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Web-based provision of information on infectious diseases: a systems study

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The National electronic Library for Health (NeLH) is an Internet medical information resources portal, principally for healthcare professionals, within which the National electronic Library of Infection (NeLI) is one of NeLH Specialist Libraries providing evidence on infectious diseases. In this article, we describe a systems-based evaluation of NeLI based on a soft systems methodology. User feedback and other data for the analysis were obtained using online questionnaires. This evaluation, which is a pilot study aimed at demonstrating proof of concept, provided evidence for improving three systems that are crucial to effective NeLI provision. These are navigation of the site, quality and tagging of information provided by NeLI, and information regarding users and their usage of the system. On the basis of a soft systems analysis, an action plan was formulated identifying areas where improvement is needed. Actions for consideration included simplifying terminologies to improve the navigation, enhancing the provision of research assessments, quality tagging NeLI documents, provided by experts in the field, and attracting a broader cross-section of healthcare professional user.

Keywords

infectious diseases, National electronic Library for Health, National electronic Library of Infection, systems study, web-based information

Introduction

The context

Healthcare professionals are increasingly finding that they have more information available than they can handle with confidence in their busy time schedules. With the burgeoning of

web-based information portals, the available information is not of uniform quality, which is a particular problem. Thus it is becoming more difficult to discern what information regarding healthcare resources is accurate and appropriate for healthcare professionals, in particular in the medical domain where good quality is essential if effective clinical decisions are to be made. While efforts are being made to monitor the quality of information on the web, such as by the Health on Net foundation (<http://www.hon.ch/>), they are not enough to cover every healthcare website.

Online clinical information resources have the potential to support clinicians who adopt an evidence-based approach, by providing them with the information they need when they need it [1]. Westbrook and colleagues [2] have shown that clinicians' online evidence use increases with patient admissions, supporting the hypothesis that clinicians' use of evidence is related to direct patient care. They have shown that patterns of evidence use and feedback from clinicians also support this hypothesis.

NeLH and NeLI

The National electronic Library for Health (NeLH) (www.nelh.nhs.uk) provides a regulated single-access point to quality-assured information on the Internet. It has the potential to play a key role in providing health professionals with access to a core knowledge base of accredited and evaluated information [3]. Much of the information is extracted from an extended set of bibliographic references, though these are not always explicitly referred to. However, since the material that is placed in the library has undergone expert review, one can be assured of the quality of the information received as a user. The National electronic Library of Infection (NeLI) (www.neli.org.uk) is one of the specialist libraries of the NeLH dedicated to infectious and communicable diseases.

The aim of NeLI is to provide a single information gateway, a portal, to evidence-based information related to the diagnosis, treatment and management of infectious and communicable diseases. Its primary audience is healthcare professionals, but it is also available to the public.

The need for evaluation of NeLI

Typically, knowledge dispensing through information portals such as NeLI is supported by search engines, site-specific navigation interfaces and information architecture based on knowledge of human information tracking strategies [4]. Developers need to evaluate the usability of their sites to help them develop and refine appropriate interfaces for different types of users [5]. In this study, we evaluate NeLI on the basis of user feedback and structured information obtained through an online questionnaire. The results have been analysed using a soft systems approach in order to determine the usability of the National electronic Library of Infection (NeLI) in terms of user satisfaction, user friendliness, ease of navigation and quality of the content. As already indicated, the site is primarily aimed at healthcare professionals, and therefore the evaluation focused on the needs and requirements of this target user group. The outcome was enhancement of the usability of NeLI by determining which of the elements of its design and operation most needed to be improved, based on user feedback. These evaluation results can then be used to improve new versions of the site.

It should be emphasised that this is essentially a pilot study aimed at demonstrating proof of concept. The focus is on the experiences of those who have actually accessed the site, rather than extending it to a study, making use of paper-based questionnaires, of those who did not use the system. This could be the subject of a possible future study.

Methodology: Checkland's soft system modelling

A systems approach was adopted, wherein the information-delivering system was taken to include all functional and non-functional elements. The relationship between different elements was investigated as in a 'whole' system where nothing is considered irrelevant. 'Whole' systems are dynamic: they change, move and develop.

The systems approach adopted is based on Checkland's Soft System Methodology (SSM) [6, 7]. SSM includes several ways of gaining a rich appreciation of the problem situation addressed [8]. This methodology takes into account both real-world and systems thinking defined constructs. The former involves people in information and knowledge seeking situations, while the systems constructs may or may not involve people. In the systems world, the real-world complexity is unravelled and understood through translation to a higher level language (or meta-language) of systems [9].

The essence of the Checkland methodology is depicted in Figure 1. Of its seven stages, stages 1 and 2 involve building a schematic representation of the system in as neutral a way as possible and then creating a rich picture of the situation. Stage 3 involves creating

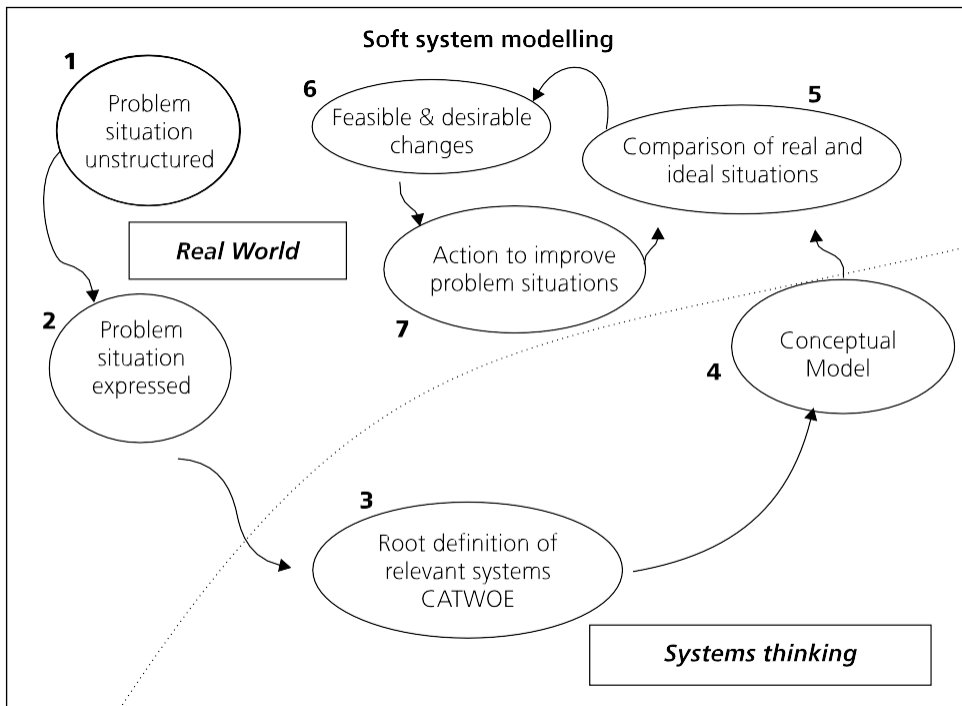


Figure 1 A diagrammatic representation of Checkland's SSM

a root definition of the problem. This root definition reflects aspects, often referred to as the mnemonic CATWOE, which can be assessed by the following questions:

C Customer: who is the victim or beneficiary of the system?

A Actor: who would perform the activities?

T Transformation: what input is transformed into what output?

W Weltanschauung: what view of the world makes the system meaningful?

O Owner: who can abolish the system?

E Environmental constraints: what in the environment does the system take as given?

Stage 4 involves building a conceptual model, based on the root definition, whilst in stage 5 there is comparison of the real world and the systems world in order to propose the agenda for possible change. Stages 6 and 7 involve culturally feasible and systemically desirable changes to structure, procedure or attitude as emerge from discussion of the agenda with relevant stakeholders.

Analysis of the current situation

Viewing NeLI systemically, it has a number of elements including its knowledge base, the technology employed in its infrastructure (background) and the interface (front end) through which a variety of users interact with it. An online questionnaire that addressed each of these elements and other related issues was used to obtain the views of the users of the system.

In seeking the views of respondents via an online questionnaire, it was therefore appropriate to include opportunities for the respondents to address these and any other dimensions of the online library.

The following factors relate to the survey:

- 1 The objective was to determine the ease of navigating the site; the quality and tagging of information available on the site; and information regarding the user.
- 2 The target population from which a sample would be drawn was defined as healthcare professionals including knowledge management professionals.
- 3 The questionnaire included a preface that requested the respondent to think of a specific infectious-disease-related question (clinical or non-clinical) and to try to answer it using the NeLI site. The respondent was then required to answer a series of questions, addressing the issues as outlined above. The questionnaire was developed using Lotus Domino 5.0 designer. Questions were formulated allowing the respondents to express their views on a range of topics and their relevance. These included: the navigation of the site, was it easy for the user to find their way through it, and how effective was the graphical layout? Was the information current and of high quality? Information was also sought to provide a profile of the users.
- 4 The questionnaire was issued by e-mail to everyone on the mailing list of NeLI. In addition, a link to the questionnaire was placed on the NeLI home page.

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- 5 Analysis and interpretation of the results, using a soft systems approach, are discussed below.

Identifying the relevant systems

The results of the questionnaire yielded evidence supporting the initial view that three systems could be identified within NeLI as being relevant if the service is to fulfil its initial aim. The results of this study are based on information provided by 25 respondents. These three systems were: (1) navigation (technology), i.e. the interface and navigation system; (2) quality and tagging of information (content) available in the system; and (3) information requirement of the users (knowledge) in terms of why and how they use the site. These systems interact as indicated in Figure 2, with the nature of the interactions offering an indication of whether the site is being used efficiently and effectively. Here, we will briefly explain each of the systems based on Checkland's soft system modelling as described earlier (Figure 1).

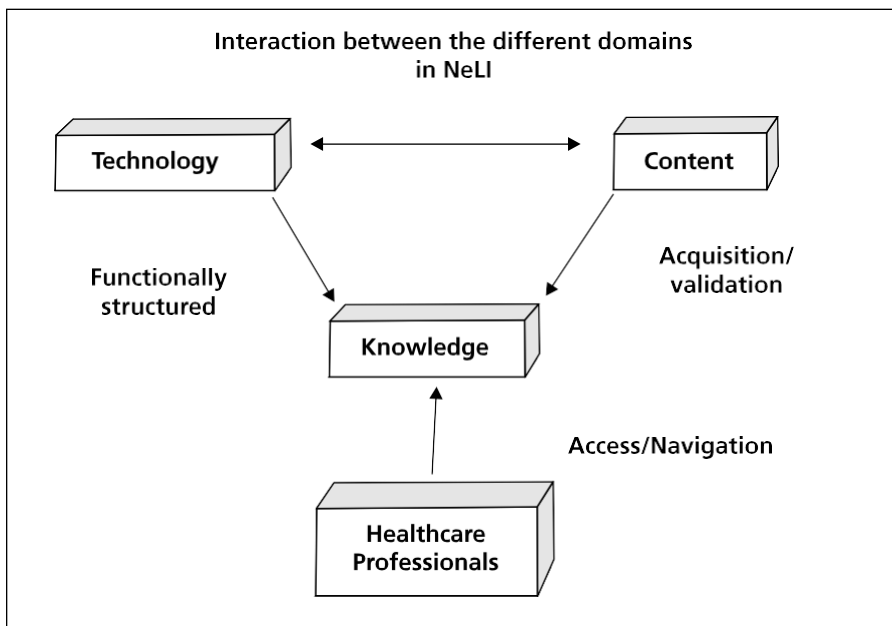


Figure 2 Interaction of the three systems

Navigation system of NeLI

Real world

The system's real-world purpose is to enable users to locate information and acquire knowledge. Our model addressed questions on specific issues of navigating the site: (1) what were the most used options for navigation; (2) was it easy for the user to find their way through it; and (3) how effective was its graphical layout?

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Root definition of the navigation system

On the basis of the above analysis and identification of relevant systems, the following root definition was produced for the navigation system:

The system is designed for healthcare professionals, but could be used by members of the public, called 'others'; it is owned and endorsed by the NeLI stakeholder community represented at the NeLI Advisory Board and by the NeLH. The combination of the keyword search, free text search and browsing provides an enhanced navigational experience, in the context of offering readily accessible Internet information on infectious and communicable diseases.

In each case the root definition was checked for compatibility with the relevant CATWOE analysis. In terms of CATWOE, in this case the *customers* (a subset of whom are also the *actors*) are healthcare professionals and other users. The *transformation* is from dispersed information of variable quality and navigability to a system that offers enhanced navigation, including high-quality graphical interface and appropriately explained navigational options, to quality-assured information.

Here and also for the root definitions of the other systems, some attributes of the CATWOE remain the same. Thus *Weltanschauung* is the need for up-to-date, high-quality health and healthcare information to be readily available and accessible for the benefit of the overall community, both healthcare professionals and members of the public. Increasing emphasis on multidisciplinary healthcare teams and patient choice is creating the need for high-quality information that is relevant to as many points of view as possible. The *owners* are the stakeholder community represented at the NeLI Advisory Board and the NeLH. Finally, the *environment* refers to easy access to information for all via the Internet.

Conceptual modelling of the navigational system

Conceptual modelling of the navigational system highlights factors that are required for an optimal navigational system (Figure 3). The conceptual model in this methodology highlights the nature of the connectivity between the elements depicted in Figure 3. In an ideal situation the following will be in place: (1) all terms within the site are self explanatory; (2) knowledge on all aspects of infectious diseases is available; (3) the graphical outlay is appealing to all; (4) all methods of navigation are equally used by all; (5) the search includes 'dropdown' menu as well as 'free text' search, both options being used equally and regularly; and (6) there is an option for 'Top 25 topics'.

Users readily and frequently access the NeLI website and are happy and satisfied with the information available on the website. The Advisory Board of the NeLI will regularly inform the NeLI developers on areas of navigation which need improvement.

Comparison of the real and systems worlds and action plans for the navigation system

From the questionnaire returns it was clear that most of the users were able to find the information they were looking for, indicating that information on a wide variety of infectious diseases was available. Most of the users found it easy to navigate through the site

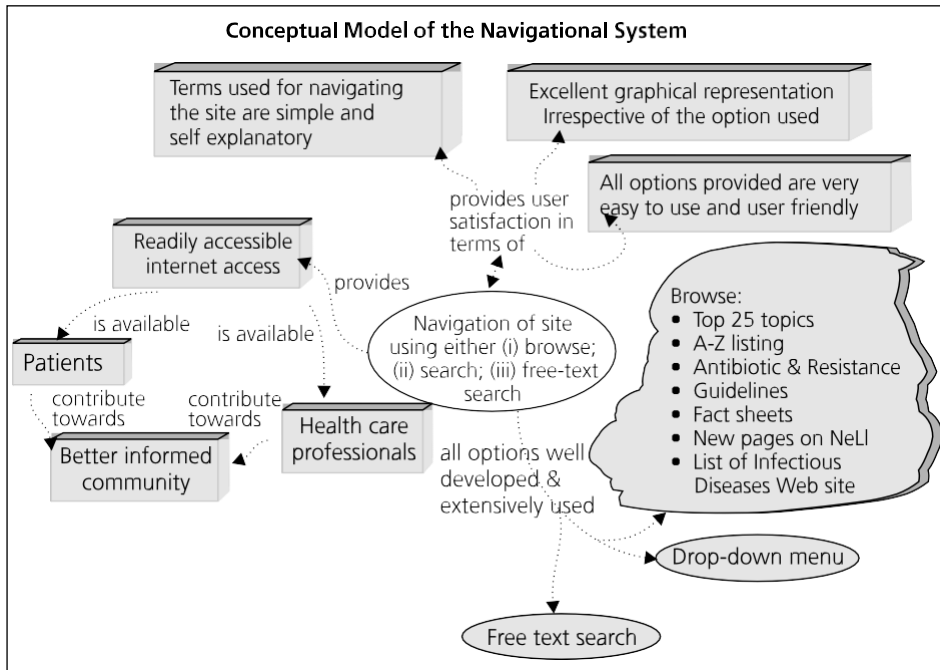


Figure 3 Conceptual model of the navigational system

(Table 1). (Note that the proportion of the respondents who deemed each particular output to be present in the real world is listed in the second column of the table.) The site was also found to be user friendly. No skilled computer expertise was required to use the site, which is the ideal for use by healthcare professionals accessing the site under time constraints.

However, most of the users noted that the graphical design of NeLI needs to be changed significantly in order to make the site more appealing. The need was for less 'wordiness' and a greater use of diagrammatic representations, schematic representations, pictures and clips (Table 1).

Three navigation options were provided to access the library content, namely search, browse or free text search. Browsing was found to be used more than searching, whilst the free text search option was the least used on the site. However, web log studies indicated that the majority of users employed a combination of options (browse and search) to find information they were looking for. The fact that they appeared to be unaware of this fact was revealed by the comparison of user actual navigation behaviour (available from web logs) and user self-perceived behaviour (available from the online questionnaire). These results are to be published in a separate study [10]. This indicated that healthcare professionals require simpler terminologies of the navigation options, or the options need to be more self-explanatory.

The most used options whilst browsing were Top 10 topics and A-Z listings. For the former it was suggested that this be expanded to Top 25 topics. Exploiting the search option, pulldown menus were widely used.

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Table 1 Real-world comparison for effective navigation on NeLI site

<i>Required output in systems world</i>	<i>Present in real world?</i>	<i>Comments</i>	<i>Include in agenda for debate?</i>
Information required by healthcare professional was available on NeLI site	100% yes	Require to maintain this high standard	Yes
Available information on site was up to date	84% yes	Regular updating wherever possible required	Yes
Overall graphical representation of site was appealing	52% yes	Most users suggest incorporation of video clips, diagrams and pictures	Yes
The site is user-friendly and easy to use	84% yes	Require simplification where possible	Yes
The three options for navigation were equally used	40% used search only; 32% browse only; 28% used combination of the two	Browsing and search mostly used, so need to concentrate on their development	Yes
In browsing, all options used equally	16% of all users each used A–Z listing and Top 10 topics	Top 10 topics and A–Z listings mostly used Increase the Top 10 topics to Top 25 topics	Yes
Search and free text search used equally	100% used drop-down menu	Pull-down menu mostly used, need to increase options	Yes
Terms used in site were easy to understand	20% got their terms wrong	Misunderstanding of terms of navigation Need to simplify terms and educate professionals	Yes

Hence, summarizing the above discussion, whilst overall navigation in NeLI was generally found to be user friendly and easy, the following themes needed to be addressed for the ‘action plan’:

- enhancement of the graphical interface
- replacement of Top 10 topics by Top 25 topics
- clarification of the navigational options.

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Quality and tagging of information of NeLI

Real world

NeLI aims to differentiate itself from other websites offering information to healthcare professionals by providing quality-assured information. All information provided on this site is reviewed by specialists in the area who fill in a reviewer's assessment form critically summarizing each paper using evidence-based criteria. These reviews, signed by the reviewer and identifying his or her professional affiliation, are made available to the users. This quality assurance process is called 'quality tagging'. As this is a distinguishing feature of NeLI, this aspect of the design is of importance for the NeLI developers.

The aim in this context was to determine whether the NeLI was able to provide information across a wide range of topics on infectious disease, to satisfy user information needs and to assess its quality. Also, we wanted to determine whether reviewing the site by specialists increases the confidence of the users about the quality of information they receive.

Root definition of the quality and tagging of information

A system which ensures the provision of high-quality and tagged information, and is owned by NeLI, the stakeholder community represented at the NeLI Advisory Board and the NeLH, in the context of offering readily accessible Internet information on infectious and communicable diseases.

In terms of CATWOE, here the customers, who again are also the actors, are the healthcare professionals and other users. The transformation is that from present provision of variably quality-assured information to uniform excellence of information provision across all aspects of infectious and communicable diseases so as to meet the needs of all users.

Conceptual model of 'quality and tagging of information'

Conceptual modelling of this system, as depicted in Figure 4, involves the interaction of the following subgroups:

- 1 *Quality of information*: the information provided on NeLI is (a) the most recent information of the highest quality; (b) applicable in clinical settings; and (c) freely and readily available to all.
- 2 *Tagging of information*: (a) tagging of information helps the confidence of all users; (b) healthcare professionals willingly help towards contributing to reviewing information to be placed on the site; and (c) all information provided on the site is reviewed by specialists in the area.
- 3 *Information resources*: NeLI will be providing information from a range of high-quality information resources, as shown.
- 4 *Users*: the customers use this information and this results in a well-informed community – both healthcare professionals and general public and patients.
- 5 *NeLI Advisory Board*: regularly provides feedback and supports the NeLI developers.

The verbs that form the basis of the conceptual model provide the connections between the elements depicted in Figure 4.

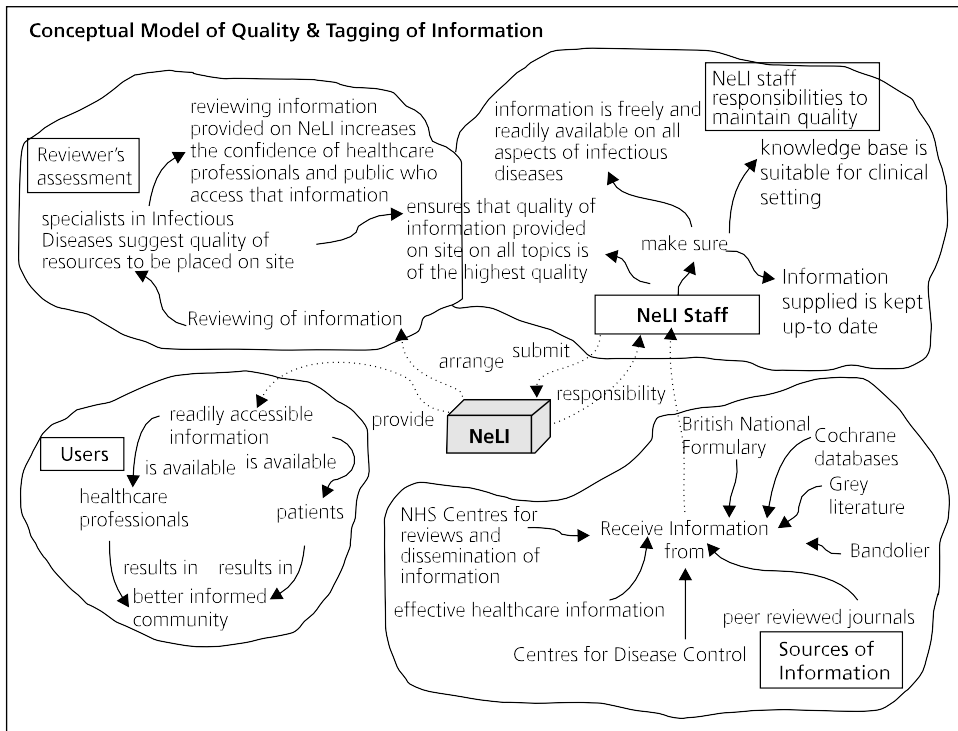


Figure 4 Conceptual model of 'quality and tagging of information'

Comparison of the real and systems worlds

The feedback obtained revealed that, in general, the relevant information sought was available, up to date and clinically relevant (Table 2). The quality of information on the site was rated as ranging from excellent to fair (on a Likert scale 1–5: poor, fair, good, very good, excellent), with the majority of the users considering the quality of information as ranging from excellent to good.

Eighty per cent of the users agreed that reviewers' comments did add to the authority of the information provided and were a source of further reassurance, though a minority felt that the process was not necessary (20%). Introducing this review process is clearly useful for patients and members of the general public accessing the site (Table 2).

Therefore, for this system the themes which need to be addressed to maintain the quality of service are the following:

- maintain breadth of information provision
- ensure continued quality review process and timeliness of information provision.

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Table 2 Comparison between real and systems worlds in quality and tagging system of NeLI

<i>Required output in systems world</i>	<i>Present in real world?</i>	<i>Comments</i>	<i>Include in agenda for debate?</i>
Quality of information available on site was acceptable	96% yes	Users satisfied that quality of high standard. Efforts required to keep up the standards	Yes
Information is updated regularly	84% yes	Regular updating wherever possible required	Yes
Knowledge available on site is useful in clinical setting	80% yes	Some users not able to comment as not working directly in a clinical setting	Yes
Reviewing of the site by specialists in the specific areas added to the user's confidence in the site	76% yes	Some users felt they were competent to judge for themselves	Yes
Information present on all aspects of infectious diseases	100% yes	User to notify if absent NeLI developers to continue to identify areas of importance	Yes
Information on NeLI is taken from specified areas, acceptable to all	100% yes	Developers to keep track of more places to gather reliable information	Yes

User information system of the user system

Real world

In this system we wanted to obtain information on (1) the background of the user, and whether NeLI was providing context targeted information to its user group; (2) the frequency of visits by the respondents to the NeLI site and overall awareness about the site; and (3) the respondents' initiative in contributing towards improving/reviewing the site. This last point covered the two issues of (a) whether users were happy to be reviewers and (b) whether they would be happy to provide feedback and so contribute to the development of the site.

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Root definition of user information

A system which is routinely used by healthcare professionals (as part of the care process) and by others (patients and public), and is owned by the stakeholder community represented at the NeLI Advisory Board and the NeLI, in the context of offering readily accessible Internet information on infectious and communicable diseases.

In terms of CATWOE, in this case the customers are patients and members of the general public and the actors are healthcare professionals. The transformation is that from a limited set of professionals providing evidence-based care to NeLI being routinely used by a wide range of healthcare professionals (as part of the care process) and others with regular feedback of information to further enhance the site. The Weltanshauung in this case is rising healthcare quality expectations among members of society, both healthcare professionals and lay people, who need information on infectious and communicable diseases.

Conceptual model of the user system

In the conceptual model of the systems world of the 'user system', the following subgroups will interact as depicted in Figure 5.

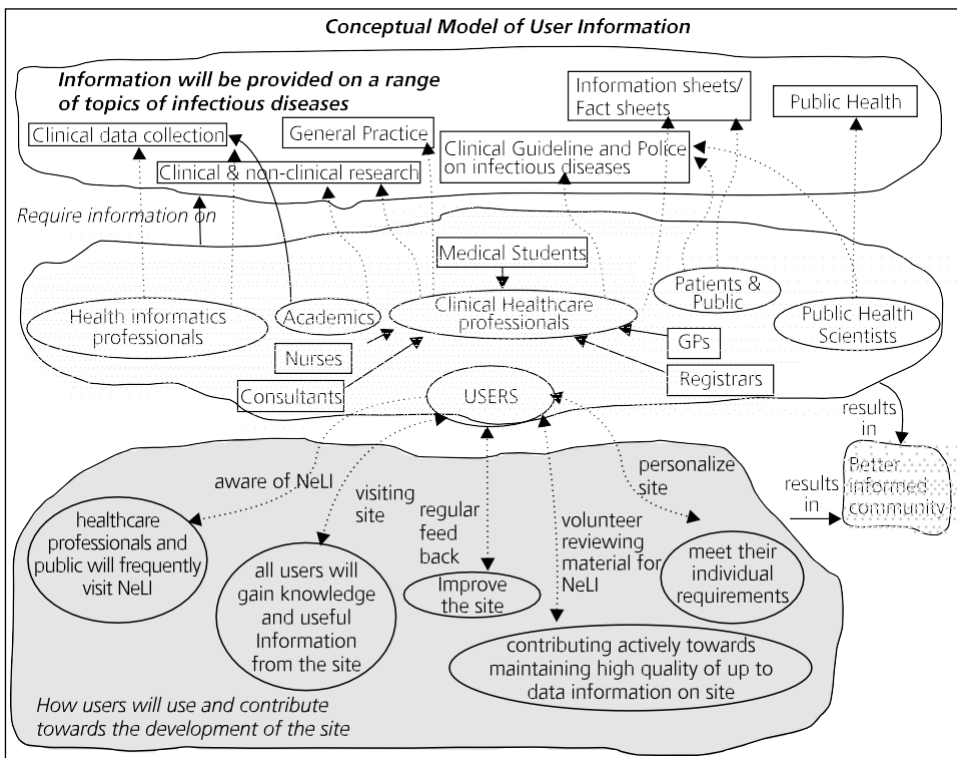


Figure 5 Conceptual model of user information

User information

Amongst professional users, the site is accessed by a variety of healthcare professionals, including academics, clinicians, health informaticians and public health scientists. Clinicians include hospital consultants and registrars, GPs, and a small number of nurses (Figure 5). Members of these groupings were included in this study, such that it is qualitatively representative of the target population even though the number of individuals involved in this pilot was small.

NeLI developers

These provide context-specific information on a range of areas from access to clinical data; information on clinical and scientific research; information specifically targeted for healthcare professionals from a variety of backgrounds; and public health information.

Users of the site

The users will (1) be aware of the NeLI site; (2) visit the site regularly to gain information on infectious disease; (3) send regular feedback to improve the site; (4) contribute towards reviewing the site; and (5) personalize the site according to their professional background (Figure 5).

Comparisons of the real world and systems thinking

The feedback obtained from the questionnaire indicated that the respondents were from varied backgrounds. However, not all the respondents were aware of the site before they responded to the questionnaire.

One of the respondents agreed to contribute to the site in terms of providing reviewers' assessments and identifying new resources, this being the way forward in terms of enhancing the site. The remainder of the respondents simply ignored the question inviting them to contribute in this way. The implication of this is that they were not ready to be reviewers. From their responses to other questions, it was evident that they generally felt reassured about using the site as the information provided on it is reviewed by specialists. However, for the success of such a major project, and the resources invested, it is imperative that the users should become involved in the development and improvement of the site. However, this requires a conscious decision on the part of regular users.

Awareness of the site needs to be raised. It is important that more people from the infectious diseases community should be using the site more regularly. Web log studies carried out on the site indicate that hospital/NHS-based users access more pages per month than other users. Therefore attempts will be need to be made to increase awareness in the other groups as well.

This highlights the need to address the following issues in the action plan (Table 3):

- involving more healthcare professionals in the creation of the site
- gaining more regular feedback from users
- increasing use of the site by more healthcare professionals (including those in PCTs and acute care trusts, not only senior personnel) as part of caring for their patients
- identifying incentives to encourage contributions to the site.

Table 3 User information system in real and systems worlds

<i>Required output in systems world</i>	<i>Present in real world?</i>	<i>Comments</i>	<i>Include in agenda for debate?</i>
Users from various healthcare backgrounds were actively using the site	Yes: respondents representative of a wide range of backgrounds	Encourage users from healthcare backgrounds not represented in the study	Yes
Healthcare professionals use this site regularly	4% daily; 32% rarely (once in 2–3 months); 8% monthly; 56% first time	Identify reasons as to why they are not visiting the site as regularly and steps to be taken to enhance this	Yes
Were the users aware of the site before answering the questionnaire?	56% visiting site for the first time	Urgent need to increase awareness	Yes
Healthcare professionals willing to contribute to the site in terms of 'reviewing' the site	96% did not answer this question	Immediate requirement to identify ways of recruiting specialists to review site	Yes
Users of site were readily prepared to provide feedback on site	60% no; 24% yes; 16% answers not provided	Need to identify ways to involve users in the further development of the site	Yes
Personalizing the site was appealing to the users	52% yes; 32% no; 16% answers not provided	Need to determine whether it is worth the developers' time and energy to design the site to enable the users to personalize the site	Yes

Discussion

This study has involved the NeLI being examined from a systems perspective, enabling its status to be assessed and areas where enhancement is needed to be identified. This has been achieved by analysing results from an online questionnaire in a manner designed to highlight key issues of concern that can be used by the site designers to improve the site to better meet the users' needs. This in turn has enabled relevant systems of interest to be defined as part of the systemic methodology that has been adopted.

Using the root definitions as expressed above, conceptual models were developed for each of the three relevant systems. These are shown in Figures 3–5 respectively. In terms of the Checkland methodology, the basis of the conceptual model is the set of verbs that

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define the core activities that are required. These verbs and the relationships between the activities, as represented by arrows, are indicated in these figures. Figure 6 draws these three individual models together to yield an overall conceptual model.

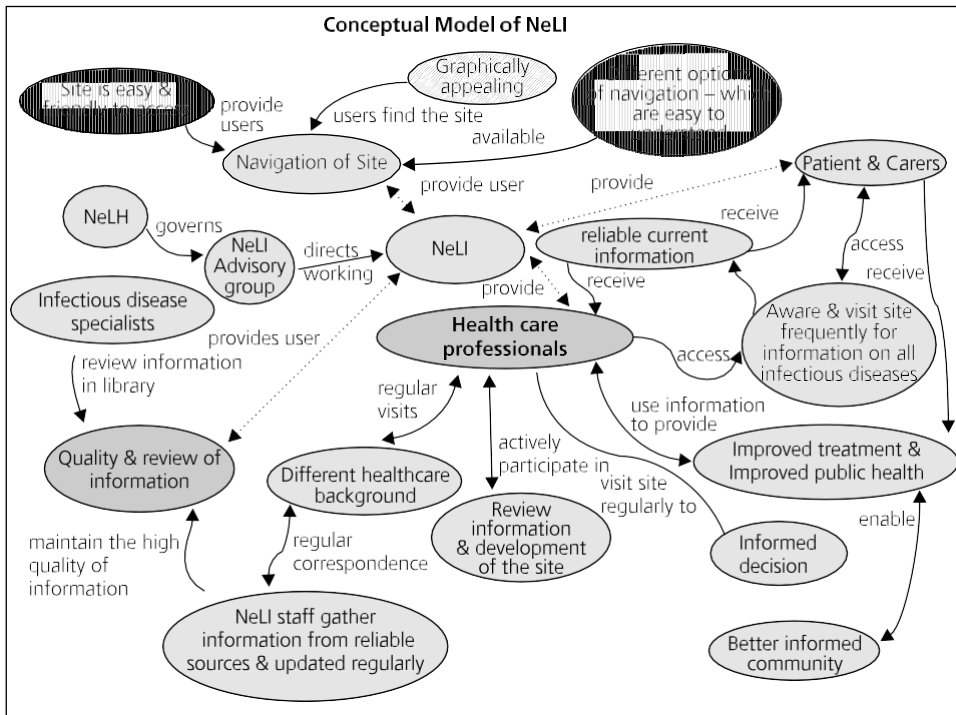


Figure 6 Conceptual model of NeLI

Once these conceptual models have been formulated, analysis proceeds by way of comparison of the conceptual models with the current real-world provision. This enables agenda items to be identified that can form the basis of debate as to what changes might be implemented for system improvement. In carrying out this process it is important to consider all relevant perspectives, setting any one particular system within the overall set of constituent systems and their varied perspectives [11].

From this analysis it has been shown that issues needing to be addressed can be categorized under the headings of navigation, quality and tagging, and user profile. These are listed in Tables 1–3 respectively. Each of the tables indicates the extent to which those involved in the study regarded the particular issue to be present in the 'real' world. These are the items which, having followed through the stages of the methodology, have been proposed for inclusion in the agenda for change with a view to enhancing NeLI service, functionality and operation.

From these listings an action plan for improvement of the NeLI site can be put forward. However, in doing this, there is a need to be aware of what is acceptable politically and organizationally, and desirable from the perspectives of all the stakeholders involved. On the basis of discussions with a number of such stakeholders, a possible action plan is shown in Table 4.

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Table 4 Action plan for improvement of the NeLI site

<i>Action</i>	<i>Purpose</i>
<i>Graphical layout of site:</i> incorporating images, video clips and diagrams into the NeLI site	Make site more appealing to the users
<i>Terms on site:</i> simplify navigation options	Make it easier for users to navigate site
<i>Ease of navigation:</i> concentrate on making site as user-friendly and easy to use as possible	Healthcare professionals can access site with minimum expert technical knowledge
<i>Improving options in browsing:</i> identify the Top 25 topics on infectious diseases	Provide more options for users to quickly glance through
<i>Quality of information:</i> concentrate on providing the highest quality of information available. Regularly update information on site	Users are assured that information provided on site is reliable and trustworthy
<i>Reviewing or tagging of information:</i> determine strategies with developers and users on incentives that can attract more specialists to review site	Ensure that more information on site is reviewed by specialists, to increase the confidence in users about the quality of information available
<i>Increase awareness about NeLI:</i> encourage more healthcare professionals to use site	Increase the number of healthcare professionals using site, in a clinical setting or otherwise, as providing evidence-based information to healthcare professionals for informed decision making is the primary aim of NeLI
<i>Source of information on site:</i> regularly review sources of information available on site	Ensure that the source of information is maintaining high standards; also if new sources arise, should incorporate them

Navigation

Whilst the overall navigation of NeLI has been reported as being user-friendly and easy to use, the developers of NeLI need to work at maintaining the high standard which NeLI has achieved. The terminologies used on the site need to be reviewed and made simpler and more self-explanatory. Within the browsing option, the Top 10 topics appears to be the preferred option. However, there is the need to increase this option to produce the Top25 topics to reflect the different information needs of the various stakeholder groups. This enhancement is already under way.

The graphical layout of the site needs to be restructured, in consultation with the relevant computer specialists, to enhance its aesthetic appeal. This will involve the replacement of portions of the text with more diagrams, clips, drawings and schematic representations.

Quality and tagging of information

The quality of information on the site was generally considered to be very good. Information available related to all aspects of infectious disease being sought by the users. NeLI needs

to be continuing to provide up-to-date information at all times. However, it needs to be borne in mind that not all topics are equally well covered. This is a function of the importance that has been attached to the specific infectious disease, its significance and the amount of money invested in that particular area of study. In fact, there are some clinical conditions where there is not much information available on NeLI, as the resources aim to provide the best available documents, not merely duplicate MedLine or other comprehensive medical portals; again the emphasis is on the provision of high-quality information. This is an important factor that needs to be taken into account while analysing the results. It is vital, however, that attempts should continuously be made to provide information in a format in which it can be accessed easily in a clinical setting.

Reviewing the information provided should be encouraged, as it has been shown to have increased the confidence attached to it by healthcare professional users of the site. Review is appropriate whatever the level of knowledge and expertise of the reviewer, though it should be noted that in general it is increasingly difficult to obtain such review by busy expert clinical consultants.

Users

This study has shown that healthcare professionals from a variety of backgrounds have accessed the site, which is very encouraging for NeLI. However, frequency of access is not uniform across all professions. This could be attributed to two possible causes. The first could relate to the amount of exposure/training the healthcare professional has received. Alternatively, it could be that they are not yet adopting a regular habit of routine computer usage. Both need to be further investigated.

Unfortunately, although NeLI is attempting to provide appropriate information for the healthcare professional, due to pressures of time etc. they are generally themselves reluctant to contribute to the site. Hence there is a need to determine more proactive strategies with developers and users which will provide incentives that can attract more specialists to review the site.

Also, training should be given to trainee doctors, nurses and allied health professionals directed towards a greater incorporation of computer use as routine in the course of treating patients. Clearly this will be a gradual process, but one that is essential in order to recoup the very substantial investment that has been made in the NeLI portal.

Conclusions

The NeLI is widely regarded as one of the success stories of e-health provision in the UK. Its specialist libraries include the NeLI which provides a substantial knowledge and information resource in relation to infectious diseases. However, it is important that proper evaluation studies should be undertaken in order that continuing improvement in such facilities can be brought about. This paper has described one such study as an ingredient of proper system evaluation.

The study has made use of a soft systems analysis to identify three areas where improvement might be achieved. These relate to the navigability of the NeLI site, the quality and tagging of its information content, and the nature of the users of NeLI. In terms of

navigability there is the need to simplify the terminologies adopted in order to enhance accessibility. With regard to quality, there is the need to ensure that new information is properly included with proper review. This highlights the need to rethink the review strategy such that some form of incentive can be provided to attract more reviewers to the site. Equally there is the need to attract a broader cohort of users from across the spectrum of healthcare professionals. Appropriate consideration and implementation of such change agenda items will help to ensure that that NeLI achieves its targets as a key component of e-health provision.

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