Efficient Therapeutic Guideline Production: Achieving Consistent Content Quality Across Multiple Output Formats.


Abstract—This paper describes the demands on therapeutic guideline production and a production system designed to cope with these demands. Guidelines are intended for use within a range of clinical information systems and vary in their content, style, intended audience and structure. Complex medical information makes up the content of guidelines and is subsequently viewed in complex and varying environments, on a variety of devices. The functionality of the production system described allows guideline content providers to produce content in a way that is sympathetic to the traditional means of writing guidelines, while also allowing guideline structure to be developed. Output in a variety of formats is produced from a single source and includes XML, print and HTML for web browsers and PDAs.

Index Terms—Therapeutic Guidelines, Decision Support, Health Informatics, Applications of XSL

I INTRODUCTION
A range of organisations produce Clinical and Therapeutic Guidelines. The guidelines produced have varying subject content and style and are intended for varying audiences. Guideline structures range from narrative text[1] to highly structured algorithmic descriptions capable of decision support[2]. In addition to these differences in guidelines themselves, guideline audiences differ on what viewing devices they expect to be able to view the information.

If the aim of producing guidelines is to enable authoritative information to be widely disseminated, these variations in guidelines and the expectations of the guideline audiences must be met. This paper describes a guideline production system and process that supports this aim. The system is currently known as the Therapeutic Guidelines Information System (TGIS).

Therapeutic Guidelines Limited (TGL) is a long established provider of best-practice guidelines concerning the treatment of choice for common conditions[3].

TGL has recently embarked on a research program to optimise the production of Therapeutic Guidelines and to enable the Guidelines to be used within electronic decision support systems[4].

The subject range dealt with in Therapeutic Guidelines covers a broad range of therapeutic areas, from antibiotic guidelines to palliative care. Although TGIS is designed to cope with the subject area and format of a particular set of guidelines, it is intended to be a generic approach adaptable to a wider range of medical subjects, as well as to the broader area of technical communication.

The guideline production process at TGL is sustainable. It is an independent organisation that depends on the sales of guidelines. Its longevity indicates the quality of the product. TGL is thus well positioned as a platform from which guideline formats and authoring tools can be developed and disseminated.

II SYSTEM REQUIREMENTS
This section describes characteristics of guidelines in general. It serves as a broad set of requirements that TGIS is expected to fulfil.

Guidelines have varying subject content and style, including narrative text, protocols and care plans, as well as clinical evidence[5], reports of clinical trials and reviews[6]. Reference sources, while not presenting themselves as guidelines, contain information which overlaps with guidelines. These latter include information on drugs (including drug interactions and reactions[7], and conditions[8]).

Different subject areas emphasise different aspects of medicine, eg. antibiotic guidelines[9] heavily emphasise diagnosis and cure, while palliative care guidelines[9] emphasise symptom relief and communication.

Different guidelines are intended for different audiences, with varying assumed knowledge. These could include general practitioners, specialists, nurses, allied health professionals, students and consumers.

A guideline production system needs to recognise that there is potentially a place for all of these forms...
of guidelines, and that content should not be automatically re-structured to fit system requirements. A structure should only be imposed on the guidelines where it can be demonstrated that this is a useful outcome, not merely because it makes system design more straightforward.

The introduction of new media for presentation of information has brought increased opportunities, as well as increasing the complexity of managing the information. The viewing devices that TGIS is currently focussing on include print and electronic browsers (web and PDA), as well as a format that enables decision support within clinical systems. The latter is to be developed but it is envisaged as an advisory reference that is internally available within a clinical system and that it is to be integrated within the workflow of clinical practice.

For a set of guidelines that has a consistent subject content and style, the variance in audience and viewing device must be accounted for in guideline production. The challenge in developing an efficient guideline production system is in maintaining consistent content across all viewing devices, as well as the increasing complexity of the information that comes with increasing the number of output formats. This is not simply a matter of reproducing content in a number of formats.

It is necessary for the content and its layout to be adapted to the capabilities and limitations of each viewing device. An example limitation: screen resolution is low compared to page resolution, so the amount of text that can be displayed on-screen is less than can be comfortably presented on a page. An example capability: Searching or browsing for content in electronic formats can be across domain elements, allowing e.g. searches for particular drugs/drug types used for treating particular conditions.

We describe a guideline production system that allows the efficient production of guideline content. The principle content of the system is a set of guideline topics.

System requirements are:

- Guideline structure and style should not be constrained by the system, except where that is a recognised and desirable outcome.
- Each output format must take advantage of the capabilities, and compensate for the shortcomings, of each output device.
- Manipulation of information must be consistent with the domain being described.
- Content structure must have sufficient flexibility to allow for the ongoing introduction of additional elements.

III SYSTEM ARCHITECTURE

This section describes the principle components of the production system and the connections between them. It demonstrates the modular approach to architecture design and the adoption of standard techniques where appropriate.

Figure 1 depicts the broad architecture of the system. Guideline creation is carried out in the top half of the figure, while guideline output in various formats occurs in the bottom half.

![Diagram of TGIS System architecture](image-url)

Authority Guideline manuscript
(Microsoft Word document)
-Prepared by an editor and multiple authors

Authoring / Editing support
-Analysis
-Access to guideline data/information
-Indexing support
-Navigation
-Output styling
-Metadata description

Guidelines DB

Typeset Guideline manuscript

CD-ROM (HTML, java)

Intranet (HTML, java)

PDA (HTML)

Decision Support (XML)

Figure 1. TGIS System architecture.
A Content authoring

Guideline content is initially authored by a writing group, with the assistance of an editor. The draft manuscript is prepared in Microsoft Word. The use of Microsoft Word as the input mechanism allows authors and editors to continue using software that is familiar to them and which has been used previously to create guideline manuscripts.

Once the content has been agreed upon by the writing group, the structural elements of the guideline topics are indicated by an editor. In some cases, the structural elements imply a meaning or interpretation of the content. In these cases, confirmation from the writing group is sought.

The connection between the database and the Word document is achieved using a COM interface. Word macros trigger routines in a database application. The database application also manipulates the Word document through a COM interface.

The end result of the authoring process is a database of guideline topics and their metadata. The functionality of TGIS during this phase is described in following sections.

B Output specification

Guideline output is sourced from the guidelines database. Having a single source for the output realises the efficiency gains of the production system. Once content has been verified, only the format of different output needs verification, rather than re-VERIFYING content in each output format.

A particular output is achieved by extracting the guidelines from the database in an XML format. The XML source is then transformed to each of the desired output formats.

Extraction of data in XML format is carried out with a generic extraction mechanism, described in10. The mechanism allows the user to specify through a user interface the portions of the database to be extracted and how they are related to each other. This is a flexible mechanism that can easily accommodate changes in the database structure.

The following 2 examples are XML and HTML fragments. The XML is given as input to an XSL processor within the authoring system. Also input is an XSLT file, which is a set of instructions that specify how the XML is to be transformed into HTML.

Example 1. XML fragment.

```xml
<REGIMEN
  DRUG_NAME = "metronidazole"> ...
  <DOSE ...
    DOSES_PER_DAY = "3"
    DOSE_FREQUENCY = "8-hourly"
    DURATION = "for 7 to 10 days"
    ROUTE = "orally" ...
</DOSE>
</REGIMEN>
```

Example 2. Example HTML fragment.

```
<HTML>
  <BODY>
    <h1>metronidazole</h1>
    <TR>
      <TD bgcolor="#ff0000">metronidazole</TD>
      <TD bgcolor="#993300">10</TD>
      <TD bgcolor="#006600">mg/kg</TD>
      <TD bgcolor="#6600CC">orally</TD>
      <TD bgcolor="#0000FF">8-hourly</TD>
      <TD bgcolor="#FF9900" font-color="FFFFFF">for 7 to 10 days</TD>
    </TR>
  </TABLE>
</BODY>
</HTML>
```
B Indexing

The second stage of content creation consists of indicating the structural elements of the document, including the index terms. Indexing functionality consists of the presentation of an index frame that interacts with the document manuscript. The index frame displays all index terms across a (user-specified) range of documents. Using the index frame the user can:

- Add and edit index terms
- Manipulate links between index terms and target points in the document
- Indicate specialisations of index terms eg. drug index terms and drug subject category index terms
- Analyse indexing structure through varying the index views and assessing the indexing of the document as a whole.

Figure 3 is a screenshot depicting some of this functionality.

C Output specification

Output specification allows the user to indicate the format that a given document should take in each output viewer. Although the mechanism for output generation is an XSL processor (as described in earlier sections), the user indicates the instructions in the XSLT file through a graphical user interface.

The different output specifications that are required vary according to the needs and possibilities of each output format. Some example differences in output formats follow.

The print output aims for a concise presentation of information, so that the end result is a small pocket-sized handbook. Traditional book index construction is automated and systematic information is presented in tables.

The web browser output has automatically restructured output that is better able to cope with the lower resolution of screens vs. print. The topic hierarchy is reconfigured to ensure a digestible amount of text is presented under each topic. This involves breaking up large topics and subsuming small topics into their parent topics. Some of this is automated, relying on indications of what maximum and minimum topic sizes are tolerated.

More whitespace is used in the browser presentation. Also automated is the construction of hyperlinks of index terms, relationships between topics and in-text references to topics.

Drug index pages, which collect information on each drug into a central point, are constructed automatically. Systematic information is either
presented in tables or database search interfaces are created.

The PDA browser version has to cope with even lower screen resolution and so requires additional restructuring and inclusion of summaries. The PDA version also features increased use of database search for systematic information.

V TOWARD DECISION SUPPORT

One of the proposed mechanisms to enable the evolution of narrative guidelines to content for decision support is via markup of guidelines according to an XML DTD or XML schema \[10\], \[11\], \[12\]. The basis of the proposition is that the knowledge necessary for decision support is in the guideline text, however an information system is not capable of interpreting it. A decision support markup process allows the identification of those parts of the guideline that are required.

This does not reduce the complexity of modelling the knowledge, but it does provide a means of labelling data points once the model has been created. The development of the TGIS authoring tool will progressively integrate decision support elements into its topic model as the appropriate knowledge structures are identified. In this way, the evolution of the topic model as well as the authoring tool associated with it will occur in parallel.

VI CONCLUSION

Therapeutic guidelines are being developed for a wide audience who have different expectations on guideline content, structure, style and viewing device. At the same time, the content and meaning of guidelines across these dimensions must remain constant.

Some of these expectations must be met if guidelines are to be successfully integrated within clinical practice.

We have described TGIS, a guideline production system designed to promote the maintenance of quality content while allowing the efficient production of multiple output formats. TGIS is in use and under development at Therapeutic Guidelines Limited, a not-for-profit organisation that has produced high volumes of guidelines of consistent high quality for over twenty years.

VII REFERENCES


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