, is undergoing a major intellectual change, or is broad in focus. As well, there can be errors in the citations themselves. Therefore, if the data gathering method, as well as the planned citation analysis method are not carefully designed to match the discipline being studied, data inadequacies can result.

Citation analysis can provide useful insights into the use researchers make of published information sources. The method has been applied successfully to such problems as identifying literature structures (Narin, Pinski and Gee 1976) and core literatures (Miyamoto and Nakayama 1983), ranking the research periodicals in a field (Garfield 1972), and tracing the spread of ideas (Chubin, Porter, and Rossini 1984). It has useful applications in the design of more efficient information systems, and in the "identification and measurement of deficiencies in present services" (White 1985).

In terms of collection management, the most important applications of citation analysis are in the areas of literature scatter and obsolescence (Wallace 1987). Bradford's Law, an empirical law derived using bibliometric methods, describes the pattern of scatter in literatures. Simply stated, for any search of a given topic, "a large number of relevant articles will be concentrated in a small number of titles and the remainder will be dispersed over a large number of titles" (Drott 1981). Application of this distribution gives information specialists a way to objectively select titles for inclusion in a collection. Bradford distributions are also used, with varying degrees of success, to identify the core literature of a subject or discipline (Drott 1981; O'Connor and Voos 1981).

Although Bradford distributions are demonstrated over and over in the study of literatures, with a different constant for each literature, the underlying reasons for these distributions are unknown (Hubert 1981; Wallace 1987). The distributions often correspond closely to the 80/20 rule of library collections (Egghe 1987) where 20% of a library collection satisfies 80% of the information requests. There have been few studies of interdisciplinary collections to determine whether the 80/20 rule holds for them, or whether Bradford type distributions exist (Wallace 1987).

Citation analysis has been used in various forms in an attempt to measure the interdisciplinary nature of research. Garfield (1972) analysed citation patterns for a number of scientific periodicals and then drew conclusions about the variety of published information cited by authors in these periodicals. Others have looked at the citation patterns of particular research articles (Chubin, Porter and Rossini 1984) and have drawn conclusions about the type of research done by researchers who cite highly-cited articles. Both of these methods relied on data generated by the Institute for Scientific Information (ISI). The conclusions drawn were based almost entirely on citations to periodicals. The non-periodical literature which might have been used by researchers was excluded from the analysis.

Porter and Chubin (1985) attempted to measure the interdisciplinary nature of research by doing a subject analysis of citations in articles from IDR fields. They found that citations outside of the subject category of the citing article could be used as indicators of the interdisciplinary nature of the research. However, they also found that researchers rarely cited distantly related subject fields. Toxicology was one of the IDR fields studied.

Again, because data generated by the ISI were used, this study excluded the non-periodical literature the researchers might have cited. The authors readily admitted that this was a study limitation. As well, the subject categories applied to the citations were extremely broad: engineering, the life sciences, the physical sciences, and the social sciences (Porter and Chubin 1985). Such a categorization does not include the medical or the applied sciences outside of engineering, and excludes altogether the humanities. Another limitation of their method was that it used only one or two periodicals to represent each research discipline studied. In the case of toxicology, one was a review periodical. Citations in review articles are to contributory research, so citations to subjects outside of the citing article are not very likely. The citations in the articles being reviewed are more likely to be to subjects outside of the citing article. The approach of using one or two periodicals, or of using review periodicals limits the potential for measuring the variety of information used in a research area.

When citation analysis is used to measure the variety of subjects used in IDR, the method should not exclude non-periodical information sources, nor should it exclude subject analysis of the citations in the research articles. The subject classification system used should be comprehensive and detailed enough to be capable of indicating when discipline boundaries are crossed. The system should also be open to change as a discipline changes. As well, it is a logical assumption that researchers working in IDR fields publish in a greater variety of research periodicals than researchers who do not. Therefore, the data-gathering method should not be limited to one or two periodicals chosen to represent a discipline. A better approach might be to identify a population of researchers known to be active in an interdisciplinary field and then to analyse all of their published articles.

Treating Citations as Concept Symbols

Citations can be considered analogous to subject headings in an indexing system (Garfield 1974, p. 63). Small (1978) elaborated on this idea by developing a method of co-citation context analysis in which the words around the citation in an article are counted and grouped according to their similarity. The counts are then compared to the counts obtained from other articles. This idea is useful for the objective creation of groups of documents that intellectually resemble disciplines (Boyce and Kraft 1985).

Analysing the subject content of a cited work allows for a detailed analysis of information use. However, as Smith (1981) has pointed out, intellectually elaborate methods of analysing citations are time-consuming and not easily applied by practising information specialists. This type of analysis can not be easily applied to indicate the crossing of discipline boundaries unless a different approach from that described above is used.

One approach would be to categorize the source in which the cited work was published (henceforth referred to as the citation source). This allows an information specialist to visualize the crossing of discipline boundaries without having to analyse the content of the citing article (henceforth referred to as the source article) or the cited work. This approach puts the level of analysis at the general subject of the citation source, rather than at actual subject of the cited work. However, this is appropriate when using citation analysis to supplement collection management practices, because research collections are made up of citation sources not citations. One internationally used method of categorizing published information sources, or citation sources, is the DDC system.

The DDC system represents concepts or subjects with numeric codes. It was developed by Melvil Dewey at the turn of this century and was designed to represent the totality of knowledge as recognized by the nineteenth century Western world. It is based arbitrarily on ten groupings so that general areas of knowledge could be uniquely identified (Dewey Decimal Classification and Relative Index 1979, p. xxviii). Further analysis of each of the ten major areas of knowledge occurs in tenths, hence the name. Generally speaking, the further apart the codes of any two concepts or subjects are, the less related they are. This results in what looks like a hierarchical arrangement of knowledge within each major area of knowledge.

However, the DDC system is not as hierarchical as it appears at first glance. In some instances, topic classification is very elaborate and in others, whole fields of research are placed within a single decimal number. However, an information specialist with some knowledge of DDC and a subject knowledge of a discipline can very quickly establish a DDC hierarchy of subjects important to a discipline.

This hierarchy could generally be made up of four levels like the system developed by Porter and Chubin (1985). The core level would be the subjects most closely related to the discipline. The next level, or the quasi-core, would be the subjects that provide the applied background to the discipline. Subjects that provide the theoretical background to the discipline would make up the next level. The last level would be the subjects that are not related to the discipline.

For example, in forensic toxicology the core subjects are pharmacology, toxicology and medical jurisprudence. These subjects are found in the DDC system between 614.1 and 615.9. Forensic toxicology is concerned with man in a public and personal health setting. Therefore, the medical sciences provide the applied background information. These subjects are found in the DDC system between 610 and 619. The pure sciences provide the intellectual and theoretical framework for the applied sciences, and forensic toxicology is an applied science. The pure sciences are found in the DDC system between 500 and 599. Other subjects, such as the social sciences or the humanities would be called on by researchers with less frequency. This would be the rest of the DDC system (Dewey Decimal Classification and Relative Index 1979).

Certain features of the DDC system make it preferable to other classification systems for categorizing citations. It is more comprehensive and detailed than that developed by Porter and Chubin (1985). The DDC heirarchy that can be developed for a discipline is open to change as the discipline changes. It also allows for the organization of concepts and subjects into an intellectually satisfying order. The Library of Congress (LC) Classification system does not lend itself to expressing detailed subject relationships.

Another benefit of using DDC numbers to represent the citation sources is that they can be applied easily in many cases. DDC numbers are available in a wide variety of printed indexes and online databases for most citation sources. An information specialist need not be restricted to the classification system used in local library collections.

An index of citation interdisciplinarity can be developed when numeric codes are used to represent the levels in the DDC hierarchy. When the codes are applied to citations, the index should be able to represent the subjects important to a particular research area and the level of interdisciplinarity of a research problem. The codes will continue to reflect the levels in the DDC hierarchy even if the DDC hierarchy changes to reflect subject changes in the research area. It should be possible to quantify the importance of each level in the DDC hierarchy simply and easily. The index should be easily reproducible and it should be possible to developed for any discipline. The applicability of this type of index to collection management will be assessed in this study.

D. Definitions

The discussion above introduced numerous terms and phrases that must be formally defined. For the sake of convenience, the terminology introduced in the next chapter will be defined here as well. The definitions are broken down into three groups: those which deal with IDR, those which deal with published information sources, and those which deal with forensic toxicology.

Interdisciplinary Research

The focus of this study was to analyse the citations in published research articles so that the variety of information used could be noted. The following terms are defined to establish the scope of this study.

Research-

is the careful search or inquiry into a matter in order to discover new or collate old facts by scientific study of the subject (Oxford English Dictionary).

Interdisciplinary research-

is that form of inquiry that integrates ideas and, or expertise from a variety of subjects in order to solve a problem (Porter and Rossini 1984).

Discipline-

is a label applied to a group of ideas, concepts or theories that can be related to one another in a systematic but not necessarily exclusive manner. A discipline is practised by a population of practitioners or researchers at any given point in time.

Published Information Sources

Completed research is often published. This study focuses on source articles published in scientific periodicals.

Article-

refers to a written work identified by its own title or heading and frequently by its author, in a document that contains many such works, for example a periodical or encyclopedia (ALA Glossay, p. 11).

Source articles-

are those identified as the study sample in this study, and are the sources of the citations analysed.

Citation-

is a note referring to a work from which a passage is quoted or used as an authority for a statement or proposition (ALA Glossary, p. 43).

Information cited-

is the bibliographic data stated in the citation.

Citation source-

is the publication in which a cited work appeared. In the case of a cited monograph, the cited work and the citation source will be identical.

Citation sources have an almost infinite variety of formats. Therefore, definitions of relevant formats are provided below.

Format-

is the general appearance and physical make-up of any publication (ALA Glossary, p. 99).

Periodical-

is a serial intended to appear indefinitely and at regular intervals, generally more frequently than annually, and is numbered or dated consecutively. Excludes newspapers (ALA Glossary, p. 166).

Handbook-

is a compendium covering one or more subjects and of basic or advanced level, arranged for the quick location of facts (ALA Glossary, p. 109).

Directory-

is a list of persons or organizations, systematically arranged, usually in alphabetic or classed order, giving address, affiliations, etc., for individuals, and address, officers, functions, and similar data for organizations (ALA Glossary, p. 75).

Monograph-

is a non serial bibliographic item complete in one part or in a finite number of separate parts (ALA Glossary, p. 148).

Conference proceeding-

is a published record of a meeting of an organization, frequently accompanied by abstracts or reports of papers presented (ALA Glossary, p. 178).

Government document-

is any publication originating in, or issued with the imprint of, or at the expense and by the authority of, any office of a legally organized government or international organization (ALA Glossary, p. 106).

Personal communication-

is a verbal or written discussion with another person and published as a citation.

Ephemera-

are materials of transitory interest and value, consisting generally of pamphlets and clippings (ALA Glossary, p. 86).

The Discipline Studied

The discipline studied here is forensic toxicology.

Toxicology-

is the study of the harmful actions of chemicals on biologic tissues (Loomis 1974, p. iii).

Forensic toxicology-

toxicology as it pertains to diagnosis, therapy and jurisprudence (Loomis 1974, p. 9).

II. Research Design

A study sample of research articles representative of forensic toxicology in Canada, published between 1981 and 1987, was collected. In order to build this sample, the names of Canadian forensic toxicologists were identified. These names were used to create a study sample of source articles. A database was then developed to store information about the source articles and their citations. Normally tedious citation analyses could be done quickly and easily by retrieving information from this database.

A. Creating the Study Sample

Name-gathering

Three name-gathering methods were used to compile a list of authors that was then used to retrieve source articles published by these authors in forensic toxicology. The first name-gathering method involved scanning a single periodical for the names of authors writing on forensic toxicology with Canadian addresses. The Journal of Forensic Sciences was selected because of its international reputation in the forensic sciences. The method of taking articles from a single periodical was selected because it is commonly used in citation studies.

The second name-gathering method involved scanning a group of periodicals chosen to represent forensic toxicology. These were the Canadian Society of Forensic Science Journal, the Journal of Forensic Sciences, Forensic Science International, The American Journal of Forensic

Medicine and Pathology, Medicine, Science and the Law, and the Medicolegal Journal. These periodicals were chosen because they represent the forensic sciences in general as well as the more specific medical aspects of forensic science. The source articles had to be on forensic toxicology, and the authors had to have a Canadian address.

The third name-gathering method involved using a membership list of an association. The list used was the 1987 Canadian membership of the International Association of Forensic Toxicologists, provided by Dr. Graham Jones of the Alberta Attorney General (Jones 1987). This method provided a relatively comprehensive list of researchers and also provided names of authors who did not publish in the periodicals used in the second name-gathering method. All members listed as Canadian residents were considered potential authors. Ethanol specialists (identified by Dr. Graham Jones) were excluded because they belong to a discipline distinct from toxicology. The three name-gathering methods were compared to identify the most efficient method for identifying a group of authors.

Retrieving Source Articles from MESH

All the authors identified using the three name-gathering methods were then used to conduct an online search of MESH, the BRS After Dark version of MEDLINE, which is the computerized database of the National Library of Medicine in Bethesda, Maryland. The search strategy developed for retrieving the articles was relatively simple. The last name, truncated initials, and nation were used to retrieve only those articles that were published by the authors while working in Canada. BRS After Dark does not allow for limiting searches by date of publication.

Therefore, those results conforming to the date restriction had to be selected manually from the search results.

Source articles dealing exclusively with ethanol were then excluded from the search results. However, those that dealt with drugs and ethanol were included. Source articles were also excluded if they dealt only with the sociological or the psychological effects of substance abuse, rather than with the quantitative determination of substances within the human body, or the toxicological effects of these substances.

Data Elements

The following data elements for each source article retrieved were recorded: author's name, the author's institutional affiliation, title of the article, name of the periodical, date of the publication, volume and issue number, and pagination. These were then used to produce a bibliography of the study sample. These data elements were all provided in the MESH database. Copies of all the source articles were obtained and these data elements were then verified.

The following data elements were recorded for each citation in each source article: date, citation source, and format. These data elements were used to do standard citation analyses. The following analyses pertinent to collection management were made: age distribution, format distribution, and the most cited citation sources. An additional data element was assigned to code data records as either source articles or citations.

The citation sources were verified for the accuracy of their bibliographic information. The periodical titles were verified in the Union List of Scientific Serials, or in the University of Alberta online DOBIS catalogue.

Non-periodical titles were verified in the DOBIS catalogue, _Books in Print_, _Proceedings in Print_, or in the catalogue of the Office of the Chief Medical Examiner Information Centre. Citation sources such as personal communications and ephemera could not be verified in any printed references.

Subject Analysis of the Citation Sources

To assess the variety of subjects cited, another data element was recorded in addition to those collected from the citations. This was a subject category as represented by a DDC number. The DDC number was assigned to each citation source. This data element was used to assess the subject variety of the citations in the study sample as a whole, and the citations made by each author.

The DDC numbers were taken wherever possible, from an established authority. _Ulrich's International Periodicals Directory_ was used to obtain numbers for periodical titles. DDC numbers for periodical titles not listed in _Ulrich's_ and for non-periodical titles were derived from the DOBIS catalogue or from the Information Centre card catalogue mentioned above. The titles for which DDC numbers could not be obtained from an established authority were analysed for subject content and then DDC numbers were applied.

B. Developing the Database

SPIRES (Stanford Public Information Retrieval System) is a powerful database management system available through MTS, the University of Alberta's operating system operated on an Amdahl 5870. Bibliographic databases can be developed easily on SPIRES. The database designed for this study established each source article and each citation as a unique database record. The citations were linked to their source articles by a bibliographic number. In this way, source articles could be called up separately from their citations or in unison with them, depending upon the type of analysis that was required.

The file definition for the study database was designed using the SPIRES File Definer. Data collected from the source articles and their citations were transfered onto pre-designed coding sheets. An MTS line file was created, which was then loaded into the SPIRES database.

C. Data Analysis

The data retrieved varied depending on the type of analysis being conducted. To retrieve data elements required to develop the bibliography of the study sample, the unique bibliographic number and the source article code were used. The data elements were listed and a bibliography was constructed from this information.

Data retrieved to determine the characteristics of the citations were the results of simple database searches and listings. The citation dates were listed so that comparisons could be made to the date of the associated source article to determine the age distribution. The format of each citation was listed so that the frequency and variety of the published formats used could be determined. The titles of the citation sources were listed and then ranked. Finally, the DDC numbers were listed in order to determine the variety and the frequency of subjects cited.

Besides calculating the age and format distribution of the citations, certain special analyses were conducted.

Bradford distributions derived from citation analysis are used to determine the core citation source in terms of how often a source is cited. The core citation sources of this study sample were determined using the Bradford distributions of

$$k:ka:ka^2$$

where,

k= the number of citation sources ranked in the top third of the study sample,

a= a constant related to the study sample,

and,

$$R(n)=k \log(n)$$

where,

n= the rank of the n-th source,

R(n)= the total number of citations contributed by the n sources,

k= a constant related to the study sample

(Drott 1981). They were compared and analysed for their size and subject content.

The DDC subject categories of the citations were grouped according to how closely they were related to forensic toxicology. Each group of citations was then given a code that reflected its distance fron the core subjects of forensic toxicology. Medical jurisprudence, pharmacology, and toxicology were considered the core of forensic toxicology. The medical sciences provide the applied basis of forensic toxicology. Subjects from this area were considered quasi-core. The pure sciences provide the theoretical support for any applied science. Subjects from this area were considered IDR-1, or from the first level of interdisciplinarity. Finally, all subjects outside of medical jurisprudence, pharmacology, toxicology, the medical sciences, or the pure sciences were considered to be the least related to forensic toxicology. Subjects from these areas were considered IDR-2, or from the second level of interdisciplinarity.

Therefore, citations in the DDC range of 614.1 to 615.9, or medical jurisprudence, pharmacology, or toxicology, were given the code 0 to represent the core subjects. Citations in the DDC range of 610 to 619, excluding the above group, or the medical sciences, were given the code 1 to represent the quasi-core subjects. Citations in the DDC range of 500 to 599, or the pure sciences, were given the code 2 to represent the IDR-1 subjects. Citations to any other DDC numbers were given the code 3. These citations represented the IDR-2 subjects.

These codes were used to develop an index of citation interdisciplinarity that could be used to describe the subject range of information used by an author, used in a particular source article, or in the study sample as a whole. The index of citation interdisciplinarity was defined as

$$I = \frac{1}{c} \sum_{i=1}^{c} a_i$$

where,

c is the number of citations in the source article, or made by the author, or made in the study sample as a whole, and

a_i is the code assigned to the i-th citation.

This is the average of the codes. The lower the I value assigned to an article or author, the more dependent the research or the authors were on core information. These I values then allowed both source articles and authors to be ranked according to their index of citation interdisciplinarity.

After the authors were ranked, the frequency of citation to each of the subject codes by each author was compared to the frequency of citation to the subject codes in the study sample as a whole. This was done to test the hypothesis that authors active in forensic toxicology will demonstrate a subject citation pattern that is different from the pattern in forensic toxicology as a whole. For statistical purposes, the null hypothesis is that authors active in forensic toxicology will not demonstrate a subject citation pattern that is different from the pattern in forensic toxicology as a whole. The hypothesis was tested using a χ^2 "goodness-of-fit" test on a 4x2 table (Volk 1982, p. 71). The expected ratio used in this χ^2 test is derived from the data. The acceptance or rejection of the hypothesis for each author was assessed for trends that could be applied to the management of research collections.

III. Results

A. A Comparison of the Name-gathering Methods

Each of the three name-gathering methods in this study resulted in the retrieval of a different number of names and resulting source articles. In all, 36 authors were identified and 90 acceptable source articles were retrieved.

The names of 12 authors were retrieved when a single periodical was scanned (Appendix A). These 12 authors published a total of 13 source articles in the Journal of Forensic Sciences between 1981 and 1987 as seen in Method 1 of TABLE 1. When the names of these authors were used to search MESH for more source articles, a further 26 were retrieved. In all, this name-gathering method resulted in a study sample of 39 source articles. This was approximately 43% of the total study sample.

The names of 24 authors were retrieved when a group of periodicals were used (Appendix B). These authors published 26 source articles in the group of periodicals between 1981 and 1987 as seen in Method 2 of TABLE 1. When the names were used to search MESH for more source articles, a further 48 were retrieved. This resulted in 74, or approximately 82% of the final number of source articles retrieved.

The membership list of the Canadian section of the International Association of Forensic Toxicologists provided the names of 112 researchers (Appendix C). These names were used to search MESH for source articles. Only 26 of the 112 researchers listed published between 1981 and 1987. The MESH search resulted in the retrieval of 54

TABLE 1

A comparison of the name-gathering methods used for retrieving source articles.

METHOD	NAMES RETRIEVED #	INITIAL ARTICLES #	ARTICLES AFTER MESH SEARCH #	TOTAL ARTICLES (n=90) %
1	12	13	39	43.3
2	24	26	74	82.2
3	112*	-	54	60.0

*Only 26 proved to be authors of articles during the study period.

source articles as seen in Method 3 of TABLE 1. This was 60% of the final number of source articles retrieved.

The Efficiency of Each Method

As would be expected, the three name-gathering methods used showed some overlap with one another in terms of the number of authors retrieved. The first name-gathering method is in effect, a subset of the second method. The overlap is 100% and 50% respectively (TABLE 2). However, half of the authors retrieved from the other five periodicals were repeats of those retrieved from the Journal of Forensic Sciences. The third method produced a large number of non-publishing researchers. Seventeen that did publish were also identified in the second method. The second method overlapped the third by 67%.

The second name-gathering method was the most efficient for leading to source articles published by the authors in forensic toxicology. It doubled the final number of source articles retrieved over the first method and provided access to about 25% more source articles than the third method.

The combined results of the three name-gathering methods were used to develop the study sample. Together, they provided the names of 36 authors who produced a total of 90 source articles. It was expected that these 90 source articles would reflect the type of research that was being done in forensic toxicology in Canada. This was not completely the case. In fact, a little less than half of the source articles were by authors publishing in other disciplines. Publications dealing with pharmacology, pharmacodynamics, pharmacotherapy, animal studies, and medical specialties were retrieved.

TABLE 2

A comparison of the overlap in the names retrieved using each name-gathering method. (n=29)

METHOD	OVERLAP WITH 1 %	OVERLAP WITH 2 %	OVERLAP WITH 3 %
1	-	100.0	66.7
2	50.0	-	66.7
3	7.1	14.3	-

Use of the entire study sample raised questions about the validity of using the results to make management decisions about collections meant to serve forensic toxicology researchers. Obviously, the authors active in forensic toxicology had diverse interests and expertise. But it is questionable whether a collection meant to support forensic toxicology research should also be required to support research in outside areas of interest.

Therefore, to be included in the final study sample, a source article had to deal with the identification of substances in body fluids and materials, methodologies for substance identification, the toxicological effect of substances on humans, or poison control. These restrictions narrowed the study sample to source articles specifically dealing with forensic toxicology. The 36 source articles excluded from the study sample are listed in Appendix D. The remaining 54 source articles are listed in Appendix E. The implications of splitting the study sample are discussed in the next chapter. The 54 source articles and their 750 citations from 29 authors formed the study sample from which the data was collected and the remaining citation analyses were conducted.

B. Characteristics of the Study Sample

The following measurements were made on the data retrieved from the SPIRES database: age distribution and the format distribution. Then the citation sources were ranked. The last measurement allowed a Bradford distribution to be determined, and the variety of subjects cited to be assessed.

Age Distribution

Authors in forensic toxicology in Canada tended to cite recent sources of published information (TABLE 3). Over 10% of the citations were 1 year old or less. 26% of the cited works were two to three years old. This was the largest group. Over half of the cited works were less than 6 years old. Slightly less than 90% of the cited works were 11 years old or less. The age of the cited works did range to a maximum of 62 years but only 0.5% of all the cited works were older than 31 years.

Format Distribution of the Citation Sources

Over 86% of all the citations were to articles in periodicals (TABLE 4). Monographs made up just over 9% of the total citations, and other formats made up just over 4% of the total citations. Of these other formats, handbooks and conference proceedings were cited the most frequently. Ephemera, personal communications, government documents, and directories made up just 1.8% of all the citations analysed.

Subjects that were distantly related to forensic toxicology were more often non-periodical in format than sources that were closely related (TABLE 5). Citation sources with the subject code 1 were predominantly (91%) periodical. Citation sources with the subject codes 0 and 2 were primarily (64% and 70% respectively) periodical. Periodicals played a less important role in the citation sources with the subject code 3 (20%). While citation sources with the subject code 3 had a variety of formats, subject code 0 had an even greater variety.

TABLE 3

Age distribution of the citations.

AGE OF CITATIONS YEARS	FREQUENCY OF CITATIONS #	%	cum %
0- 1	78	10.4	10.4
2- 3	194	26.0	36.4
4- 5	158	21.0	57.4
6- 7	122	16.3	73.7
8- 9	76	10.1	83.8
10-11	44	5.9	89.7
12-13	33	4.4	94.1
14-15	15	2.0	96.1
16-17	5	0.7	96.8
18-19	9	1.2	98.0
20-21	3	0.4	98.4
22-23	5	0.7	99.1
24-25	2	0.3	99.4
26-27	0	0	99.4
28-29	1	0.1	99.5
30-31	1	0.1	99.6
> 31	4	0.5	100
TOTAL	750	100	

TABLE 4

Format distribution of the citations.

FORMAT OF CITATIONS	FREQUENCY OF CITATION #	%
Periodicals	648	86.4
Monographs	69	9.3
Handbooks	9	1.2
Conference proceedings	9	1.2
Ephemera	8	1.1
Personal communications	4	0.5
Government documents	2	0.1
Directories	1	0.1
TOTAL	750	100

TABLE 5

Range of subject codes seen in each of the formats of the citation sources. (n=242)

FORMAT OF THE CITATION SOURCES	SUBJECT CODES 0		1		2		3	
	#	%	#	%	#	%	#	%
Periodicals	59	64	72	91	36	70	4	20
Monographs	18	20	6	8	11	22	6	30
Handbooks	4	4	1	1	2	4	2	10
Conference Proceedings	2	2			2	4	4	20
Ephemera	6	7						
Personal Communications	2	2					2	10
Government Documents							2	10
Directories	1	1						
TOTALS	92	100	79	100	51	100	20	100

Citation Sources

There were a total of 242 citation sources cited by the authors in the study sample. The citation sources were ranked by frequency (Appendix F). The most cited citation source in the study sample was the Journal of Analytical Toxicology. The next most cited citation source was the Journal of Chromatography. The Journal of Forensic Sciences was the most cited forensic periodical, and the New England Journal of Medicine was the most cited general medical periodical. One of the most cited monographs was R. C. Baselt's 1982 publication, Disposition of toxic drugs and chemicals in man.

The ranked list provided the data from which a Bradford distribution was determined. The ranked list was divided into three groups according to the relationship

$$k:ka:ka^2$$

where,

k= the number of citation sources in the first group,

a= a constant related to the study sample,

and where each group contained a similar number of citations. The relationship seen in the ranked list of the study sample was

10 sources contributed 250 citations
48 sources contributed 251 citations
184 sources contributed 249 citations

This reduced to approximately

$$10:10(4.8):10(4.8)^2$$

As is usually observed, the formula did not quite give the observed number of citation sources. According to this formulation of the Bradford distribution, there were ten core sources in forensic toxicology in Canada between 1981 and 1987. These are the first ten citation sources listed in Appendix F.

A formula of the Bradford distribution that is dependent on the rank of the citation sources rather than on groupings of them is

$$R(n) = k \log(n)$$

where,

n= the rank of the n-th source,
R(n)= the total number of citations contributed by the n sources,
k= a constant related to the study sample.

The calculated formulation for this study sample was

$$R(n) = 314.6 \log(n)$$

using the total study sample of R(n)=750 citations, and n=242 citation sources.

Bradford's Law is often reduced to the 80/20 rule when applied to collection management. In a discipline that has a well defined literature, 20% of a collection would serve 80% of the information requests. In this study sample, 20% of the citation sources provided a calculated value of only 71% of the citations, and it took a calculated value of 33% of the citation sources to provide 80% of the citations. However, the raw data showed that 20%, or 48 citation sources provided only 63% of the citations and that 103, or 43% of the citation sources were needed to provide 80% of the citations (Appendix F).

Analysis of the subjects of the most productive 20% of the citation sources in the raw data showed that they were not only in the core of forensic toxicology. Only 48% of these citation sources were related to medical jurisprudence, pharmacology, and toxicology (subject code 0). 35% of the citation sources were related to other aspects of the medical sciences (subject code 1), and 15% were related to the pure sciences (subject code 2). Just 2% of the sources were related to other topics (subject code 3) (TABLE 6). A slightly different subject distribution was shown for the most productive 43% of the citation sources in the raw data.

C. Index of Citation Interdisciplinarity

Citations by Source Article

The subject codes developed for this study were used to assess how dependent a source article was on core subject sources of information. An I value was calculated for each source article. The source articles were then ranked according to their I values (Appendix E). Those source articles associated with the lowest I values had the most citations assigned subject codes closely related to forensic toxicology. Source articles with an I value between 0.6 and 0.8 contained as many citations assigned subject codes 1, 2, or 3 as citations assigned the subject code 0. Any source article with an I value of 0.9 or greater had more citations assigned the subject codes 1, 2, or 3 than it had to the subject code 0. The maximum I value calculated for a source article in the study sample was 2.0. Only the source article ranked 52 contained no citations assigned the subject code 0. However, since this source article only contained two

TABLE 6

Range of assigned subject codes present in the top-ranked citation sources.

TOP-RANKED CITATION SOURCES (%)	SUBJECT CODES (%) 0	1	2	3	TOTAL
20	48	35	15	2	100
43	45	32	21	2	100

citations, it is doubtful whether or not anything significant could be said about it. The entire study sample had an I value of 0.8 which resulted from a subject distribution of 373 citations assigned the subject code 0, 203 citations assigned the subject code 1, 147 citations assigned the subject code 2, and 27 citations assigned the subject code 3.

Citations by Author

I values were calculated for each author in the study sample and then each author was ranked accordingly (TABLE 7). I values ranged from a minimum of 0 to a maximum of 1.5. All authors cited at least one citation source assigned the subject code 0.

To test the hypothesis stated earlier, a X^2 was calculated for each author. The significance of a X^2 cannot be tested if the expected value of any of the cells is less than 1, or less than 5 if the cell makes up more than 20% of the total. As can be seen in TABLE 7, many of the authors had too few citations to test the significance of the range of subject codes. Those X^2 values that could not be tested are enclosed in brackets and were only used to indicate trends. Those X^2's that were significant are starred.

The X^2's for authors 5, 12, and 16 agree with the expected value for the study sample as a whole. Therefore the test hypothesis was rejected for these authors. They conformed to the subject citation pattern demonstrated by the authors in forensic toxicology as a whole. On the other hand, the X^2's for authors 7, 8, 9, 22, 23, and 26 do not agree with the expected subject citation pattern seen in forensic toxicology as a whole. The test hypothesis that an author will demonstrate a subject

TABLE 7

The subject codes cited, I values, and X^2's for each author.

AUTHOR NUMBER	SUBJECT CODES (#) 0	1	2	3	I	X^2
1	1				0	(0.919)
2	4				0	(3.646)
3	5				0	(4.494)
4	4		1		0.4	(2.289)
5	29	19	3		0.5	6.186
6	15		5		0.5	(8.711) *
7	85	47	17		0.5	9.745 *
8	56	33	5	1	0.5	12.331 *
9	72	51	6	1	0.5	22.106
10	5	3	1		0.6	(0.652)
11	10	4	3		0.6	(0.781)
12	25	5	4	3	0.6	7.594 *
13	20	4	2	3	0.6	9.541
14	7	2	3		0.7	(1.364)
15	4		2		0.7	(2.943)
16	44	12	17	2	0.7	5.273
17	5	2	3		0.8	(1.449)
18	5	12		1	0.8	(15.936)
19	3	3	2		0.9	(1.199)
20	5	4	4		0.9	(2.331)
21	12	2	8	1	0.9	(6.96) *
22	33	1	14	7	0.9	30.242 *
23	21	13	19		1.0	13.99
24	11	1	10		1.0	(14.943)
25	7	1	6	1	1.1	(7.336) *
26	17	47	5	12	1.2	81.979
27	6	2	13		1.3	(29.398)
28	6		13		1.4	(35.926)
29	2		6		1.5	(18.911)
TOTAL	519	268	172	33		

*Significant X^2's. X^2's enclosed in brackets were not tested for significance.

Degrees of freedom = 3. Level of significance = 0.05. Significant value = 7.815.

citation pattern that is different from the pattern in forensic toxicology as a whole, is accepted for these authors.

A general trend indicated in the data presented in TABLE 7 is that as their I values increased, the authors were more likely to demonstrate a subject citation pattern that deviated from the pattern demonstrated in forensic toxicology as a whole.

IV. Discussion

A. Development of the Study Sample

Citation studies, such as those conducted by Garfield (1972) or Porter and Chubin (1985), used all the articles from selected periodicals as the basis for study. Others, such as Chubin, Porter, and Rossini (1984), used articles with selected characteristics as the basis for study. This study used the names of authors to identify source articles for study. This approach allowed a greater variety of research to be assessed than would have been possible using either of the other approaches.

The three name-gathering methods used in this study illustrated the differences in results that can occur because of data-gathering methods. The selection of a single periodical to represent a discipline is a common method used to study information use within a discipline. In this study, it resulted in a small study sample that was limited in scope by the editorial policies, objectives, and the audience of the chosen periodical. The use of a group of periodicals to represent a discipline resulted in a larger study sample that was still limited in scope. The use of a membership list resulted in a study sample of moderate size but broad in scope because it was not limited to source articles that were acceptable for publication in only a few periodicals. However, this last method produced a large number of non-publishing researchers.

The scope and size of the study samples derived from the first two methods were increased when author names were used to retrieve source articles from MESH. These expanded study samples showed that authors active in forensic toxicology in Canada did not rely on periodicals devoted to forensic science alone to convey their research to the scientific community. Therefore, using a single periodical or a select group of periodicals to identify a study sample is not adequate when studying a discipline.

The method of using the names of authors to identify source articles for analysis was selected for this study because it resulted in a study sample that best represented the information use of researchers in a discipline. The intent was to assess the subject variety of information cited to solve discipline problems. However, this method also retrieved source articles by the authors that had nothing to do with the discipline being studied. Therefore, the data-gathering method was not completely acceptable for this study. Its use meant that another layer of decision making had to be developed to obtain an acceptable study sample. This increased the chance of error when developing a representative sample.

However, use of this method produced some interesting results. Besides providing source articles appropriate for analysis in this study, it also indicated the extent to which researchers in this discipline practiced other disciplines, and what these other disciplines were. Analysis of a study sample that included these other source articles could lead to a better understanding of the dynamics of IDR.

B. Information Use Characteristics of the Study Sample

Age and Format of the Citations

Authors in forensic toxicology in Canada tended to cite recent sources of information. This is not unusual in a scientific discipline. The literature half-life (the median age of the cited works) for this discipline was about four years, putting it on the low end of the age scale for scientific disciplines (O'Connor and Voos 1981). Therefore the obsolescence rate of a research collection serving this discipline is fairly high.

The sources cited by these authors were most often periodical in format. Monographs were the next most important and the remainder of the formats were cited rarely. When subjects that were distantly related to the discipline were cited, the sources were often non-periodical in format. Authors who cited the subject group 3 relied on non-periodical formats in this area. When subject group 2 was cited, the periodical format dominated but monographs were important as well. Other formats were much less important. Citations to subject group 1 were almost completely dominated by the periodical format. Other formats made virtually no impact in this subject group.

The format trend alluded to in the literature is that citations to subjects closely related to the discipline were more likely to be periodical in format than citations to subjects distantly related to the discipline. However, in this study sample, citations to the subject group 0 showed the greatest diversity in format type. An explanation for this might be that the researchers in the discipline were more familiar with the body of literature closely related to the discipline than they were with the literature that was distantly related. The high level of citations to periodicals in subject group 1, the medical sciences, indicates that they were likely making use of very specific medical information that would not be found in other formats. When citing subject group 2, or the pure sciences, they were still making use of the specific information found in periodicals but were also possibly making use of the more general and established information found in non-periodical formats.

This analysis of the study sample indicates that a research collection supporting this discipline would contain a variety of formats and subjects. Important periodical sources from subject groups 0, 1, and 2 would be present as would key monographs from each group. There would be a greater diversity of formats available for subject group 0 than the other groups, and if any collecting were done for subject group 3 it would emphasize non-periodical formats. There were also indications from this data that a verticle file would be a useful supplement to this type of collection.

Most Cited Citation Sources

The most cited citation sources in this study were periodicals closely related to the discipline. The most cited monographs were also closely related to the discipline. Other sources that were highly cited came from the subject groups 1 and 2. Bradford distributions were calculated that did not conform to calculations done by other researchers studying subject literatures.

Most Bradford distributions reported in the literature were calculated from specialized subject bibliographies. IDR tends not to be subject specialized. Therefore, a typical Bradford distribution was not expected for the study sample. Even so, the distribution observed raised many questions about the underlying basis of literature distributions and the application of these distributions to collection management.

Neither of the calculated distributions exactly reflected the observed data in this study. The logarithmic formulation came closer than the other, but there were important differences. The authors active in forensic toxicology in Canada were not as dependent on a "core" of literature as Bradford's Law would predict. The most cited citation sources were less important in terms of over all citations than is usually observed. The calculated distribution predicted that the 80/20 rule would not be observed. However, the prediction of 71/20 and 80/33 was closer to the 80/20 rule than the observed 63/20 and 80/43. The differences between the observed and the calculated distributions in this study indicated that more was affecting the literature distribution than the rank of the citation sources. The results indicated that the 80/20 rule should be applied with caution to collections serving IDR.

The results also showed that the citation rankings of the sources were not dependent on the subject of the citation sources. The subject codes 0, 1, and 2 were well represented in the top ranked citation sources. The 24th ranked citation source was the first from the subject code 3. This is well within the top 20% of the study sample. What this means in terms of other Bradford distribution studies is unknown, since the citation sources in these studies were never assessed according to subject.

C. Index of Citation Interdisciplinarity

The authors active in forensic toxicology in Canada showed varying degrees of dependency on subjects closely related to the discipline. Every article but one had at least one citation to the subject group 0. The I values of the articles in the study sample ranged from 0 to 2.0 with the I value for the entire study sample being 0.8. The variability in the I values indicated that the variety of subjects used to solve research problems in this discipline varied from problem to problem.

The distribution of the citations to various subjects in the study sample as a whole was used to represent the variety of subjects used in forensic toxicology as a whole. To see whether individual researchers could be served by a collection developed with an entire discipline in mind, the distribution of their citations to various subjects was compared to the study sample. The X^2 values calculated for each author showed that some conformed to the distribution seen in the entire study sample, while others did not. If the researchers were ranked according to the I values of their published research, the data indicated the researchers with high I values were less likely to be well served by a general discipline collection. Researchers with low I values were more likely to be well served by a general discipline collection. Unfortunately, not enough data were collected to say whether this trend was significant.

Those researchers that had low I values but high X^2 values were interesting cases. While these researchers were very dependent on sources from the subject group 0, the were also very dependent on the subject group 1. Since sources from this last group would be expected to play an important role in any research collection serving this discipline, these researchers would be easier to serve than researchers with high I and X^2 values.

The results indicated that I values would be useful in gauging the variety of information a researcher might need access to when resolving research problems. When used in conjunction with χ^2 "goodness-of-fit" tests, the I values would be even more useful. However, when deviations occur, it would be necessary to check the researcher's citation distribution to be sure these deviations have implications for collection management. The hypothesis tested in this study is a self-evident one. However, an information specialist would find the hypothesis useful when comparing their clients to I values of research disciplines that have been calculated independently.

V. Conclusions and Suggestions for Further Study

Using the names of authors to retrieve the source articles resulted in a better study sample for analysis than using either the articles from a single periodical or from a group of periodicals. The sample was better because it was not limited by the editorial policies, objectives, and audience of the selected periodicals. These types of limitations result in the introduction of unnecessary biases into data being assessed for their subject variety. The success this study had in showing the use of distantly related subjects in IDR, compared to Porter and Chubin's failure to do so in their 1985 study, may well be due in part to the different data-gathering methods used.

Of the methods tested, the best way to retrieve names of authors active in forensic toxicology was to use a group of periodicals. The membership list gave a large number of known researchers, but many did not publish during the study time period. Using a membership list alone to identify authors gave a list of names that was relatively unproductive and expensive when used to retrieve source articles from MESH. The number of authors retrieved from the membership list that were not already retrieved from the periodical searches was very small. Therefore, including a membership list to expand the number of articles retrieved would not be necessary for most purposes.

The study sample that resulted from using the data-gathering method described was too broad for the purposes of this study. It was a good representation of the type of research conducted by those active in forensic toxicology in Canada, but many of the authors actively practiced other disciplines as well. This meant that use of the entire study sample to assess the variety of subjects cited in forensic toxicology would have resulted in inaccurate results.

The necessity of applying another level of decision making to the study sample to make it acceptable for the purposes of this study increased both the subjectivity of the study and the chance of introducing errors. This data-gathering method might be applied successfully by information specialists wanting to assess the dynamics of IDR. A more efficient and simpler approach will have to be developed for study samples meant to serve as guides for the management of research collections.

The database developed for this study was meant to be used for citation analysis. A whole range of patterns could be determined with the addition of the single data element of subject category. In this study, the subject citation pattern of the authors and in forensic toxicology as a whole were assessed. The database also allows comparisons to be made between subject category and age, institution affiliation, or the source article. Comparisons could also be made between the age and format of the citations. Numerous non-subject citation patterns of the authors, their affiliations, and the sources they published in could also be determined.

The ISI data tapes are used by many investigators as the database for their citation analyses. These tapes are capable of producing only the most rudimentary citation counts. This database was developed for the sole purpose of studying citations and elements of importance are not left out. Information use is not dependent upon a single variable such as citation rank. Many believe that the research area, the work environment, and the researcher's personal interests play important roles as well. These variables must be represented in a citation database if any type of meaningful multi-variate analysis of information use is to be contemplated.

The database developed for this study was not large enough to do the multi-variate analysis mentioned above. The size of the database could be increased by increasing the time period studied, by removing the geographic limitation, or by searching another online indexing service. Some of the variables mentioned were looked at in more detail than was reported here. Citation patterns to various subjects did shift according to the author's institutional affiliation, and according to the source periodical the research was published in. While the citation counts were too low to determine whether or not there was any significance to these shifts, the trends were obvious enough to warrant further study. The age and format of the citation sources may also shift according to the author, the institutional affiliation, and the source periodical.

The index developed for this study was relatively successful. The codes were representative of the levels in the DDC hierarchy established for forensic toxicology when used for collection management purposes. The I values were easy to calculate. The protocol for developing the DDC hierarchy and the formula for calculating the I values would be easy to apply to other areas of research. However, the differences between the levels in the DDC hierarchy may not be exactly arithmetic. Codes representing a geometric or an exponential progression within the hierarchy should be tested.

This study was more successful at showing the variety of subjects cited in IDR than past studies (Porter and Chubin 1985) have been. Use of the DDC system, rather than Porter and Chubin's (1985) system, was one of the main reasons for this success. The DDC system classifies concepts. With the expertize of information specialists, these concepts can be easily grouped to resemble the concepts important to a particular research area. The system used by Porter and Chubin (1985) was intended to group research projects together mainly for funding purposes. If their system was superimposed on the subject codes developed from the DDC numbers in this study, all of subject codes 0, 1, and most of 2 would be grouped together as the "life sciences". The remainder of code 2 would be placed in the "physical sciences". Most of code 3 would be in the "social sciences" and the rest in "engineering".

If the citations to non-periodical formats were excluded, the "social sciences" and "engineering" would virtually disappear. This would leave the researchers in the discipline of forensic toxicology in Canada making citations only to the life sciences and intermittently to the physical sciences. While this is generally true, the term "life science citation" does not come close to describing the variety observed in this study.

Being able to assess the variety of information used is important to information specialists concerned with the management of IDR collections. Not only must they be able to assess the variety of information used at any given point in time, they must also be able to track changes in the variety that are bound to occur in any discipline. Using DDC numbers to develop subject codes would allow them to do this.

Using subject codes derived from DDC numbers to determine I values for individual researchers gives information specialists a tool for assessing the individual needs of researchers and adjusting collection management policies accordingly. High I values for a group of researchers is an indication that a regular collection, even one developed with a specific research discipline in mind, is unlikely to adequately serve these researcher's needs. Approaches other than collection development, such as interlibrary loan or selected dissemination of information (SDI), would have to be considered.

This study also raised concerns about relying on Bradford distributions when making collection management decisions. The distribution calculated for this discipline did predict that a core of literature is not as important to forensic toxicology as it is to other disciplines. However, the differences between the calculated and the observed distributions indicate Bradford formulae are of questionable value here. More analysis of the variables affecting literature distributions is needed to explain these discrepancies. Until then, the 80/20 rule of collection management should be applied with caution to collections serving IDR. Information specialists should expect a much larger proportion of their collections to be heavily used in these situations, and should manage them accordingly.

The method developed in this study was tested on a single discipline. However, it should be applicable to any discipline. All that is required is a database that reflects a discipline, an understanding of the DDC system, and some subject expertise in the discipline being assessed. Wider application of this method could lead to the development of more quantitative tools to help information specialists to develop collections that serve the dynamic information needs of researchers.

Bibliography

Anbar, M. 1973. "The 'bridge scientist' and his role." Reprinted in Interdisciplinary analysis and research: Theory and practice of problem-focused research and development. 1986. Edited by D. E. Chubin, et al. Mt. Airy, Maryland : Lomond Publications. pp. 155-163.

Bailey, M. J. 1978. "Selecting materials for interdisciplinary programs." Special Libraries. 69(12) : 468-474.

Bawden, D. 1986. "Information systems and the stimulation of creativity." Journal of Information Science. 12(5) : 203-216.

Bertalanffy, L. von. 1968. General systems theory: Foundations, developments, applications. New York, New York : George Braziller. 289 p.

Beveridge, W. I. B. 1957. The art of scientific investigation. New York, New York : Vintage Books. 239 p.

Beveridge, W. I. B. 1980. Seeds of discovery: A sequal to The art of scientific investigation. London, England : Heinemann Educational Books. 130 p.

Boyce, B. R., and D. H. Kraft. 1985. "Principles and theories in information science." Annual Review of Information Science and Technology. 20 : 153-178.

Broadus, R. N. 1983. "An investigation of the validity of bibliographic citations." Journal of the American Society for Information Science. 34(2) : 132-135.

Chubin, D. E., A. L. Porter, and F. A. Rossini. 1984. "'Citation Classics' analysis: An approach to characterizing interdisciplinary research." Journal of the American Society for Information Science. 35(6) : 360-368.

Darden, L., and N. Maull. 1977. "Interfield theories." Reprinted in Interdisciplinary analysis and research: Theory and practice of problem-focused research and development. 1986. Edited by D. E. Chubin, et al. Mt. Airy, Maryland : Lomond Publications. pp. 307-321.

Derr, R. L. 1983. "A conceptual analysis of information need." Information Processing and Management. 19(5) : 273-278.

Dewey decimal classification and relative index. Devised by Melvil Dewey. 1979. 19th edition. Volume I. Edited by B. A. Custer. Albany, New York : Forest Press. 482 p.

Drott, M. C. 1981. "Bradford's Law: Theory, empiricism and the gaps between." Library Trends. 30(1) : 41-52.

Garfield, E. 1972. "Citation analysis as a tool in journal evaluation." Science. 178(4060) : 471-479.

Garfield, E. 1974. "The Citation Index as a subject index." Reprinted in E. Garfield. 1977. Essays of an information scientist. Volume 2. Philadelphia, Pennsylvania : ISI Press. pp. 62-64.

Garvey, W. D. 1979. Communication: The essence of science. Facilitating information exchange among librarians, scientists, engineers and students. Oxford, England : Pergamon Press. 332 p.

Herner, S. 1954. "Information gathering habits of workers in pure and applied sciences." Industrial and Chemical Engineering. 46(1) : 228-236.

Hubert. J. J. 1981. "General bibliometric models." Library Trends. 30(1) : 65-82.

Jones, G. 1987. Personnal communication.

Kasperson, C. J. 1978. "Psychology of the scientist: xxxvii. Scientific creativity: A relationship with information channels." Psychological Reports. 42(3) : 691-694.

Kissman, H. M., and P. Wexler. 1983. "Toxicological information." Annual Review of Information Science and Technology. 18 : 185-230.

Klein, J. T. 1986. "The broad scope of interdisciplinarity." In Interdisciplinary analysis and research: Theory and practice of problem-focused research and development. Edited by D. E. Chubin, et al. Mt. Airy, Maryland : Lomond Publications. pp. 409-424.

Koenig, M. E. D. 1978. "Citation analysis for the arts and humanities as a collection management tool." Collection Management. 2(3) : 247-261.

Koenig, M. E. D. 1983. "Bibliometric indicators versus expert opinion in assessing research performance." Journal of the American Society for Information Science. 34(2) : 136-145.

Kuhn, T. S. 1970. The structure of scientific revolutions. 2d ed. Chicago, Illinois : University of Chicago Press. 210 p.

Lamb, D., and S. M. Easton. 1984. Multiple discovery : The pattern of scientific progress. Avebury, England : Avebury. 248 p.

Loomis, T. A. 1974. Essentials of toxicology. 2d ed. Philadelphia, Pennsylavnia : Lea and Febiger. 223 p.

Martin, P. 1982. "The innovation process and the online information channel." in Information and innovation: Proceedings of a seminar of ICSU-AB on the role of information in the innovation process, Amsterdam, May 24-25, 1982. Edited by B. T. Stern. Amsterdam, Netherlands : North-Holland. pp. 159-168.

Meeth, L. R. 1978. "Interdisciplinary studies: A matter of definition." Change. 10(7) : 10.

Miyamoto, S., and K. Nakayama. 1983. "A technique of two-stage clustering applied to environmental and civil engineering and related methods of citation analysis." Journal of the American Society for Information Science. 34(3) : 192-201.

Narin, F., G. Pinski, and H. H. Gee. 1976. "Structure of the biomedical literature." Journal of the American Society for Information Science. 27(1) : 25-45.

Newey, J. M. 1985. Information specialist as team player in the research process. Westport, Connecticut : Greenwood Press. 194 p.

O'Connor, D. O., and H. Voos. "Emperical laws, theory construction and bibliometrics." Library Trends. 30(1) : 9-20.

O'Dette, R. E. 1969. "Literature and the creative process- Help or hindrance?" Journal of Chemical Documentation. 9(3) : 183-190.

Pachevsky, T. 1982. "Problems of information services with respect to integration of the sciences." Journal of the American Society for Information Science. 33(3) : 115-123.

Petrie, H. D. 1976. "Do you see what I see? The epistemology of interdisciplinary inquiry." Journal of Aesthetic Education. 10(1) : 29-43.

Porter, A. L. 1983. "Interdisciplinary research: Current experience in policy and performance." Interdisciplinary Science Reviews. 8(2) : 158-167.

Porter, A. L., and F. A. Rossini. 1984. "Interdisciplinary research redefined: Multi-skill, problem-focused research in the STRAP framework." R & D Management. 14(2) : 105-111.

Porter, A. L., and D. E. Chubin. 1985. "An indicator of cross-disciplinary research." Scientometrics. 8(3-4) : 161-176.

Repo, A. J. 1986. "The dual approach to the value of information: An appraisal of use and exchange values." Information Processing and Management. 22(5) : 373-383.

Rosenberg, V. 1967. "Factors affecting the preferences of industrial personnel for information gathering methods." Information Storage and Retrieval. 3 : 119-127.

Salasin, J., and T. Cedar. 1985. "Information-seeking behavior in an applied research/ service delivery setting." Journal of the American Society for Information Science. 36(2) : 94-102.

Salasin, J., and T. Cedar. 1985. "Person-to-person communication in an applied research/service delivery setting. Journal of the American Society for Information Science. 36(2) : 103-115.

Small, H. G. 1978. "Cited documents as concept symbols." Social Studies of Science. 8(3) : 327-340.

Smith, L. C. 1981. "Citation analysis." Library Trends. 30(1) : 83-106.

Swanson, D. R. 1987. "Two medical literatures that are logically but not bibliographically connected." Journal of the American Society for Information Science. 38(4) : 228-233.

Toulmin, S. 1972. Human understanding: The collective use and evolution of concepts. Volume 1. Oxford, England : Claredon Press. 520 p.

Vickery, J. E. 1977. "A note in the defence of browsing." BLL Review. 5(3) : 110.

Voigt, M. J. 1961. Scientists' approaches to information. Chicago, Illinois : American Library Association. (ACRL Monograph Number 24). 81 p.

Volk, W. 1982. Engineering statistics with a programmable calculator. New York, New York : McGraw Hill. 362 p.

Wallace, D. P. 1987. "A solution in search of a problem: Bibliometrics and libraries." Library Journal. 112(8) : 43-47.

Weimer, W. B. 1979. Notes on the methodology of scientific research. Hillsdale, New Jersey : L. Erlbaum. 257 p.

White, E. C. 1985. "Bibliometrics: From curiosity to convention." Special Libraries. 76(1) : 35-42.

Willard, D. D. 1973. "Differences in needs for interdisciplinary materials by authors of theoretical and practical writings in two applied disciplines." Ph.D. Dissertation, University of Illinois at Urbana-Champaign, Graduate College, Library Science. 264 p.

Woodward, A. M. 1977. "The role of reviews in information transfer." Journal of the American Society for Information Science. 28(3) : 175-180.

Reference Works Consulted

The ALA glossary of library and information science. 1983. Young, H., ed. Chicago, Illinois : American Library Association. 245 p.

Books in print. 1948- New York, New York : R. R. Bowker.

Dewey decimal classification and relative index. Devised by Melvil Dewey. 1979. 19th edition. Volumes 1-3. Edited by B. A. Custer. Albany, New York : Forest Press.

Proceedings in print. v. 1- . Oct. 1964- New York, New York : Special Libraries Association. Aerospace Division.

Ulrich's international periodical directory. 1932- New York, New York : R. R. Bowker.

Union list of scientific serials in Canadian libraries. 1985. 11th ed. Ottawa, Ont. : Canada Institute for Scientific and Technical Information. 3 volumes.

Appendix A

The list of authors active in forensic toxicology in Canada that was derived from the *Journal of Forensic Sciences*.

Bailey, K.
Drug Investigation Division, Drug Research Laboratory, Health Protection Branch, Ottawa.

Chan, E. M.
Provincial Toxicology Centre, Riverview Hospital, Port Coquitlam.

Cimbura, G.
Centre for Forensic Sciences, Toronto.

Fraser, A. D.
Division of Clinical Chemistry, Victoria General Hospital, Halifax.

Isner, A. F.
Division of Clinical Chemistry, Victoria General Hospital, Halifax.

Jeffery, W.
Toxicology Section, Crime Detection Laboratory, RCMP, Vancouver.

Keenan, J. R.
RCMP Criminal Laboratory, Winnipeg.

Koves, E.
Toxicology Section, Centre for Forensic Sciences, Toronto.

Lucas, D. M.
Centre for Forensic Sciences, Toronto.

Meatherall, R. C.
Department of Laboratory Medicine, St. Bonniface General Hospital, Winnipeg.

Pate, B. D.
Faculty of Pharmaceutical Sciences, University of British Columbia, Vancouver.

Peel, H. W.
Science and Technology Advisory Group "L", Directorate RCMP, Ottawa.

Appendix B

The list of authors active in forensic toxicology in Canada that was derived from the Canadian Society of Forensic Science Journal, the Journal of Forensic Sciences, the Forensic Science International, The American Journal of Forensic Medicine and Pathology, Medicine, Science and the Law, and the Medicolegal Journal.

Archibald, K. T.
Toxicology Section, Forensic Laboratory, RCMP, Halifax.

Avdovich, H. W.
Bureau of Drug Research, Health and Welfare Canada, Ottawa.

Bailey, K.
Drug Investigation Division, Drug Research Laboratory, Health Protection Branch, Ottawa.

Bernard, G.
Ministere de la Justice, Laboratoire de police scientifique, Montreal.

Bertrand, M. J.
Institute National de la Recherche Scientifique, Section sante, Montreal.

Chan, E. M.
Provincial Toxicology Centre, Riverview Hospital, Port Coquitlam.

Chan, S. C.
Department of Laboratory Medicine, Foothills Hospital, Calgary.

Cimbura, G.
Centre for Forensic Sciences, Toronto.

Degouffe, M.
Toxicology Section, CD Laboratory, RCMP, Edmonton.

Fraser, A. D.
Division of Clinical Chemistry, Victoria General Hospital, Halifax.

Hindmarsh, K. W.
College of Pharmacy, University of Saskatchewan, Saskatoon.

Isner, A. F.
Division of Clinical Chemistry, Victoria General Hospital, Halifax.

Jeffery, W.
Toxicology Section, Crime Detection Laboratory, RCMP, Vancouver.

Kaliciak, H. A.
Provincial Toxicology Centre, Riverview Hospital, Port Coquitlam.

Keenan, J. R.
RCMP Criminal Laboratory, Winnipeg.

Koves, E.
Toxicology Section, Centre for Forensic Sciences, Toronto.

Lucas, D. M.
Centre for Forensic Sciences, Toronto.

McBurney, L. J.
Defence and Civil Institute of Environmental Medicine, Downsview.

Meatherall, R. C.
Department of Laboratory Medicine, St. Boniface General Hospital, Winnipeg.

Pate, B. D.
Faculty of Pharmaceutical Sciences, University of British Columbia, Vancouver.

Peclet, C.
Ministere de la Justice, Laboratoire de police scientifique, Montreal.

Peel, H. W.
Science and Technology Advisory Group "L", Directorate RCMP, Ottawa.

Sharp, M. E.
Toxicology Section, Forensic Laboratory, RCMP, Regina.

Wells, J.
Centre for Forensic Sciences, Toronto.

Appendix C

The list of researchers active in forensic toxicology in Canada that was derived from the 1987 membership list of the International Association of Forensic Toxicologists (provided by Dr. G. R. Jones, Chief Toxicologist, Office of the Chief Medical Examiner, Department of the Attorney General, Edmonton, Alberta).

Adotey, A. K. K.
RCMP Forensic Laboratory, Vancouver.

Archibald, J. T.
RCMP Forensic Laboratory, Halifax.

Armstrong, R.
Scarborough, Ontario.

Asselin, W. M.
RCMP Forensic Laboratory, Vancouver.

Bakich, N.
Vancouver, British Columbia.

Baumier, P. M.
Mann Testing Laboratories Ltd., Mississauga.

Beesley, R.
RCMP Forensic Laboratory, Winnipeg.

Bell, A. A. H.
Centre for Forensic Sciences, Toronto.

Benedetti, J.-L.
Centre de Toxicologie du Quebec.

Bergman, R. A.
Gloucester, Ontario.

Boffey, G. C.
Clinical Pathology Service, Royal Inland Hospital, Kamloops.

Bowthorpe, W.
RCMP Forensic Laboratory, Vancouver.

Boyce, G. A.
Health Protection, Halifax.

Carpenter, R. P.
RCMP Forensic Laboratory, Halifax.

Caughlin, J. D.
RCMP Forensic Laboratory, Vancouver (Since 1985).

Chan, E. M.
Riverview Hospital, Port Coquitlam.

Chan, S. C.
Foothills Hospital, Calgary.

Charlebois, R.
Centre for Forensic Sciences, Toronto.

Church, J.
Centre for Forensic Sciences, Toronto.

Cimbura, G.
Centre for Forensic Sciences, Toronto.

Cody, T. E.
RCMP Forensic Laboratory, Edmonton.

Comeau, F. J. E.
Brampton, Ontario.

Dalpe-Scott, M.
RCMP Central Forensic Laboratory, Ottawa.

Degouffe, M.
RCMP Central Forensic Laboratory, Ottawa.

Dehaut, L.
Laboratoire de police scientifique, Montreal.

Del Bigio, K.
RCMP Forensic Laboratory, Winnipeg.

De Luca, L.
Moncton, New Brunswick.

Dittmar, E. A.
RCMP Forensic Laboratory, Edmonton.

Donelson, A.
Traffic Injury Research Foundation of Canada, Ottawa.

Dorian, V.
RCMP Forensic Laboratory, Edmonton.

Douglas, D. E.
Westmount, Quebec.

Drost, M. L.
RCMP Forensic Laboratory, Edmonton.

Elves, S. M.
RCMP Forensic Laboratory, Regina.

Fennell, E. J.
Vancouver, British Columbia.

Fenwick, J. D.
Lynn and Johnston Laboratories Inc., Lachine.

Fromm, F. L.
RCMP Forensic Laboratory, Regina.

Gabe, A.
Pharmtec, Toronto.

Garbutt, D. J.
RCMP Central Forensic Laboratory, Ottawa.

Gaudet, M.
Laboratoire de police scientifique, Montreal.

Gerlitz, B. J.
RCMP Forensic Laboratory, Edmonton.

Hall, A. E. D.
Centre for Forensic Sciences, Toronto.

Hallett, R. A.
Centre for Forensic Sciences, Toronto.

Hindmarsh, K. W.
University of Saskatchewan, Saskatoon.

Hirsch, G. H.
Health Protection Branch, Vancouver.

Hoday, J.
RCMP Central Forensic Laboratory, Ottawa.

Hodgson, B. T.
RCMP Central Forensic Laboratory, Ottawa.

Hudson, J. C.
RCMP Forensic Laboratory, Regina.

Hugel, J.
Whitby, Ontario.

Isner, A. F.
Victoria General Hospital, Halifax.

Jakus, J. T.
RCMP Forensic Laboratory, Vancouver.

Janzen, K. E.
RCMP Forensic Laboratory, Edmonton.

Jeffery, W.
RCMP Forensic Laboratory, Vancouver.

Johnson, H. M.
RCMP Forensic Laboratory, Vancouver.

Johnston, G. H.
Lynn and Johnston Laboratories, Inc., Lachine.

Johnston, G. J.
Commission on Drug Dependency, Halifax.

Jones, G. R.
Department of the Attorney General, Edmonton.

Joynt, B. P.
RCMP Central Forensic Laboratory, Ottawa.

Kapur, B. M.
Addiction Research Foundation of Ontario, Toronto.

Keenan, J. R.
RCMP Forensic Laboratory, Winnipeg.

Kertesz, J. P.
Centre for Forensic Sciences, Toronto.

Kirkwood, C. M.
City Analyst's Laboratory, Vancouver.

Koves, E.
Centre for Forensic Sciences, Toronto.

Koves, G.
Centre for Forensic Sciences, Toronto.

Krepiakevich, T. A.
RCMP Forensic Laboratory, Winnipeg.

Kuperferschmidt, G. J.
Oakville, Ontario.

Ladelpha. S.
RCMP Forensic Laboratory, Sackville.

Lamb, S. F.
RCMP Forensic Laboratory, Halifax.

Larue, L. E.
RCMP Forensic Laboratory, Edmonton.

Laughlin, A. G.
RCMP Forensic Laboratory, Regina.

Lipka, J. E.
Lipka Consultant Service and Investments, Sherwood Park.

Lupp, I.
Centre for Forensic Sciences, Toronto.

Mason-Daniel, V. A.
RCMP Forensic Laboratory, Winnipeg.

Maynard, G. E.
North Vancouver, British Columbia.

McAuley, F.
Centre for Forensic Sciences, Toronto.

McBurney, L. J.
Defence and Civil Institute of Environmental Medicine, Downsview.

McClure, D. J.
RCMP Central Forensic Laboratory, Ottawa.

McGuire, H. J.
RCMP Central Forensic Laboratory, Ottawa.

Meatherall, R. C.
St. Boniface General Hospital, Winnipeg.

Moffat, A. C.
Gloucester, Ontario.

Morin, J.
Laboratoire de police scientifique, Montreal.

Mullen, P. W.
Kemic Bioresearch Laboratories, Kentville.

Newton, P.
Edmonton, Alberta.

kamura, J. O.
RCMP Forensic Laboratory, Regina.

Papple, W.
RCMP "L" Directorate, Ottawa.

Peclet, C.
Laboratoire de police scientifique, Montreal.

Peel, H. W.
RCMP "L" Directorate, Ottawa.

Perrigo, B. J.
RCMP Central Forensic Laboratory, Ottawa.

Picotte, P.
Laboratoire de police scientifique, Montreal.

Pon, R.
RCMP Forensic Laboratory, Edmonton.

Prokopanko, R. T.
RCMP Forensic Laboratory, Winnipeg.

Purchase, C. A.
RCMP Forensic Laboratory, Winnipeg.

Radych, W.
Kanata, Ontario.

Rideout, E. F.

Robichaud, J. R.
RCMP Forensic Laboratory, Sackville.

Robinson, D. W.
Centre for Forensic Sciences, Toronto.

Rousseau, J. J.
Laboratoire de police scientifique, Montreal.

Sharp, M. E.
RCMP Forensic Laboratory, Regina.

Sun, W.-C.
Centre for Forensic Sciences, Toronto.

Tauscher, U. M.
Edmonton, Alberta.

Tenneson, S. M.
Laval, Quèbec.

Ulrich, R. J.
RCMP Forensic Laboratory, Vancouver.

Walter, L.
RCMP Forensic Laboratory, Edmonton.

Ward, M. J.
Centre for Forensic Sciences, Toronto.

Wells, A. E.
RCMP Forensic Laboratory, Halifax.

Wells, J.
Centre for Forensic Sciences, Toronto.

Westenbrink, W.
RCMP Forensic Laboratory, Winnipeg.

Wigmore, J. G.
Centre for Forensic Sciences, Toronto.

Wong, A.
Centre for Forensic Sciences, Toronto.

Yen, B.
Centre for Forensic Sciences, Toronto.

Yeung, E. A.
Health and Welfare Canada, Ottawa.

Yip, M. W.
City Analyst's Laboratory, Vancouver.

Zamecnik, J.
Health and Welfare Canada, Downsview.

Appendix D

The bibliography of source articles the authors published that were retrieved from the periodical and MESH searches but were not included in the final study sample.

Bailey, K., A. Menzies, and H. Watanabe. 1983. "Structure of the isonicotinyl hydrazone of norethindrone." Journal of Pharmaceutical Sciences. 72(9) : 1084-1086.

Bailey, K., B. H. Thomas, M. Vezina, L. W. Whithouse, and W. Zeit. 1983. "2,6- diamino-5- hydroxy-3- (phenylazo) pyridine, a novel metabolite of phenazopyridine in the rat." Drug Metabolism and Disposition. 11(3) : 277-278.

Barbeau, A., M. Bertrand, R. Bouchard, G. L. Gauthier, and J. P. Bouchard. 1982. "Effect of a valine load test on plasma alpha-keto acids in Friedreich ataxia." Canadian Journal of Neurological Science. 9(2) : 239-242.

Bergeron, M. G., M. Le Bel, A. Charest, J. F. Focier, J. Morin, and F. Vallee. 1986. "Comparative study of serum bactericidal activity of cefotaxime alone or in combination with tobramycin." Antimicrobial Agents and Chemotherapy. 29(2) : 379-381.

Bertrand, M. J., R. Bouchard, G. L. Gauthier, J. P. Bouchard, and A. Barbeau. 1982. "Quantitative metabolic profiling of alpha-keto acids in Friedreich's ataxia." Canadian Journal of Neurological Science. 9(2) : 231-234.

Bertrand, M. J., P. Thibault, M. J. Evans, and D. Zidarov. 1987. "Determination of the empirical formula of peptides by fast atom bombardment mass spectrometry." Biomedical and Environmental Mass Spectrometry. 14(6) : 249-256.

Bielmann, P., D. Brun, C. Gagne, S. Morrjani, J. C. Jequier, M. Bertrand, and P. J. Lupien. 1982. "Beta blockers and their effects on lipoproteins, phospholipids, apoproteins A and B, in whole plasma and the different fractions." International Journal of Clinical Pharmacology, Therapy and Toxicology. 20(6) : 259-264.

Church, J. G. and A. K. Sen. 1983. "Regulation of canine heart sarcolemmal Ca +2 -pumping ATPase by cyclic GMP." Biochimica et Biophysica Acta. 728(2) : 191-200.

Church, J. G., J. B. Derdemezi, S. Yuan, and A. K. Sen. 1986. "Species specific isoenzyme subtypes of membrane bound cyclic AMP dependent protein kinase in highly purified cardiac sarcolemma." Journal of Biochemistry. 238(2) : 341-344.

Easton, P. A., C. Jadue, M. E. Arnup, R. C. Meatherall, and N. R. Anthonisen. 1985. "Effects of upper and lower airway anesthesia on hypercapnic ventilation in humans." Journal of Applied Physiology. 59(4) : 1090-1097.

Easton, P. A., P. West, R. C. Meatherall, J. F. Brewster, M. Lertzman, and M. H. Kryger. 1987. "The effect of excessive ethanol ingestion on sleep in severe chronic obstructive pulmonary disease." Sleep. 10(3) : 224-233.

Fornazzari, L., D. A. Wilkinson, B. M. Kapur, and P. L. Carlton. 1983. "Cerebellar, cortical and functional impairment in toluene abusers." Acta Neurologica Scandinavica. 67(6) : 319-329.

Fraser, A. D. 1983. "Clinical evaluation of the EMIT salicylic acid assay." Therapeutic Drug Monitoring. 5(3) : 331-334.

Furesz, J., R. E. Armstrong, G. Contreras, and B. Wachmann. 1984. "Genetic characterization of poliovirus isolates in Canada 1962-1981." Review of Infectious Diseases. 6(suppl 2) : S521-S534.

Ganes, D. A., K. W. Hindmarsh, and K. K. Midha. 1986. "Doxylamine metabolism in rat and monkey." Xenobiotica. 16(9) : 781-794.

Goulden, K. J., P. Camfield, J. M. Dooley, A. Fraser, D. C. Meek, K. W. Renton, and J. A. Tibbles. 1986. "Severe carbamazepine intoxication after coadministration of erythromycin." Journal of Pediatrics. 109(1) : 135-138.

Guay, D. R., R. C. Meatherall, P. A. Macaulay, and C. Yeung. 1984. "Activated charcoal absorption of diphenhydramine." International Journal of Clinical Pharmacology, Therapy and Toxicology. 22(8) : 395-400.

Guay, D. R., R. C. Meatherall, H. Baxter, W. R. Jacyk, and B. Penner. 1984. "Pharmacokinetics of metronidazole in patients undergoing continuous ambulatory peritoneal dialysis." Antimicrobial Agents and Chemotherapy. 25(3) : 306-310.

Guay, D. R., R. C. Meatherall, G. K. Harding, and G. R. Brown. 1986. "Pharmacokinetics of cefixime (CL 284, 635:FK 027) in healthy subjects and patients with renal insufficiency." Antimicrobial Agents and Chemotherapy. 30(3) : 485-490.

Hendrix Treacy, S., S. M. Wallace, K. W. Hindmarsh, G. M. Wyant, and A. Danilkewich. 1986. "The effect of acetominophen administration on its disposition and body stores of sulphate." European Journal of Clinical Pharmacology. 30(3) : 273-278.

Hindmarsh, K. W., R. L. Nation, G. L. Williams, E. John, and J. N. French. 1983. "Pharmacokinetics of gentamicin in very low birth weight preterm infants." European Journal of Clinical Pharmacology. 24(5) : 649-653.

Hindmarsh, K. W., S. M. Wallace, C. B. Schneider, and E. D. Korchinski. 1983. "Methaqualone- diphenhydramine interaction study in humans." Journal of Pharmaceutical Sciences. 72(2) : 176-180.

Hudson, R. J., I. R. Thomson, J. E. Cannon, R. M. Friesen, and R. C. Meatherall. 1986. "Pharmacokinetics of fentanyl in patients undegoing abdominal aortic surgery." Anesthesiology. 64(3) : 334-338.

Negrete, J. C., W. P. Knapp, D. E. Douglas, and W. B. Smith. 1986. "Cannabis affects the severity of schizophrenic symptoms: Results of a clinical survey." Psychological Medicine. 16(3) : 515-520.

Pecknold, J. C., D. J. McClure, D. Fleuri, and H. Chang. 1982. "Benzodiazepine withdrawl effects." Progress in Neuro-Psychopharmacology and Biological Psychiatry. 6(4-6) : 517-522.

Pecknold, J. C., D. J. McClure, L. Appeltauer, T. Allan, and L. Wrzesinski. 1982. "Does tryptophan potentiate clomipramine in the treatment of agoraphobic and social phobic patients?" British Journal of Psychiatry. 140 : 484-490.

Pecknold, J. C., D. J. McClure, L. Appeltauer, L. Wrzesinski, and T. Allan. 1982. "Treatment of anxiety using fenobam (a nonbenzodiazepine) in a double blind standard (diazepam) placebo- controlled study." Journal of Clinical Psychopharmacology. 2(2) : 129-133.

Pecknold, J. C., P. Familamiri, D. J. McClure, R. Elie, and H. Chang. 1985. "Trimipramine and maprotiline: Antidepressant, anxiolytic, and cardiotoxic comparison." Journal of Clinical Psychiatry. 46(5) : 166-171.

Reimche, L. D., M. E. Rooney, K. W. Hindmarsh, D. K. Gorecki, A. J. Remillard, and K. Sankaran. 1987. "An evaluation of gentamicin dosing according to renal function in neonates with suspected sepsis." American Journal of Perinatology. 4(3) : 262-265.

Sankaran, K., K. W. Hindmarsh, and V. G. Watson. 1984. "Plasma beta-endorphin concentration in infants with apneic spells." American Journal of Perinatology. 1(4) : 331-334.

Sharp, M. E., S. M. Wallace, K. W. Hindmarsh, and M. A. Brown. 1981. "Acetylator phenotype and serum levels of sulfapyridine in patients with inflamatory bowel disease." European Journal of Clinical Pharmacology. 21(3) : 243-250.

Steffenrud, S., P. Borgeat, M. J. Evans, and M. J. Bertrand. 1986. "Mass spectrometry of prostaglandins, leukotrienes and steriods as their allyldimethylsilyl ether derivatives." Biomedical and Environmental Mass Spectrometry. 13(12) : 657-661.

Steffenrud, S., P. Borgeat, H. Salari, M. J. Evans, and M. J. Bertrand. 1987. "Gas chromatography-mass spectrometry of monohydroxyeicosatetraenoic acids and their methylesters, trimethylsilyl, allyldimethylsilyl and tert-butyldimethylsilyl ethers." Journal of Chromatography. 416(2) : 219-235.

Theophanides, T., P. K. Ganguli, and M. J. Bertrand. 1981. "Binding of the anticancer drug cis-dichlorodiammineplatinum to 3'(2')- guanosine monophosphate and nucleic acids." Anticancer Research. 1(6) : 383-388.

Thomson, I. R., R. J. Hudson, M. Rosenbloom, and R. C. Meatherall. 1987. "A randomized double blind comparison of fentanyl and sufentanil anaesthesia for coronary artery surgery." Canadian Journal of Anaesthesia. 34(3) : 227-232.

Zoster, T. T. and J. G. Church. 1983. "Calcium antagonists. Pharmacodynamic effects and mechanism of action." Drugs. 25(2) : 93-112.

Appendix E

The bibliography of source articles that made up the study sample listed in rank order of their I values. The I value of each source article is given rounded to one decimal.

1. Bernard, G. and C. Peclet. 1982. "Amidation of acid drugs." Canadian Society of Forensic Science Journal. 5(2) : 97-98. I=0

2. Martin, C. D. and S. C. Chan. 1986. "Distribution of temazepam in body fluids and tissues in fatal overdose." Journal of Analytical Toxicology. 10(2) : 77-78. I=0

3. Archibald, J. T. 1984. "A case report of suspected sulindac poisoning." Canadian Society of Forensic Science Journal. 17(2) : 71-76. I=0

4. McAuley, F. and D. S. Reive. 1983. "Rapid identification of cyanide in blood by gas chromatography." Journal of Analytical Toxicology. 7(5) : 213-215. I=0

5. Peel, H. W. and B. J. Perrigo. 1981. "Detection of cannabinoids in blood using EMIT." Journal of Analytical Toxicology. 5(4) : 165-167. I=0

6. Sharp, M. E., S. M. Wallace, K. W. Hindmarsh, and H. W. Peel. 1983. "Monitoring saliva concentrations of methaqualone, codeine, secobarbital, diphenhydramine and diazepam after single oral doses." Journal of Analytical Toxicology. 7(1) : 11-14. I=0

7. Fraser, A. D., E. Susnik, and A. F. Isner. 1987. "Analysis of 2-hydroxyimipramine in an imipramine related fatality. Journal of Forensic Sciences. 32(2) : 543-549. I=0.2

8. Meatherall, R. C., D. R. Guay, and J. L. Chalmers. 1985. "Analysis of meperidine and normeperidine in serum and urine by high performance liquid chromatography." Journal of Chromatography. 338(1) : 141-149. I=0.3

9. Peel, H. W., B. J. Perrigo, and N. Z. Mikhael. 1984. "Detection of drugs in saliva of impaired drivers." Journal of Forensic Sciences. 29(1) : 185-189. I=0.3

10. Zamecnik, J. and J. Tam. 1987. "Cyanide in blood by gas chromatography with NP detector and acetonitrile as internal standard: Application in air accident victims." Journal of Analytical Toxicology. 11(1) : 47-48. I=0.4

11. Chan, E. M. and S. C. Chan. 1984. "Screening for acidic and neutral drugs by high performance liquid chromatography in post-mortem blood." Journal of Analytical Toxicology. 8(4) : 173-176. I=0.4

12. Fraser, A. D., A. F. Isner, and M. A. Moss. 1986. "A fatality involving clomipramine." Journal of Forensic Sciences. 31(2) : 762-767. I=0.4

13. McBurney, L. J., B. A. Bobbie, and L. A. Sepp. 1986. "GC/MS and EMIT analyses for delta-9-tetrahydrocannibinol metabolites in plasma and urine of human subjects." Journal of Analytical Toxicology. 10(2) : 56-64. I=0.4

14. Fraser, A. D. 1985. "Experience with a specific request form for antidepressant drug monitoring." Therapeutic Drug Monitoring. 7(3) : 299-302. I=0.5

15. Goulden, K. T., J. M. Dooley, P. R. Camfield, and A. D. Fraser. 1987. "Clinical valproate toxicity induced by acetylsalicylic acid." Neurology. 37(8) : 1392-1394. I=0.5

16. Meatherall, R. C., D. R. P. Guay, J. Nokes, and J. R. Keenan. 1983. "Toxicological findings in a death resulting from ingestion of trimipramine." Journal of Forensic Sciences. 28(4) : 1023-1029. I=0.5

17. Meatherall, R. C., D. R. Guay, J. L. Chalmers, and J. R. Keenan. 1983. "A fatal overdose with clomipramine." Journal of Analytical Toxicology. 7(4) : 168-171. I=0.5

18. Bailey, K. 1983. "Physiological factors affecting drug toxicity." Regulatory Toxicology and Pharmacology. 3(4) : 389-398. I=0.5

19. Guay, D. R., R. C. Meatherall, J. L. Chalmers, and G. R. Grahame. 1984. "Cimetidine alters pethidine disposition in Man." British Journal of Clinical Pharmacology. 18(6) : 907-914. I=0.5

20. Chan, S. C., E. M. Chan, and H. A. Kaliciak. 1986. "Distribution of morphine in body fluids and tissues in fatal overdose." Journal of Forensic Sciences. 31(4) : 1487-1491. I=0.6

21. Wells, J., I. Moftah, G. Cimbura, and E. Koves. 1981. "The identification of methyprylon metabolite which interfers with U. V. differential spectra of barbiturates." Canadian Society of Forensic Science Journal. 14(2) : 47-53. I=0.6

22. Degouffe, M. and J. Rice. 1982. "Possible involvement of promethazine in a sudden unexpected infant death." Canadian Society of Forensic Science Journal. 15(3/4) : 166-168. I=0.6

23. Fraser, A. D. and A. F. Isner. 1987. "A carpipramine related fatality." Journal of Forensic Sciences. 32(4) : 1103-1108. I=0.6

24. Guay, D. R., R. C. Meatherall, J. L. Chalmers, G. R. Grahame, and R. J. Hudson. 1985. "Ranitidine does not alter pethidine deposition in Man." British Journal of Clinical Pharmacology. 20(1) : 55-59. I=0.6

25. Cimbura, G., D. M. Lucas, R. C. Bennett, R. A. Warren, and H. M. Simpson. 1982. "Incidence and toxicological aspects of drug detection in 484 fatally injured drivers and pedestrians in Ontario." Journal of Forensic Sciences. 27(4) : 855-867. I=0.6

26. Kaliciak, H. A. and S. C. Chan. 1986. "Distribution of prilocaine in body fluids and tissues in lethal overdose." Journal of Analytical Toxicology. 10(2) : 75-76. I=0.7

27. Coutts, R. T. and G. R. Jones. 1982. "In vivo and in vitro o-methylation of 1- (3,4- dihydroxyphenyl) -2- (n-propyl-amino) propane: An intermediate of N-(n-propyl) amphetamine metabolism." Research Communications in Chemical Pathology and Pharmacology. 36(1) : 173-176. I=0.7

28. Avdovich, H. W., A. W. By, J. -C. Ethier, and G. A. Neville. 1986. "Facile transesterification of propantheline bromide by methanol." Canadian Society of Forensic Science Journal. 19(4) : 241-249. I=0.7

29. Meatherall, R. C., D. R. Guay. 1984. "Isothermal gas chromatographic analysis of diphenhydramine after direct injection onto a fused silica capillary column." Journal of Chromatography. 307(2) : 295-304. I=0.7

30. Meatherall, R. C., P. T. Green, S. Kenicks, and N. Donen. 1981. "Diazoxide in the management of chlorpropamide overdose." Journal of Analytical Toxicology. 5(6) : 287-291. I=0.7

31. Bailey, K. and D. Legault. 1981. "Carbon-13 nuclear magnetic resonance spectra of trimethoxy-amphetamines: A comparison of predicted with experimental results." Journal of Forensic Sciences. 26(2) : 368-372. I=0.8

32. Isner, A., R. A. Perry, and A. D. Fraser. 1982. "A fatal case involving oxprenolol." Canadian Society of Forensic Science Journal. 15(3/4) : 163-166. I=0.8

33. Mackintosh, J. and B. D. Pate. 1982. "The absorption of mercuric ions into single human head hairs." Journal of Forensic Sciences. 27(3) : 572-591. I=0.8

34. Sellers, E. M., J. A. Marshman, H. L. Kaplan, H. G. Giles, B. M. Kapur, U. Busto, S. M. MacLeod, C. Stapleton, and F. Sealy. 1981. "Acute and chronic drug abuse emergencies in metropolitan Toronto." International Journal of the Addictions. 16(2) : 283-303. I=0.8

35. Fraser, A. D., A. F. Isner, and R. A. Perry. 1984. "Toxicologic studies in a fatal overdose of 2,4- D, Mecoprop, and dicamba." Journal of Forensic Sciences. 29(4) : 1237-1241. I=0.8

36. Sharp, M. E. 1986. "Evaluation of a screening procedure for basic and neutral drugs: N-Butyl chloride extraction and megabore capillary gas chromatography." Canadian Society of Forensic Science Journal. 19(2) : 83-101. I=0.8

37. Fraser, A. D. and J. F. L. Woodbury. 1983. "Liquid chromatographic determination of piroxicam in serum." Therapeutic Drug Monitoring. 5(2) : 239-242. I=0.9

38. Sankaran, K., K. W. Hindmarsh, and V. G. Watson. 1984. "Hypoxic-ischemic encephalopathy and plasma beta-endorphin." Developmental Pharmacology and Therapeutics. 7(6) : 377-383. I=0.9

39. McBurney, L. J. 1981. "Detection of diazepam and determination of time of ingestion." Canadian Society of Forensic Science Journal. 14(4) : 152-164. I=0.9

40. Sankaran, K., K. W. Hindmarsh, S. M. Wallace, R. J. McKay, and M. O'Donnell. 1986. "Cerebrospinal fluid and plasma beta-endorphin concentrations in prolonged infant apnea (near-miss sudden infant death syndrome)." Developmental Pharmacology and Therapeutics. 9(4) : 224-230. I=1.0

41. Peclet, C., M. Rousseau, G. Ponton, and J. J. Rousseau. 1982. "Carbon monoxide and cyanide inhalation." Canadian Society of Forensic Science Journal. 5(2) : 81-86. I=1.0

42. Hindmarsh, K. W., K. Sankaran, and V. G. Watson. 1984. "Plasma beta-endorphin concentration in neonates associated with acute stress." Developmental Pharmacology and Therapeutics. 7(3) : 198-204. I=1.1

43. Koves, E. 1985. "An evaluation of fused silica capillary columns for screening of basic drugs in postmortem blood: Qualitative and quantitative analysis." Journal of Forensic Sciences. 30(3) : 692-707. I=1.1

44. Koves, G. and J. Wells. 1986. "The quantification of triazolam in post-mortem blood by gas chromatography / negative ion chemical ionization mass spectrometry." Journal of Analytical Toxicology. 10(6) : 241-244. I=1.1

45. Manolis, A., L. J. McBurney, and B. A. Bobbie. 1983. "The detection of delta-9- tetrahydrocannabinol in the breath of human subjects." Clinical Biochemistry." 16(4) : 229-233. I=1.1

46. Buzik, S. C. and K. W. Hindmarsh. 1986. "Poisoning: Incidence and knowledge in Saskatchewan." Veterinary and Human Toxicology. 28(5) : 421-423. I=1.3

47. Wong, A. S. 1983. "An evaluation of HPLC for the screening and quantitation of benzodiazepines and acetaminophen in post-mortem blood." Journal of Analytical Toxicology. 7(1) : 33-36. I=1.4

48. Fung, T., W. Jeffery, and A. D. Beverridge. 1982. "The identification of capsaicinoids in tear-gas spray." Journal of Forensic Sciences. 27(4) : 812-821. I=1.5

49. Perrigo, B. J., D. J. Ballantyne, and H. W. Peel. 1984. "Considerations in developing a data base for drugs on a DB1 capillary column." Canadian Society of Forensic Science Journal. 17(2) : 41-49. I=1.5

50. Avdovich, H. W., J. -C. Ethier, and G. A. Neville. 1981. "Spectral identification of a lachrymatory exhibit as CS." Canadian Society of Forensic Science Journal. 14(4) : 172-178. I=1.8

51. Bailey, K. and D. Legault. 1981. "The use of carbon-13 nuclear magnetic resonance spectra in the identification and authentication of monomethoxyamphetamines and dimethoxyamphetamines." Journal of Forensic Sciences. 26(1) : 27-34. I=1.9

52. Avdovich, H. W., S. H. Jin, and W. L. Wilson. 1985. "NMR method for identification of look-alike drugs." Canadian Society of Forensic Science Journal. 18(1) : 24-31. I=2.0

53. Buzik, S. C. and K. W. Hindmarsh. 1987. "An alternative to the poison control system in Saskatchewan." Veterinary and Human Toxicology. 29(2) : 157-159. I=2.0

54. Peel, H. W. and B. J. Perrigo. 1981. "Application of the microcomputer to analytical toxicology." Journal of Forensic Sciences. 26(2) : 352-357. I=2.0

Appendix F

The ranked list of the most cited citation scurces in forensic toxicology in Canada between 1981 and 1987. The list includes the total number of citations for each of the 242 sources, cumulative totals and subject codes.

RANK	CITED SOURCE	CITATIONS	CUMM	CODE
1	Journal of Analytical Toxicology	55	55	0
2	Journal of Chromatography	40	95	2
3	Clinical Pharmacology and Therapeutics	31	126	0
4	Journal of Forensic Sciences	30	156	0
5	Journal of Pharmaceutical Sciences	21	177	0
6	Clinical Chemistry	20	197	0
7	New England Journal of Medicine	16	213	1
8	British Medical Journal	13	226	1
9	Clinical Toxicology	13	239	0
10	Analytical Chemistry	11	250	2
11	Clinical Pharmacokinetics	11	261	0
12	Postgraduate Medical Journal	11	272	1
13	Therapeutic Drug Monitoring	11	283	0
14	British Journal of Clinical Pharmacology	9	292	0
15	Biomedical Mass Spectrometry	8	300	1
16	Forensic Science International	8	308	0
17	Journal of High Resolution Chromatography and ...	8	316	2
18	Drugs	7	323	0
[illegible]	Journal of Chromatography: Biomedical Applications	7	330	2
[illegible]	Lancet	7	337	1
21	Pediatric Research	7	344	1
22	Canadian Society of Forensic Science Journal	6	350	0
23	Pediatrics	6	356	1
24	Veterinary and Human Toxicology	6	362	3
25	Annals of Internal Medicine	5	367	1
26	Association of Official Analytical Chemists. Journal	5	372	2
27	Canadian Medical Association Journal	5	377	1
28	Cannabinoid assays in humans. Research Monograph 7	5	382	0
29	Clinical Chemistry News	5	387	1
30	Drug Intelligence and Clinical Pharmacy	5	392	0
31	Journal of Chromatographic Science	5	397	2
32	Journal of Clinical Pharmacology	5	402	0
33	Journal of International Medical Research	5	407	1
34	Journal of Pharmacology and Experimental Therapeutics	5	412	0
35	Journal of Pharmacy and Pharmacology	5	417	0
36	Psychopharmacology Communications	5	422	0
37	Scandinavian Journal of Gastroenterology	5	427	1
38	American Journal of Medicine	4	431	1
39	American Journal of Public Health	4	435	0
40	Arzneim Forsch/ Drug Research	4	439	0
41	Canadian Journal of Chemistry	4	443	2
42	Diabetes	4	447	1
43	Disposition of toxic drugs and chemicals in Man	4	451	0
44	Journal of Clinical Psychiatry	4	455	1
45	Journal of Medicinal Chemistry	4	459	0
46	Journal of Pediatrics	4	463	1
47	Journal of the American Medical Association	4	467	1
48	Methodology for analytical toxicology	4	471	0
49	Acta Pharmacol Toxicol	3	474	0
50	Am J Dis Child	3	477	1
51	Am J Psychiatr	3	480	1
52	Analytica Chimica Acta	3	483	2
53	Br J Anaesth	3	486	1
54	Compendium of pharmaceutical and specialities	3	489	0
55	Epilepsia	3	492	1
56	Isolation and identification of drugs	3	493	0
57	Joint meeting of the Canadian Society of Forensic ...	3	498	0
58	J Clin Endocr Metab	3	501	1
59	Life Sciences	3	504	2
60	Marihuana: Chemistry, biochemistry and ...	3	507	1
61	Med Sci Law	3	510	0
62	Nature	3	513	2
63	Psychopharmacology	3	516	0
64	Research Communications in Chemical Pathology ...	3	519	0
65	Science	3	522	2
66	The analysis of cannabinoids in biological ...	3	525	0
67	Xenobiotica	3	528	2
68	Am J Clin Path	2	530	1
69	Am J Hosp Pharm	2	532	0
70	Am J Obstet Gynec	2	534	1

RANK	CITED SOURCE	CITATIONS	CUMM	CODE
71	Am J Perinatol	2	536	1
72	Anal Lett	2	538	2
73	Analyst, London	2	540	2
74	Ann Clin Biochem	2	542	2
75	Ann N Y Acad Sci	2	544	2
76	Ann Rev Pharmacol	2	546	0
77	Ann Rev Pharmacol Toxicol	2	548	0
78	Aust Paediat J	2	550	1
79	Biostatistics: A foundation for analysis in the ...	2	552	2
80	Br J Psychiat	2	554	1
81	Bull Int Assoc For Toxicol	2	556	0
82	Cancer Res	2	558	1
83	Chromatographic and electrophoretic techniques	2	560	2
84	Clin Biochem	2	562	2
85	Clinical pharmacology of psychoactive drugs	2	564	0
86	Dev Pharmacol Ther	2	566	0
87	Drug Metab Dispos	2	568	0
88	Drug Metab Rev	2	570	0
89	EMIT-dua cannabinoid urine assay	2	572	0
90	Eur J Clin Pharmacol	2	574	0
91	Eur J Pharmacol	2	576	0
92	Experientia	2	578	2
93	Fundamentals of clinical pharmacokinetics	2	580	0
94	Gastroenterology	2	582	1
95	Hepatology	2	584	1
96	Hosp Formul	2	586	0
97	Instrumental applications in forensic drug chemistry	2	588	3
98	Int J Clin Pharmacol	2	590	0
99	Isolation and identification of drugs in ...	2	592	0
100	J Biol Chem	2	594	2
101	J Lab Clin Med	2	596	1
102	J Med Assoc State Ala	2	598	1
103	J Org Chem	2	600	2
104	L'Encephale	2	602	1
105	Meth Find Exp Clin Pharmacol	2	604	0
106	Mini-Micro Systems	2	606	3
107	Org Magn Res	2	608	2
108	Pharmacokinetics, 2d ed	2	610	0
109	Societe Medico-Psychologique	2	612	1
110	Tetrahedron Letters	2	614	2
111	The cannabanoids: Chemical, pharmacologic and ...	2	616	0
112	Therapie	2	618	1
113	Toxilogic	2	620	0
114	Toxicological and pathological studies on ...	2	622	1
115	A compendium of information on agricultural ...	1	623	3
116	Acta Med Scand	1	624	1
117	Acta Neurol Scand	1	625	1
118	Acta Pharm Suec	1	626	0
119	Acta Pol Pharm	1	627	0
120	Adv Biosci 22-23	1	628	0
121	Aldrich library of infrared spectra	1	629	2
122	Am Heart J	1	630	1
123	Amer Lab	1	631	2
124	Anal Biochem	1	632	2
125	Analytical procedures for therapeutic drug monitoring ..	1	633	0
126	Ann Neurol	1	634	1
127	Ann Rev Pharmacol Ther	1	635	0
128	Annals Francais Anesthesia Reanimation	1	636	1
129	Annual meeting of the Canadian Society of Forensic ...	1	637	0
130	Antiepileptic drugs: Quantitative analysis ...	1	638	1
131	Antiepileptic Drugs	1	639	1
132	Arch Gen Psychiat	1	640	1
133	Arch Path	1	641	1
134	Arch Pharm	1	642	0
135	Arch Surg Chicago	1	643	1
136	Arch Toxicol	1	644	0
137	Aviat Space Environ Med	1	645	1
138	Beitrage Gericht Medizin	1	646	1
139	Benzodiazepines in clinical practice	1	647	0
140	Biochem Pharmacol	1	648	0

RANK	CITED SOURCE	CITATIONS	CUMM	CODE
141	Biochem Soc Trans	1	649	2
142	Biostatistical analysis	1	650	2
143	Br J Addict	1	651	1
144	Bull Soc Chim Biol	1	652	2
145	Bull Chem Soc Japan	1	653	2
146	Bull Drug Addict Narc Appl	1	654	0
147	BASIC and the personal computer	1	655	3
148	Can J Physiol Pharmacol	1	656	0
149	Can Pharm J	1	657	0
150	Carbon thirteen nuclear magnetic resonance for ...	1	658	2
151	Carbon-thirteen NMR spectra	1	659	2
152	Carbon-13 data bank. Vol 1	1	660	2
153	Carbon-13 NMR spectroscopy	1	661	2
154	Cardiol	1	662	1
155	Care of the high risk neonate, 2d ed	1	663	1
156	Chem Pharm Bull	1	664	0
157	Chromatographia	1	665	2
158	Clin Chem Acta	1	666	0
159	Clin Pediat	1	667	1
160	Conducting educational research, 2d ed	1	668	3
161	Crit Care Med	1	669	1
162	Curr Ther Res	1	670	1
163	Demedts, personal communication	1	671	0
164	Developing regional poison systems, 2d ed	1	672	3
165	Director of Finance, University Hospital, Saskatoon	1	673	3
166	Drug Experience Unit	1	674	0
167	Drugs and driving. Research Monograph 11	1	675	3
168	Ecol Food Nutrit	1	676	1
169	Endocrinology	1	677	1
170	Environ Health Perspect 36	1	678	2
171	Eur J Drug Metab Pharmacokinet	1	679	0
172	Eur J Rheumatol Inflam	1	680	1
173	Francaise Reviews Alcool	1	681	3
174	Frontiers in catecholamine research	1	682	2
175	Fundam Appl Toxicol	1	683	0
176	Gas chromatography with glass capillary columns	1	684	2
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180	Hosp Pract	1	688	1
181	Hum Toxicol	1	689	0
182	Information brochure, National Psychopharmacology ...	1	690	0
183	International Journal of Applied Radiation and Isotopes	1	691	2
184	International Pharmacopsychiatry	1	692	1
185	Interpretation of carbon-13 NMR spectra	1	693	2
186	Intl J Biol	1	694	2
187	Introductory statistics guide: SPSS-X	1	695	3
188	Israel J Chem	1	696	2
189	J Amer Chem Soc	1	697	2
190	J Anal Chem	1	698	2
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192	J Clin Pharmacol Ther Toxicol	1	700	0
193	J Combust Toxicol	1	[illegible]	0
194	J Liquid Chromatogr	1	702	2
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196	J Pharm Soc Japan	1	704	0
197	J Pharmacokinet Biopharm	1	705	0
198	J Toxicol: Clin Toxicol	1	706	0
199	Japan J Clin Chem	1	707	0
200	Journal of Legal Medicine	1	708	1
201	Manual of analytical toxicology	1	709	0
202	Mass spectrometry of organic compounds	1	710	2
203	Mayo Clin Proc	1	711	1
204	Med J Aust	1	712	1
205	Merck Index	1	713	1
206	Microcirculation	1	714	1
207	National Psychopharmacology Laboratory Inc	1	715	0
208	Nihon Eiseiguku Zasshi	1	716	1
209	Nihon Yakurisaku Zasshi	1	717	0
210	On computing	1	718	3

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215	Plasma level measurements of psychoactive drugs and ...	1	723	0
216	Practitioner	1	724	1
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219	Proceedings of the Human Factors Society of Canada, ...	1	727	3
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221	Proceedings of the 14th annual meeting of the Human ...	1	729	3
222	Product monograph, Clinoril tablets	1	730	0
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228	Saskatchewan Hospitals Services Plan, ...	1	736	3
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230	South Med J	1	738	1
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232	Statistics Canada	1	740	3
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238	Therapeutic drug monitoring	1	746	0
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