One major criticism of paper medical records is the time and effort required to find data items or to gain an overview. Computerisation does not necessarily help. To help clinicians find data faster and with less effort, everyone designing and writing in records needs to understand how and why we search records and the design features that make searching easier. This paper describes how clinicians search medical records and how to improve record design, whether on paper or computer, to help clinicians find all the data they need without delay.

Records contain a wide range of data on patients and, with evidence from published medical papers and the patient, form one of the three evidence sources that underpin care (see the first paper in this series2). Clinicians search records both for specific facts relevant to the current decision—eg, penicillin allergy in a patient with pneumonia—and for broader impressions—eg, has there been a previous episode?

Berger3 describes how a farmer looking at a neighbour’s field sees in a single glance what crop is growing, its maturity, and the soil quality. Preconscious psychological processes infer such information from the topography, colour, and texture of the field; farmers seldom view fields as beautiful green rectangles, as might an artist or rambler. Similarly, doctors infer diseases, unexplained symptoms, risk factors, and so on, as they browse a record, though they can rarely specify in advance which data will trigger these impressions. This ability explains why the rapid, precise searching capacity of computers can be disappointing for clinicians searching electronic records. To design records that are easier to search, we need a clear understanding of the reasons why doctors consult records and of the search processes that support each.

Medical records and the search process

Reasons why doctors consult records
An observational study of how clinicians use paper medical records found that the search method varied with the clinician’s reason for consulting the record.3 The three commonest reasons were to gain an overview of a familiar or new patient, to search for specific details, and to prompt or explore hypotheses.

Gaining an overview of a familiar patient relies on cues triggering recognition. Any feature that makes the record distinctive, such as an unusual surname or the letterhead of the referring hospital, will help refresh the clinician’s memory. The referral letter also helps the clinician to gain an overview of a new patient. An example in the previous paper showed how correspondence can be structured to assist this process. Features such as time-lines and summaries also help the doctor to gain an overview. Once the clinician is familiar with a patient, he or she searches for specific details or to explore hypotheses. The clinician navigates to likely locations for data by using knowledge of the record structure, the ordering of documents, and the layout of text and data on each document. This approach helps to limit the search space and so speeds the search, as long as the record structure matches expectations.4

Process of searching records
In our studies of doctors searching records, we observed that the doctors skimmed rapidly over pages of text while continuously making assessments of relevance.4 Skimming of the first few words in a paragraph was sufficient in many instances. A paragraph judged irrelevant was immediately skipped, whereas a paragraph judged relevant caused a switch from skimming to reading word by word. How can record design support doctors in carrying out these skimming, skipping, and reading processes?

What design features aid searching?
To explore how document design influences the ability of clinicians to search for data, a laboratory report was manipulated so that each letter or figure was replaced with X but their relative positions were maintained (figure 1, left). We were surprised to find that clinicians allowed only a brief look at this manipulated report acquired a fairly accurate picture of the patient’s condition.4 For example, clinicians recognised a horizontal line of Xs in a certain position as well-controlled diabetes and a vertical line of Xs as the battery of tests ordered when a patient is admitted to hospital. Of course, clinicians read the actual numbers in a real situation, but they also effortlessly acquire useful information from the overall pattern. Although imprecise and incomplete, that information is sufficient to define the context, so that the brain knows where to stop skipping and reading can start.

By contrast, a typical computer-generated laboratory report (figure 1, right) is “pattern-dead”, with test results tightly packed and no space between different kinds of tests. In the experiments, doctors required more time and effort to interpret these reports, even when they were very familiar with the computer report. Given the same content, document structure and format determine the time and effort needed for relevant information to be extracted. For example, subtle improvements in the format of the document shown on the left-hand side of figure 2—highlighting the time when the albumin test was ordered, aligning the column of “Index” figures by

---

**Medical records**

**Helping clinicians to find data and avoid delays**

Else Nygren, Jeremy C Wyatt, Patricia Wright

Lancet 1998; 352: 1462–66

Department of Information Science, University of Uppsala, Uppsala, Sweden (E Nygren MD); School of Public Policy, University College London, 29 Tavistock Square, London WC1H 9EZ, UK (J C Wyatt DM); and School of Psychology, Cardiff University, Cardiff (P Wright MD)

Correspondence to: Dr Jeremy C Wyatt
(e-mail: jeremy.wyatt@ucl.ac.uk)
decimal point, and locating each drug at the time it was administered on a simple scale (figure 2, right)—halved the average time required for information to be extracted.7

In general, there are three main methods for improving the design of records to make patients’ data easier to find: organisation of the documents within the record; better organisation of data on document pages; and highlighting of certain data items by use of colour or other means.

Organisation of documents in the record
Disordered records severely slow searching.5 A document order that is fixed, explicit, and well known to all record users within the institution is essential to navigation, and is usefully supplemented by labelled card dividers. However, there is wide variety of strategies for organising documents in the record. Some institutions file all documents chronologically, whereas others group documents by speciality, by document type, place of origin, or even document function (panel). Different organising strategies have different benefits, such as ease of maintenance and clarity. Which strategy is chosen probably matters less than consistency and the number of documents per section, so that users can find each kind of document in a predictable place in the record.

Within sections, documents should be organised logically, or at least consistently. The document order used widely in Sweden8 and the UK uses forward and reverse chronological order and document type. In the...
Some strategies for organising documents in a medical record

<table>
<thead>
<tr>
<th>Strategy</th>
<th>Example section</th>
<th>Example contents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clinical specialty</td>
<td>Surgery</td>
<td>Admission note, consent form, operation note, anaesthetic chart, pathology report, inpatient summary, progress note</td>
</tr>
<tr>
<td>Document type</td>
<td>Correspondence</td>
<td>Referral letter, outpatient letter, inpatient summary, discharge prescription letter</td>
</tr>
<tr>
<td>Document origin</td>
<td>Laboratory reports</td>
<td>Biochemistry, haematology, histology, cytology report</td>
</tr>
<tr>
<td>Document function</td>
<td>Supporting</td>
<td>Drug allergy list, anaesthetic chart, inpatient prescription chart, digoxin assay report</td>
</tr>
</tbody>
</table>

first half of the records, progress notes are sorted chronologically, most recent last. In the second half, other document types are filed in reverse chronological order by type between dividers, most recent first. This apparent inconsistency makes good sense because, with the record open on the doctor’s desk, time moves down on both sides, with the most recent progress note on the left and most recent letter or laboratory report on the right.

To help distinguish the many kinds of documents in a section and also to identify the section clearly, different types of documents should look different. Distinctive titles or logos help, as do coloured paper, coloured ink, stickers, or stripes along the margin. A distinctive appearance also means that the document is more likely to be filed in the correct section. However, the colours of paper and ink must be carefully chosen to ensure legibility.

Clinicians change jobs often, and the difficulties of such changes can be compounded if each institution has a different record-organising strategy. An index of all document types by section, printed on the inside front of the record folder, is helpful. Alternatively, a one-page structured abstract, listing each encounter, diagnosis, therapy review in a chronic disease might include diagnosis, disease stage, complications, sequential disease markers, and a list of successful and unsuccessful therapies. Such summary sheets can be paper proformas completed by hand at each visit or computer-generated documents.

A major risk is that important details get buried in lengthy progress notes. The risk of losing data is decreased if data are carefully laid out on the page so that a clinician can find them by skimming. Structured text and tables are efficient means to achieve this. A blank line or two between each note will make it easy for the eye to jump from note to note. The length of each note also gives an indication of the complexity of that consultation.

A standardised set of headings and subheadings helps doctors locate themselves in lengthy documents such as progress or operation notes. Indenting of subheadings creates visual landmarks, makes specific data items easier to find, and is easily achieved even when handwriting. Headings and subheadings should appear in predefined order, so that readers can quickly ascertain whether a certain clinical finding was recorded without examining all subheadings.

Now that even the most trivial document is word processed, there is a risk that fancy formatting can conceal content. Thus, record designers should be aware of the principles of text formatting (figure 3). Use of too many fonts within a document confuses readers about the reason for each. For headings, variation of size and weight (boldness) is more effective than use of different fonts. In general, the choice of a font with serifs or a font without serifs will make little difference, although there is evidence that older people find serif fonts easier to read. Paragraphs in italics slow readers. Bigger fonts with wider line spacing are more legible, and generous use of white space around text aids navigation and speeds reading. However, if application of these principles would mean that important data have to be placed on the next page, some trade-offs are necessary. Centred headings are fine, but if they are of variable length (for example, patients’ names), a flush left position ensures that data start consistently on each page.

The format of tables also influences readers’ searching speed. Numbers can be compared more quickly and easily if they are arranged down a vertical column rather than along a horizontal row. In an experiment on this topic, participants were asked to assess whether ten numbers constituted a rising trend; even after practice, people were 20% faster in the vertical orientation than in the horizontal. Numerical columns should be centred on the decimal point, to ensure that, for example, 11·1 is visually distinct from 1-11. Most proportionally spaced fonts now have the single-spaced numbers required for tables.
Highlighting of data with colour and other cues

Colour codes can help doctors to find data as long as they are used consistently. In Sweden, red date-stamps mark the beginning of each progress note and assist the doctor to skip encounter by encounter. Highlighting of key findings with a coloured marker-pen has a secondary benefit: the ink slowly vanishes, hinting at how recently the marking was done. Coloured labels, paper, or print are useful to distinguish documents such as test-report forms or the sheets of a multipart prescription form. In handwritten tables, the difference between pen and pencil can be informative if values written in pen indicate data that have been checked. On some wards, the night-shift annotates the record in red, so a doctor can see at a glance if the patient had a troublesome night. However, legibility is reduced by poor contrast between coloured or pencil writing and the background. Since colour blindness affects one in ten men, designers must never rely on red/green cues alone.

Another method to improve searching and orientation in documents is to add dates, initials, short codes, or other annotations in the left margin. Computers can add a wide range of pictorial icons to flag possible adverse drug events, tentative diagnoses, and so on. However, to avoid errors, record users must always be familiar not only with the meaning of every code or icon but also with the criteria governing their use.

Use of computers

To find information on a patient, the doctor must start with the correct record. Paper records are commonly stored together on a shelf or trolley, and it is therefore easy to grab the wrong one. Such “off by one” selection errors also occur on computer systems—selecting an adjacent patient from a list or typing an adjacent letter on the keyboard. Computerised displays can avoid such errors by use of natural mapping. For example, to reduce errors in selection of records, named icons representing patients in beds or clinic rooms can be arranged around the screen on a map that also shows fixed features such as doors and walls.

Once the correct patient’s record is chosen, clinicians need to find all data relevant to their current task, which may involve skimming, skipping, or reading. Computers make it hard for people to navigate, because they convey no spatial clues to orient the searcher. They may also censor outliers or artefacts, temporarily conceal certain data items because they are apparently irrelevant to the task in hand, or locate data inconsistently. To aid clinicians searching computer-based records, designers must avoid further disorientation. This means careful attention to the details described above and especially to consistency of data format and location.

In electronic records, containing copious data, data use can be hindered more by difficulty in focusing on the right subset of data than by difficulty in finding the data. Focusing on critical data requires an overview of the patient’s record and the data within it. Computers offer specific focusing techniques such as searching for partial or complete text matches, views of data by time, clinical problem, or clinical task (discussed in the next paper in this series), and overviews. Overviews are a screen showing 10–20 miniatures of data screens (“thumbnails”), which faithfully reflect the original’s layout and visual pattern (figure 4). When each data screen is carefully designed with its own characteristic layout, clinicians can identify the miniature they want on the overview, click, and go direct to the data screen they need.

Other forms of computer interaction go beyond simulation of the familiar pen, card files, and graph paper and may help us find data. For example, Rector and colleagues have developed a body-chart interface, which
replaces traditional forms with a diagram. When the cursor is moved over, say, the abdomen, relevant information (eg, “mass right upper quadrant”) is displayed. The data are stored in coded form so can also be formatted as a prose record for later print-out. Doctors in the pilot test liked this approach, but effects on retrieval speed were not measured.

Conclusions

Good record design can double the speed at which a practised reader extracts information from a document, whereas poor design introduces an upper limit on speed that cannot be overcome by training. Good design does not require the use of computers—coloured paper, clear, consistent organisation of documents in the record, and structured pro formas can achieve a great deal. Indeed, computers can confuse the record user, making information harder to find. Advanced techniques such as natural mapping, overviews, and time-lines can overcome these disadvantages but must build on firm foundations such as careful table and graph design and cautious use of fonts and other embellishments.

Good design usually goes unnoticed, but still needs to be confirmed in an evaluation study. In one study, participants had no recall of the layout of a well-formatted document they had just read but good recall of one with text attributes that slowed reading or were likely to induce errors. Asking people for their opinions about the format can help to show whether revisions have improved a document. Another simple test of document layout is to make miniatures of the documents so small that no words or numbers can be distinguished (figure 4). If the design is clear, the searcher should be able to identify the document and extract something interesting about the patient. Once the document passes this test, objective measurement of reading speed and error rates with the full-sized version show how well it supports users carrying out typical tasks. Such testing also allows the designer to examine the impact of alternative layouts on interpretation of data, the topic of the next paper in this series.

References

7 Nygren E. From paper to computer screen: human information processing and user interface design. Acta Univ. Ups, Comprehensive Summaries of Uppsala Dissertations from the Faculty of Science and Technology, Uppsala, 1996: 118.