
Performing continuous quality improvement for a digital health sciences library through an electronic mail analysis*

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Background: The goal of this prospective, cross-sectional study was to determine the user demographics of a digital health sciences library (DHSL), motives for use, the nature of users information requests, and success rate in finding answers. **Methods:** The content of 500 consecutive electronic mail messages (e-mails) submitted to a DHSL were analyzed using a predetermined coding scheme. Data were entered into a database and frequency analysis was performed. **Results:** The number of information requests from the 500 e-mail messages was 751. The largest sender category was patients and laypersons followed by students, then physicians. Motivations for use were primarily medical advice (42.8%) and patient care (13.8%). E-mail subject areas were mainly medical (61.8%) and technical (20.6%). Answers to information requests were found 54.3% of the time and senders felt the DHSL was valuable (97.8%). **Conclusions:** A DHSL is a valuable medical resource. DHSLs must serve the broad information needs of patients and laypersons in addition to health care providers. Developers and managers of DHSLs can use this information to guide future development of DHSL information content and services, as has been done at The University of Iowa.

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INTRODUCTION

Health care practitioners need access to quality medical information that is current and their patients need access to similar information to take care of themselves and their families. Inserting information from medical libraries into the patient care process has been shown to decrease inpatient stays and costs and improve patient care [1–2]. In the past, practitioners and patients have had difficulty conveniently accessing information in print form [3]. With the advent of the Internet and Web, digital health sciences libraries (DHSLs) now offer more convenient access to information in electronic form for health care practitioners, patients, and their families [4]. The resources of a DHSL, like a print library, are limited. In order to meet the needs of its users as part of an ongoing process of continuous quality improvement, prioritization of the creation of new materials and services is necessary [5]. As DHSLs are in their infancy, there is little published data concerning who uses them and how they are used.

The purpose of this prospective, cross-sectional study was to perform an e-mail analysis of DHSL users to determine users of the DHSL, motives for use, information requested, and success rate in finding answers. This information will be useful in guiding future development of DHSL information content and services.

MATERIALS AND METHODS

The Virtual Hospital[‡] is a prototype DHSL that has been in operation on the Internet since 1992. It was implemented using Web technology [6]. Its content currently consists of hundreds of medical booklets and books, evenly divided between content created primarily for use by practitioners and content created primarily for use by patients. The content is created by staff clinicians in the health sciences center, professional health care societies, nonprofit health care organizations, state and government health care agencies, and professional publishers. Copyright permission is obtained from the content authors in all cases. All content is in English and is clearly marked with the name, credentials, and affiliation of its author; whether or not it has been peer reviewed; and its date of last modification. The DHSL does not provide services such as news groups, e-mail discussion lists, or computer conferencing.

The DHSL has two mechanisms for receiving questions and comments from users via e-mail. The DHSL user (sender) submitting the message may submit a standard unstructured e-mail message or a DHSL elec-

tronic comment form§ may be filled out and submitted. Links to the DHSL e-mail address and comment form are located at the bottom of every page in the DHSL. Unless noted, both unstructured e-mail messages and comment forms will be termed e-mail throughout the rest of the paper. The DHSL comment form is a twelve-item survey with multiple choice and written responses. The e-mail messages and comment forms are forwarded to the librarian in the DHSL who responds to technical and administrative questions concerning the DHSL using standard e-mail replies. Due to limited resources and liability, all medical questions are answered by a standard e-mail reply, which refers questioners to other DHSLs that may be searched for answers.

E-mail messages were eliminated from analysis if they were duplicates or written in a non-English language because of translation difficulties. Messages were received and archived for later coding and analysis.

Data from the e-mail messages were abstracted onto a separate abstraction form to aid data entry (Appendix). A coding categorization scheme was developed from a review of papers in the literature [7–11]. A detailed coding manual was prepared and used during the data abstraction process. The abstraction forms were pilot tested and modified. Abstraction forms were coded by one investigator and all data on 10% of the abstraction forms were reviewed by another investigator to verify accurate coding. The coding of the medical content on 100% of the abstraction forms was also reviewed and verified by a separate investigator. Variables included:

1. **Location of the sender**—determined by the comment form answer, the sender's e-mail address, and content of the unstructured e-mail.
2. **Gender of the sender**—determined by comment form answer, name of sender, and content of the unstructured e-mail.
3. **Gender and age of the patient the e-mail concerns**—determined by the content of the comment form or unstructured e-mail.
4. **Sender type**—determined by comment form answer and content of the unstructured e-mail. Categories were physician, allied health care professional, patient and layperson, student of any type, librarian, and technical support person such as computer programmer. For example, an unstructured e-mail could state "I am a computer programmer, but I have a question about my husband and his heart problem." The sender would be an adult female who is a patient or layperson, because she is asking the question as a spouse, not as a computer programmer.

‡ The Virtual Hospital is available at <http://www.vh.org>.

§ The comment form is available at <http://www.vh.org/Misc/Comment.html>.

5. **Sender motivation for submitting the e-mail**—determined by comment form answer and content of the unstructured e-mail.

6. **E-mail subject** (the e-mails' specific topic of concern)—determined by the content of the comment form or unstructured e-mail. Examples could include treatment of breast cancer, how to create a Web site, referral to a physician, etc.

7. The e-mail subjects were also categorized into one of four **e-mail subject areas**:

- medical subject area such as drug therapy of a disease, laboratory testing evaluation, etc.
- technical subject area such as problems with viewing images, networking, security, etc.
- suggestions subject area such as information or services which the DHSL could provide
- general subject area such as social conversation ("I like your Web site") or non-medical topics (market research) [Note these were included because this was a study of all e-mail sent to a DHSL]

8. **Medical content** (if appropriate)—determined from the content of the comment form or unstructured e-mail. Examples include internal medicine, pediatrics, podiatry, etc.

9. **Resources necessary to answer the information request**—determined by the content of the comment form or unstructured e-mail. The necessary resources were categorized into one of three categories.

- general and medical information from standard references including digital references or searching by a librarian
- medical content expert
- technical content expert

10. Was the sender's **information request answered** by the DHSL—determined by comment form answer and content of unstructured e-mail.

11. **Where in the DHSL was the answer found**—determined by comment form answer and content of unstructured e-mail.

12. **Perceived value of the DHSL**—determined from the content of the comment form or unstructured e-mail. Specific statements such as "This is a great site," "This site is very helpful," would be coded as valuable. If there were positive comments but no specific statements, the e-mail was coded as somewhat valuable. If the e-mail contained negative specific statements or negative comments, it was coded as not valuable.

13. **DHSL problems**—determined from the content of the comment form or unstructured e-mail.

Data was coded into the most specific category available. For example, "I would like some information about breast cancer for my fifty-seven year old mother." This would be coded into the age category fifty-one to sixty. If the age had been left out of the e-mail, then the data would be coded as adult not otherwise specified. Each individual e-mail might not include all data because specific data were inappropriate,

missing, or unclear. Data of this type was coded as indeterminate.

All data were entered into a FoxPro database operating on an Apple Macintosh computer. Frequencies were obtained using the same software program.

Limitations of this study include:

1. The use of a sample of DHSL users who voluntarily submitted e-mail messages to the DHSL and not all users of the DHSL.
2. All study questions were not answered by each individual sender because information was inappropriate, missing, or was not clear. Each e-mail did not need a pre-set number of variables to be included in the study.
3. Medical content was also coded into one specialty only, therefore an individual specialty may be over- or underrepresented.
4. Content analysis provides much information, but lent itself to the potential of inaccurate coding. Coding was done by one person and accuracy was checked by a second person in an attempt to decrease this problem [12].
5. This study also did not evaluate the DHSL by other research techniques such as questionnaires or interviews [13–16].

RESULTS

From January 26, 1997, to March 15, 1997 (49 days), the content of 500 consecutively received e-mail messages was analyzed, averaging ten messages per day. The messages had a total of 751 information requests (range 1–35) for an average of 1.5 requests per e-mail. Messages came from the United States (77.4%, $n = 387$) and from international senders (22.6%, $n = 113$). The five most common states were California, Pennsylvania, New York, Michigan, and Iowa in decreasing frequency. The five most common countries after the United States were Canada, England, Italy, Australia, and Brazil, also in decreasing frequency.

Females comprised 40% ($n = 200$) of the senders and males comprised 37.2% ($n = 186$), with the gender of 22.8% ($n = 114$) not being identifiable. The largest sender type was patients and laypersons (36.8%, $n = 184$), with students (11%, $n = 55$) and physicians (8.6%, $n = 43$) being the next largest identifiable categories. Miscellaneous senders included journalists, teachers, publishers, and scientific researchers. Ninety senders could not be identified (Table 1). The patient gender in the e-mail could be determined for 223 e-mails with 53.4% being female ($n = 119$) and 46.6% being male ($n = 104$). The patient age in the e-mail could be determined for 214 e-mails. Children and adolescents were 33% ($n = 70$) and 66% were adults ($n = 144$).

Table 1
Sender motivation for requested information

Motivation	All senders	Patient/ layperson	Student	Physicians	Allied health professional	Technical support	Nurse	Librarian	Misc user	Indeterminate
Medical education/consumer health information	214 (42.8%)	125 (67.9%)	43 (78.2%)	17 (39.5%)	6 (21.4%)	0 (0%)	3 (42.9%)	0 (0%)	12 (18.2%)	8 (8.9%)
Patient care	69 (13.8%)	49 (26.6%)	3 (5.5%)	4 (9.3%)	7 (25%)	0 (0%)	0 (0%)	0 (0%)	1 (1.5%)	5 (5.6%)
Technical education	11 (2.2%)	1 (0.5%)	2 (3.6%)	0 (0%)	1 (3.6%)	2 (8.3%)	0 (0%)	0 (0%)	1 (1.5%)	4 (4.4%)
Social conversation	78 (15.6%)	6 (3.3%)	2 (3.6%)	9 (20.9%)	8 (28.6%)	7 (29.2%)	1 (14.3%)	1 (33.3%)	29 (43.9%)	15 (16.7%)
Offering services, help to DHSL	38 (7.6%)	2 (1.1%)	1 (1.8%)	6 (14%)	2 (7.1%)	8 (33.3%)	0 (0%)	0 (0%)	11 (16.7%)	8 (8.9%)
Clarification of information	24 (4.8%)	0 (0%)	2 (3.6%)	3 (7%)	1 (3.6%)	4 (16.7%)	1 (14.3%)	1 (33.3%)	6 (9.1%)	6 (6.7%)
Offering praise for DHSL	9 (1.8%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	3 (12.5%)	0 (0%)	0 (0%)	3 (4.5%)	3 (3.3%)
Providing requested information back to DHSL	2 (0.4%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	2 (3%)	0 (0%)
Indeterminate	55 (11%)	1 (0.5%)	2 (3.6%)	4 (9.3%)	3 (10.7%)	0 (0%)	2 (28.5%)	1 (33.4%)	1 (1.5%)	41 (45.6%)
Total	500 (100%)	184 (100%)	55 (100%)	43 (100%)	28 (100%)	24 (100%)	7 (100%)	3 (100%)	66 (100%)	90 (100%)

Motivation for using the DHSL is shown in Table 1. Medical education or consumer health information was the most frequent motivation for e-mailing the DHSL, accounting for 42.8% (n = 214) of overall use. Patients and laypersons (67.9%, n = 125), students (78.2%, n = 43), and physicians (39.5%, n = 17) listed medical education or consumer health information as their most frequent motivation for sending e-mail. Motivation by a specific patient care question was only noted in 26.6% of the patients and laypersons (n = 49) and in 9.3% of the physician e-mails (n = 4).

The e-mail subjects and e-mail subject areas are shown in Table 2. Overall 61.8% (n = 309) of the subjects were categorized into the medical subject area. Of these, the most common subjects were general overview of a disease process (20.6%, n = 103), therapy of a disease (19.2%, n = 96), differential diagnoses of a disease (4.4%, n = 22), and diagnostic testing (2.8%, n = 14). The technical subject area comprised 20.6% (n = 103), with most of subjects being senders offering services (8.8%, n = 44), senders asking personal computer questions (4%, n = 20), and senders requesting permission to use content in the DHSL (2.8%, n = 14). The general subject area comprised 12.6% (n = 63) of the e-mails, with social conversation (7.4%, n = 37) and non-medical topics (2.6%, n = 13) the most common subjects. The medical subject area was the predominant subject area for all sender types except for technical support and miscellaneous senders who had more subjects in the technical subject area.

The medical content of the messages is shown in Table 3. The number of messages with medical content was 386; 114 were not medically related. The medical

content was different than the e-mail subject area. For example, a message offered to link the DHSL Web site to a new Web site concerning asthma. The e-mail subject area would be technical because the e-mail offered a service (i.e., linking the Web sites together), but the content was medically related (i.e., asthma). Therefore, there were more messages with medical content than there were messages in the medical subject area. Overall, the most common medical content areas were pulmonology, orthopedics, and hematology/oncology. The medical content was also different if the patient subject in the e-mail was an adult or child. For adult patient subjects, the most common areas were pulmonology, orthopedics, and hematology/oncology; for child patient subjects, the most common areas were general pediatrics, infectious diseases, and gastroenterology.

This study found certain areas to have more frequent information requests. In the surgical areas, orthopaedics (back and spine problems, leg problems especially knee and trauma), obstetrics and gynecology (breast problems, endometriosis, pre-menstrual syndrome), and otolaryngology (hearing loss, laryngeal papillomatosis) were frequently requested. In adult medicine, pulmonary (asbestosis, emphysema, idiopathic pulmonary fibrosis), hematology/oncology (breast cancer, lung cancer), gastrointestinal disorders (lower gastrointestinal problems including bleeding, inflammatory bowel disease), and neurological disorders (multiple sclerosis) were the most frequent. In pediatric medicine, infectious diseases (childhood illnesses), gastrointestinal disorders (lower gastrointestinal problems), and pulmonary disorders (croup) were fre-

Table 2
E-mail subjects and subject areas

E-mail subject and subject areas	All senders	Patient/layperson	Student	Physician	Allied health professional	Technical support	Nurse	Librarian	Misc user	Indeterminate
Medical Subject	309	174	37	20	16	0	4	0	14	44
	(61.8%)	(94.6%)	(67.3%)	(46.5%)	(57.1%)	(0%)	(57.1%)	(0%)	(21.2%)	(48.9%)
General overview of disease	103	64	15	4	3	0	1	0	1	15
	(20.6%)	(34.8%)	(27.3%)	(9.3%)	(10.7%)	(0%)	(14.3%)	(0%)	(1.5%)	(16.7%)
Therapy of disease	96	66	8	3	3	0	1	0	0	15
	(19.2%)	(35.9%)	(14.5%)	(7%)	(10.7%)	(0%)	(14.3%)	(0%)	(0%)	(16.7%)
Differential diagnosis of disease	22	18	0	1	0	0	0	0	0	3
	(4.4%)	(9.8%)	(0%)	(2.3%)	(0%)	(0%)	(0%)	(0%)	(0%)	(3.3%)
Diagnostic testing	14	9	1	2	1	0	0	0	0	1
	(2.8%)	(4.9%)	(1.8%)	(4.7%)	(3.6%)	(0%)	(0%)	(0%)	(0%)	(1.1%)
Online journals	13	0	3	1	2	0	0	0	4	3
	(2.6%)	(0%)	(5.5%)	(2.3%)	(7.1%)	(0%)	(0%)	(0%)	(6.1%)	(3.3%)
Referrals to hospitals/physician	11	7	0	0	1	0	0	0	1	2
	(2.2%)	(3.8%)	(0%)	(0%)	(3.6%)	(0%)	(0%)	(0%)	(1.5%)	(2.2%)
Other	50	10	10	9	6	0	2	0	8	5
	(10%)	(5.4%)	(18.2%)	(20.9%)	(21.4%)	(0%)	(28.6%)	(0%)	(12.1%)	(5.6%)
Technical Subject Area	103	3	8	9	4	19	3	2	32	23
	(20.6%)	(1.6%)	(14.5%)	(20.9%)	(14.3%)	(79.2%)	(42.9%)	(66.7%)	(48.5%)	(25.6%)
Offering services	44	0	0	3	1	14	0	0	23	3
	(8.8%)	(0%)	(0%)	(7%)	(3.6%)	(58.3%)	(0%)	(0%)	(34.8%)	(3.3%)
Personal computer information request	20	1	3	1	2	1	0	0	3	9
	(4%)	(0.5%)	(5.5%)	(2.3%)	(7.1%)	(4.2%)	(0%)	(0%)	(4.5%)	(10%)
Permission to use DHSL content	14	1	1	0	0	2	2	2	5	1
	(2.8%)	(0.5%)	(1.8%)	(0%)	(0%)	(8.3%)	(28.6%)	(66.7%)	(7.6%)	(1.1%)
General information about DHSL	11	0	2	3	1	0	1	0	1	3
	(2.2%)	(0%)	(3.6%)	(7%)	(3.6%)	(0%)	(14.3%)	(0%)	(1.5%)	(3.3%)
Other	14	1	2	2	0	2	0	0	0	7
	(2.8%)	(0.5%)	(3.6%)	(4.7%)	(0%)	(8.3%)	(0%)	(0%)	(0%)	(7.8%)
Suggestion Subject Area	23	3	2	4	5	0	0	0	4	5
	(4.6%)	(1.6%)	(3.6%)	(9.3%)	(17.9%)	(0%)	(0%)	(0%)	(6.1%)	(5.6%)
Information content	18	3	2	3	3	0	0	0	2	5
	(3.6%)	(1.6%)	(3.6%)	(7%)	(10.7%)	(0%)	(0%)	(0%)	(3%)	(5.6%)
Other	5	0	0	1	2	0	0	0	2	0
	(1%)	(0%)	(0%)	(2.3%)	(7.1%)	(0%)	(0%)	(0%)	(3%)	(0%)
General Subject Area	63	4	8	9	3	5	0	1	16	18
	(12.6%)	(2.2%)	(14.5%)	(20.9%)	(10.7%)	(20.8%)	(0%)	(33.3%)	(24.2%)	(20%)
Social conversation	37	4	1	5	3	4	0	1	9	10
	(7.4%)	(2.2%)	(1.8%)	(11.6%)	(10.7%)	(16.7%)	(0%)	(33.3%)	(13.6%)	(11.1%)
Other non-medical topic	13	0	4	4	0	0	0	0	3	2
	(2.6%)	(0%)	(7.3%)	(9.3%)	(0%)	(0%)	(0%)	(0%)	(4.5%)	(2.2%)
Other	13	0	3	0	0	1	0	0	4	5
	(2.6%)	(0%)	(5.5%)	(0%)	(0%)	(4.2%)	(0%)	(0%)	(6.1%)	(5.6%)
Indeterminate	2	0	0	1	0	0	0	0	0	1
	(0.4%)	(0%)	(0%)	(2.3%)	(0%)	(0%)	(0%)	(0%)	(0%)	(1.1%)
Total	500	184	55	43	28	24	7	3	66	90
	(100%)	(100%)	(100%)	(100%)	(100%)	(100%)	(100%)	(100%)	(100%)	(100%)

quently requested. Other requested areas were pharmacology (general overview of a drug, side effects, chemotherapy, natural medications, and steroids), radiology and nuclear medicine (magnetic resonance imaging), dentistry and orthodontia (available dental programs), and psychiatry (depression, panic attacks, Tourette's syndrome, trichotillomania).

The type of resources needed to answer the senders' information request were mainly medical content experts (47.4%, n = 237) and technical experts (40.2%, n = 201), with general information and reference constituting 7.4% (n = 37). The type of resource needed

could not be determined for 5% of the messages (n = 25). Whether or not the sender found an answer in the DHSL could be determined for 223 messages. Answers were found 54.3% of the time in the DHSL (n = 121), while 45.7% were not (n = 102). Only sixty-five senders specifically stated where in the DHSL they had found the answer to their information request. The most common site was multimedia textbooks (56.9%, n = 37), followed by patient simulations (18.5%, n = 12).

Sender impressions of DHSL value was coded into three categories (valuable, somewhat valuable, and not

Table 3
Most common medical content of e-mail messages

Top 10	All senders	Adult patient subject	Child patient subject
1	Pulmonology (33)	Pulmonology (13)	General Pediatrics (16)
2	Orthopaedics (30)	Orthopaedics (12)	Infectious Diseases (6)
3	Hematology/Oncology (27)	Hematology/Oncology (9)	Gastroenterology (5)
4	Pharmacology (24)	Gastroenterology (8)	Pharmacology (4)
5	Infectious Diseases (23)	Neurology (7)	Orthopaedics (4)
6	Neurology (21)	Pharmacology (6)	Pulmonology (4)
7	Gastroenterology (21)	Cardiology (5)	Dermatology (3)
8	Pediatrics (20)	Endocrinology (5)	Cardiology (2)
9	Obstetrics/Gynecology (17)	Infectious Diseases (4)	Dentistry/Orthodontics (2)
10	Rheumatology (16)	Otolaryngology *(4)	Otolaryngology +(2)

Remark:

() = Number of e-mails.

* = Also Psychiatry (4).

+ = Also Radiology/Nuclear Medicine (2).

valuable). Of the 406 messages where value could be determined, 80.8% (n = 328) of senders felt the DHSL was valuable, 17% (n = 69) felt it was somewhat valuable, and only 2.2% (n = 9) felt it was not valuable. Problems with the DHSL were noted in 44 messages. The most common problems were finding information (43.2%, n = 19) and not enough information (31.8%, n = 14).

DISCUSSION

Among the ways to examine usage of a DHSL anonymously are Web server logfile analysis to determine global usage patterns and e-mail analysis to determine individual usage patterns. Web server logfile analysis can provide information on overall usage of resources in a DHSL but has the limitation of not being able to provide information on the demographics of individual users, their motives, their original questions, and how successful they were in answering them [17]. An e-mail analysis is helpful in providing this information.

Although the majority of the e-mails to the DHSL were from the United States, nearly 25% were international in origin. Although in the past Internet users were nearly entirely from the United States, this has been rapidly changing as the rest of the world comes online, and the data reflected this growing trend. However, development of localized content, in the users' native language, has lagged behind and this might account for the heavy international usage of the DHSL [18].

A total of 61.8% of the e-mails had a medical subject area. Most senders wanted information on general overviews of disease and therapy. The e-mails concerned children and adolescents 33% of the time. While this may seem to be a large percentage, approximately 28% of the United States population are persons under the age of twenty years [19]. Thus pe-

diatric and other information targeted at special groups must be considered when DHSL content decisions are made.

This DHSL was initially designed to serve health care providers and health professional students, but early on the importance of serving patients was recognized and the DHSL mission was broadened. High-quality consumer health information is and will continue to be exceedingly important as patients become more involved in their own health care decisions. Having content for both patients and providers allows for each group to obtain access to information that would not have been available to them because of various barriers. While DHSLs have their own barriers to access, they do provide another means, often very conveniently, to accessing medical information.

One of the most common problems listed by users was *not* finding information in the DHSL. The information architecture of the DHSL was initially organized from a librarian's perspective (by organ system, department, and information type) rather than from a user's perspective (by problem). As a direct result of this study, a new problem-based interface has been added to the DHSL's information architecture allowing DHSL users quickly to access information on fifty common medical problems from a single page in the DHSL.** This provides a personalized view into the DHSL and substantially increases the ease and speed of the user's interaction with the DHSL.

Another common problem listed by users was the lack of information in the DHSL. Although the DHSL contained a large amount of information, it was only a small fraction of that available in the traditional print literature. Comprehensive and authoritative educational materials in all areas of medicine need creation and

** The problem-based interface is available at <http://www.vh.org/Beyond/PeerReviews/PeerReviewHomePage.html>.

distribution with emphasis on general overview of diseases and therapy. Specific topics outlined in the results can serve to help prioritize recruitment of content authors in these high-frequency request areas that currently have little or no content. At The University of Iowa, such content authors are being recruited. In the meantime, in areas for which content cannot be created locally, links have been made to other DHSLs with authoritative content.

Access to online journals was also requested by senders. Accordingly, a link to the National Library of Medicine's new MEDLINE service, PubMed, was created. PubMed gives its users free access to article abstracts and has provisions for the purchase of complete articles from commercial vendors if the user is so inclined.

A number of services were identified for future implementation at The University of Iowa. Medical content experts were found to be needed for 47.4% of the information requests. This could be accomplished by identifying a panel of clinicians who had the responsibility to answer these requests. Many barriers must be overcome before this could and should be practically implemented including issues of medical liability, practicing medicine across state boundaries, and compensation issues (monetary and academic). These information requests could not be answered by a general reference librarian or other similarly qualified person because of the nature of the questions (only 7.4% of the information requests were found to be answerable in this manner). Technical experts were needed for 40.2% of the information requests. Many of these were questions that could be answered by a Web supervisor, qualified librarian, or other appropriately qualified individual. Librarians, as part of their professional duties, might be asked to provide this type of technical expertise. A frequently asked question (FAQ) list could be implemented online to answer some of these technical information requests. In addition, options for searching the DHSL will be broadened by adding a context-based search engine to supplement the current free-text search engine.

The number of information requests answered by the DHSL was 54.3% as determined by this e-mail analysis. This number might be low as DHSL users may not send an e-mail if they already found the information they sought in the DHSL. A truer overall estimate of the number of information requests answered by the DHSL could be obtained by surveying all users of the DHSL.

Senders found the DHSL to be valuable or somewhat valuable 97.8% of the time. While this data was encouraging, senders might be more enthusiastic about the DHSL than non-senders. The continuous quality improvement process outlined above, will hopefully lead to continued high user satisfaction. The DHSL team hopes to continue high user satisfaction by daily

improvements of the content and services provided by the DHSL.

CONCLUSIONS

A DHSL is a valuable medical resource for persons seeking medically-related information. In addition to serving the broad-based information needs of their traditional audience of health care practitioners, the DHSL must also serve the broad information needs of patients and laypersons. This study shows that special attention should be paid to the needs of international users; to pediatric content areas; to user-centered, problem-based interfaces to the DHSL's information; and to obtaining authoritative information from other DHSLs if it cannot be found locally. Developers and managers of DHSLs should use this information for allocation and prioritization of resources to guide future development of DHSL information content and services.

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APPENDIX

_____	Subject Number four digit
_____	Encoder Initial XX or XXX
____/____/199__	Encoding Date mm/dd/199X
d d m m y	Date of E-mail mm/dd/199X
____/____/199__	Time of E-mail 24 hr military time
d d m m y	Domain .XXX or .XX or .NUM=number
_____	Zip Code
_____	Town or City
_____	State or Country
_____	Message Codable 1=Yes 2=No (List why)
_____	Voice see sheet

Occupation see sheet
Gender of E-mailer 1=Male 2=Female 3=Multiple 8=NA 9=Indet
Info Question/Comments 1=Quest 2=Comm 3=Both 9=Indet
No. of Question/Requests List number
Intellect. Motivation see sheet
Subject of E-mail see sheet
Medical Content Area see sheet
Age of Person E-mail Is About
Gender of Person E-mail is About 1=Male 2=Female 3=Multiple 8=NA 9=Indet
Procedure to Answer Question 1=Gen Info 2=Ref 3=Cont Expert 4=Tech Expert 5=No Proceed 8=NA 9=Indet
Was Question Answered 1=Yes 2=No 3=Somewhat 8=NA 9=Indet
Where found Answer in VH 1=Not stated, see sheet
Urgency of Response 1=No time stated, see sheet
Understand VH as a Resource 1=Yes 2=No 8=NA 9=Indet
VH is a valuable resource 1=Yes 2=No 3=Somewhat Valuable 8=NA 9=Indet
Emotional Tone 1=Positive 2=Neutral 3=Negative 9=Indet
Frequency of VH Usage 9=No Time Stated 2=1st Time 3=More than First Time 8=NA
Problems with VH see sheet 98=NA 99=Indet
Problems with VH see sheet 98=NA 99=Indet