Design Guidance

Timeline View

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Prepared by
Microsoft

Microsoft®

PREFACE

Documents replaced by this document

Document Title	Version
None	

Documents to be read in conjunction with this document

Document Title	Version
Design Guidance – Drug Administration	2.0.0.0
Design Guidance – Medication Line	2.0.0.0
Design Guidance – Medications List	1.0.0.0
Design Guidance – Displaying Graphs and Tables	2.0.0.0

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1 INTRODUCTION

This document provides guidance for the design of Timeline Views. It describes the area of focus, lists mandatory and recommended guidance points with usage examples and explains the rationale behind the guidance.

Patients' medical records contain vast quantities of information which play a pivotal role in clinical decision making. This decision making relies critically upon swiftly gleaning an accurate and complete picture from a catalogue of previous and planned events while identifying cause-effect relationships and trends. In addition, being able to visualise planned activities in the context of past events provides the clinician with an 'integrated vision' of what has happened, what is about to happen, and what has just failed to happen. Timeline Views of patient clinical data provide this visualisation.

Timelines provide an easy mechanism to view and compare both items with duration, and single events, against time. There are a few current clinical systems which employ timelines of some description to convey information, sometimes to the patient, other times to the clinician or multi-disciplinary team.

There are not, however, guidelines which Independent Software Vendors (ISVs) can follow to help mitigate patient safety risks which may be encountered when showing clinical data in a Timeline View. This guidance document provides guidelines relating to the use of timelines to convey duration and event data in clinical systems developed by ISVs.

To indicate their relative importance, each guideline in this document is ranked by **Conformance** and by **Evidence Rating**. Table 1 defines those terms:

Term	Definition
Conformance	Indicates the extent to which you should follow the guideline when defining your UI implementation. There are two levels: ■ **Mandatory** – An implementation should follow the guideline ■ **Recommended** – An implementation is advised to follow the guideline

Evidence Rating	Summarises the strength of the research defining the guideline and the extent to which it mitigates patient safety hazards. There are three ratings (with example factors used to determine the appropriate rating):
	■ **Low:**
	  ■ Does not mitigate specific patient safety hazards
	  ■ User research findings unclear and with few participants
	  ■ Unreferenced usability principles indicate the design is not significantly better than alternatives
	■ **Medium:**
	  ■ Mitigates specific patient safety hazards
	  ■ User research findings clear but with few participants
	  ■ References authoritative guidance (for example, from the UK-based National Patient Safety Agency (NPSA), Institute for Safe Medication Practices (ISMP) or World Health Organization (WHO)) that is potentially soon to be superseded
	  ■ Referenced usability principles indicate the design is significantly better than alternatives
	■ **High:**
	  ■ Mitigates specific patient safety hazards
	  ■ User research findings clear and with a significant number of participants
	  ■ References recent authoritative guidance (for example, from NPSA, ISMP or WHO)
	  ■ Referenced usability principles indicate the design is significantly better than alternatives

Table 1: Conformance and Evidence Rating Definitions

> **Note**
>
> Refer to section 9.2 for definitions of the specific terminology used in this document.

1.1 Customer Need

The visualisation of clinical data against time is commonplace in clinical systems, but tends to be limited to quantitative information such as physiological observations data. However, the ability to visualise clinical event and duration information (in isolation or in combination with quantitative information such as 'observations' data) gives clinicians more context as to the patient's condition and may assist them in identifying patterns in the data available for a patient.

Pattern detection is a universal human capacity which people tend to do very efficiently and often subconsciously. However, the detection and meaning of a data pattern can be heavily influenced by the way in which the data is presented, and misinterpretation may occur if the data is not presented in a way that clinicians can easily understand.

> **Note**
>
> When clinical data is visualised in a Timeline View, there is the possibility that clinicians may incorrectly interpret coincidental occurrences in time of clinical event and duration information as being evidence of a cause-effect relationship.
>
> However, wrongly assuming a cause-effect relationship is not unique to Timeline Views, and clinicians have a professional responsibility to fully validate such assumptions before acting on them.

Unpublished research undertaken by the National Health Service (NHS) in the UK identified the following areas, amongst others, where the visualisation of clinical events and durations for a patient could be beneficial for patient care and improve patient safety:

- Medications History

  The visualisation of prescribed medications and data relating to the administration of those medications

- Medical History (the 'past' visualisation of the patient)

  Being able to view at varying levels of detail the past medical history recorded for the patient, to enable the clinician to easily assimilate it

- Transfer of Care (the 'about now' visualisation of the patient)

  In addition to transfer of care within hospital teams, transfer of care between hospital and acute care and general practice care, as well as between different hospitals, could benefit from the visualisation of patient data on a timeline.

- Secondary uses (for example, Clinical Audit)

The electronic format of medical records and coding in general already facilitates clinical audit. However, timelines may enable audit to be taken a step further and allow causal relationships to be identified. This guidance draws upon User Interface (UI) current best practice and upon research into the use of timelines in clinical settings.

This guidance is for use by Independent Software Vendors to ensure that good design principles support clinicians' interpretation of duration and event information, reveal critical patterns and assist users in accessing more detailed information relating to the data being viewed.

1.2 Scope

1.2.1 In Scope

Scope Area	Details
Navigating vertically and horizontally (potentially simultaneously)	How to navigate the timeline canvas to view timeline data
Indication of data beyond the visible area of the canvas	How to indicate that there is information outside the current viewing window which may be relevant to the user
Indication of now, past and future	How to identify whether the range of time for which the user is currently viewing data is in the past, the future, or spans past and future.
Position of timeline element labels	How to position the timeline canvas elements (labels, durations, events) in a patient-safe manner
Visual design of continuous duration timeline elements	How to display duration elements on the timeline canvas
Visual design of discrete event timeline elements	How to display event elements on the timeline canvas
Display of timeline element attributes	How to display information related to a duration or event element (such as dosage and rate for medications prescriptions)
Position of timeline elements on the canvas	How to position timeline elements on the canvas to optimise the canvas space available whilst maintaining patient safety
Mixing timelines with graph data / integrating quantitative data with timeline data	How timeline data and quantitative data (such as physiological observations data) can be displayed in the same view - high level guidance only
Background and gridlines	How to display the canvas on which the timeline elements are displayed
Time navigation	High level guidance relating to changing the viewed time range
Levels of detail	High level guidance on adjusting the level of detail shown for the timeline elements
'Time window' selection	High level guidance only

Table 2: Subject Areas Covered by This Guidance

1.2.2 Out of Scope

This section defines areas that are not covered in this guidance. Although there may be specific risks associated with these areas that are not addressed in this guidance, it is likely that the principles in this guidance will extend to Timeline Views in many of the areas listed in Table 3.

Table 3 lists the subject areas that are not covered in this guidance:

Scope Area	Details
Grouping timeline entries	How to show different types of timeline data on the same canvas
Designing for multiple time axes	This guidance is applicable to where time is displayed on the x-axis only
Collapse/expand control	The appearance and interaction behaviour of any user control that collapses and expands (that is, hides and reveals) timeline visualised data
Sorting, filtering and grouping	How to sort, filter and group timeline entries(for example, by title, time of occurrence or by some other data taxonomy attribute)
Non-linear timescale	Displaying data on a timeline where the time axis is non-linear (such as logarithmic)

Scope Area	Details
Linkage of control variables	How to link controls on the form (for example, linking the level of detail shown for element attributes with the time window selection control so that for large time windows, minimal attributes are displayed)
Adding, removing or moving other data series	How to manage which data series are displayed as timelines, including the method of selecting from a list of available data series
Accessing more info by navigating to or revealing more data	How to access further information related to a selected item by navigating to another view or revealing the information in parallel with the timeline (for example, within a 'pop-up' dialogue)
Default time window	The time period to be displayed by default (that is, when a user accesses a Timeline View for the first time within a session)
Defaults for controls	The defaults for controls (such as level of detail and section collapse/expand)
Representing absence of data	How to indicate when information for a data series or type is not available to the system either temporarily (for example, due to a hardware failure) or for more fundamental reasons (such as lack of compatibility between systems)
Representing uncertainty	How to graphically represent such notions of uncertainty as 'event occurred sometime between January and March 2008', 'patient self-administered during Tuesday evening', and 'condition is likely to clear up within next 2 months'.
When to use a timeline representation	When (and when not) to use a timeline representation as opposed to other representations of the same data.

Table 3: Subject Areas Not Covered by This Guidance

> **Note**
>
> Listing an item as out of scope does not classify it as unimportant. Project time and resource constraints inevitably restrict what can be in scope for a particular release. It is possible that items out of scope for this release may be considered for a future release.

1.3 Assumptions

ID	Assumption
A1	The quality (that is, provenance, accuracy, and completeness) of the data displayed in the Timeline View is of an acceptable level. Data quality will be particularly important in scenarios where there are multiple data sources (for example, from general practice and hospital and acute care settings) as the quality of the data may vary between sources. Although the quality of data is not in scope for this guidance, the following risks were recorded during user research (see APPENDIX B): ■ Coding of data is suboptimal; for example, coding is not good quality, or at the 'wrong' level for displaying on timeline (where coding is at symptomatic level rather than at underlying etiology), or different codes are used to represent the same concept ■ System cannot display all the data, or cannot be certain that all data is there ■ User infers from the absence of unavailable data that no event(s) occurred ■ Data is known to be missing but a 'best estimate' is not displayed ■ If timelines are not implemented based upon encoded data (which aids aggregation of results) and are not in a record which uses an individual coded statement approach, then Timeline Views may misrepresent the data stored in the system, and therefore clinicians may gain a mistaken or (unnecessarily) incomplete understanding of the patient

ID	Assumption
A2	The system performance is adequate to display the quantity of data without significant delays (for example when scrolling through large quantities of data). Although system performance is out of scope for this guidance, approaches that may improve performance recorded during research are: ■ Cache data directly adjacent to the currently viewed time period (a technique used by popular Internet mapping sites to enable seamless scrolling to adjacent areas) ■ When navigation beyond the adjacent time periods is being performed, only update the viewing area once the user has completed the action
A3	The minimum screen resolution used by the clinician is 1024 x 768 pixels, although a higher resolution may be employed.
A4	Medications viewed on a timeline will be shown using the intended start and end dates of the course of medication.
A5	The Timeline View is not the only view of patient medical data in the Clinical System. All the data shown on the Timeline View is accessible through other views, including the view that represents the data as entered into the system.
A6	Timelines are implemented based upon encoded data which aids aggregation of results, and a record which uses an individual coded statement approach.
A7	Source data for the timeline supports duration, explicitly or by inference

Table 4: Assumptions

1.4 Dependencies

ID	Dependency
D1	The following design guidance documents (changes in these documents may affect current guidance): ■ Design Guidance – Drug Administration ■ Design Guidance – Medication Line ■ Design Guidance – Medications List ■ Design Guidance – Displaying Graphs and Tables

Table 5: Dependencies

2 TIMELINE GUIDANCE OVERVIEW

This guidance document provides high-level guidance for the implementation of a Timeline View within an ISV application. It aims to create a framework that will allow a variety of clinical data to be displayed in a timeline format. This can be any clinical data where temporal aspects are of interest (that is, the start and end times, duration and timing compared to other events).

This guidance does not seek to describe safe default settings for particular data-types in particular clinical contexts (for example, the safe default settings for displaying inpatient medications in a Timeline View). Guidance that does describe these kinds of safe defaults can be found in *Design Guidance – Medications List* **{R7}** and *Design Guidance – Drug Administration* **{R5}**.

The usage examples throughout this guidance display medications data. The settings the usage examples show (such as the level of detail per medication) should not be taken as safe for display in every clinical context where that medication is used.

> **Note**
>
> Significant patient safety risks were identified which can only be mitigated when taking into account the specific context of use. System implementers should conduct a detailed patient safety risk assessment to ensure the safe use of the timeline in their particular context.
>
> Refer to sections 5.2.1, 6.2.3 and 7.2.1 for further details.

For more information on the safe display of medications please see:

- *Design Guidance – Drug Administration* **{R5}**
- *Design Guidance – Medication Line* **{R6}**
- *Design Guidance – Medications List* **{R7}**
- *Design Guidance – Search and Prescribe* **{R14}**

Figure 1 shows how a Timeline View might look when displaying patient medications in an inpatient context. The default settings, such as how much detail is displayed per medication and whether administration status is shown, are notional and not part of this guidance.

> **Important**
>
> The visual representations used within this document to display the guidance are illustrative only. They are simplified in order to support understanding of the guidance points. Stylistic choices, such as colours, fonts or icons are not part of the guidance and unless otherwise specified are not mandatory requirements for compliance with the guidance in this document.
>
> Some examples within this document are based on the requirements for the NHS within the UK. You should consider how your clinical application will need to handle information, such as patient identification numbers (shown with the label 'NHS No.' in some images in this guidance), within the country of use.

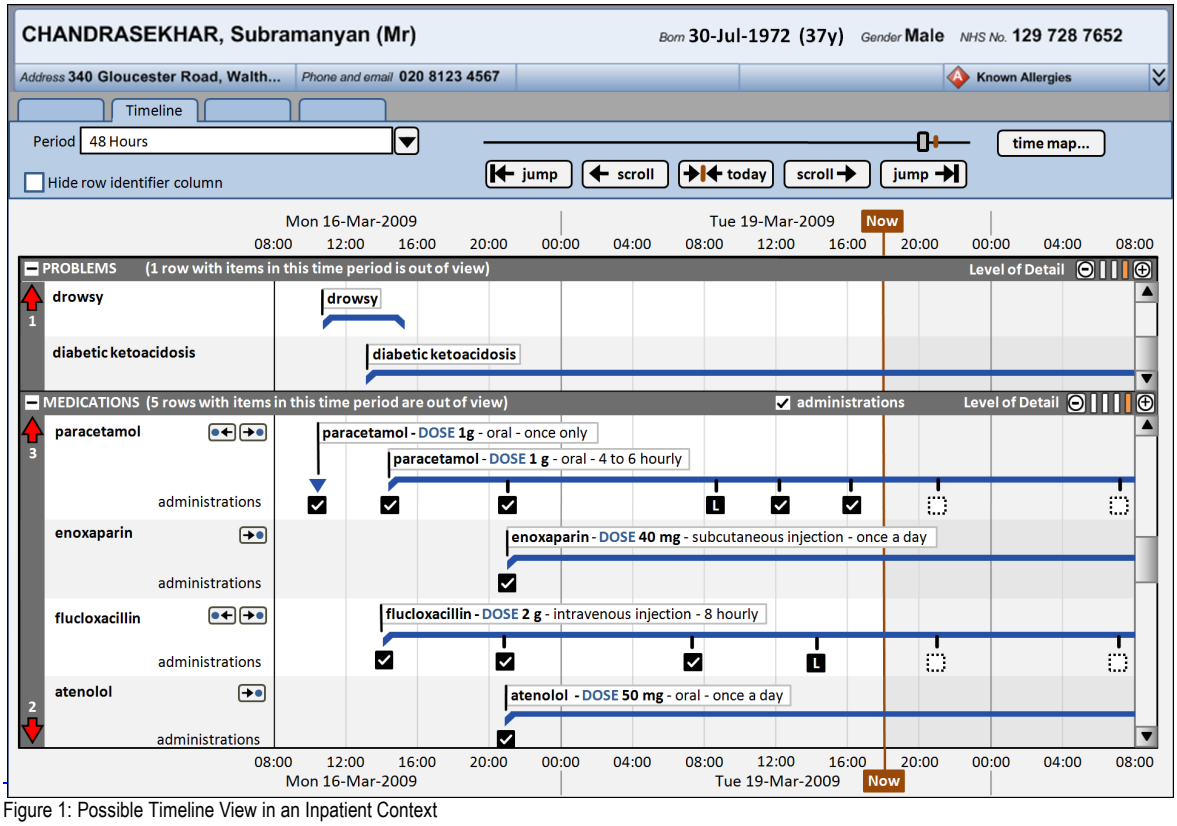


Figure 1: Possible Timeline View in an Inpatient Context

The guidelines illustrated by the usage examples can be applied to other data-types in other clinical contexts. Similarly, any medication-specific guidance points could be abstracted to a higher level to also apply to other data-types.

2.1 Rationale Summary

The rationale for the current guidance draws on several pieces of evidence.

Research:

- Secondary research
  - Existing guidelines and standards
  - UI best practice
  - Clinical timelines literature:
    - *Gaining New Medical Insights through Interactive Visual Exploration* **{R9}**
    - *LifeLines: Using Visualization to Enhance Navigation and Analysis of Patient Records* **{R10}**
    - *LifeLines: Visualizing Personal Histories* **{R11}**
    - *TimeLine: Visualizing Integrated Patient Records* **{R12}**
    - *Viewing personal history records: A comparison of Tabular format and graphical presentation using LifeLines* **{R13}**
- Primary research
  - Interviews with healthcare professionals, including doctors

- Regular consultation with experts
  - A panel of clinical experts
  - A technical audience (developers)

Usability Principles (see APPENDIX A for details on these principles):

- Nielsen's usability heuristics
- Shneiderman's eight golden rules of interface design
- ISO 9241: Characteristics of presented information (taken from *ISO 9241-10: 1996 Ergonomic requirements for office work with visual display terminals (VDTs) -- Part 10: Dialogues principles* **{R3}**)

Existing Standards:

- BS ISO 9241-10:1996 *Ergonomic requirements for office work with visual display terminals (VDTs): Part 10: Dialogues principles* **{R3}**

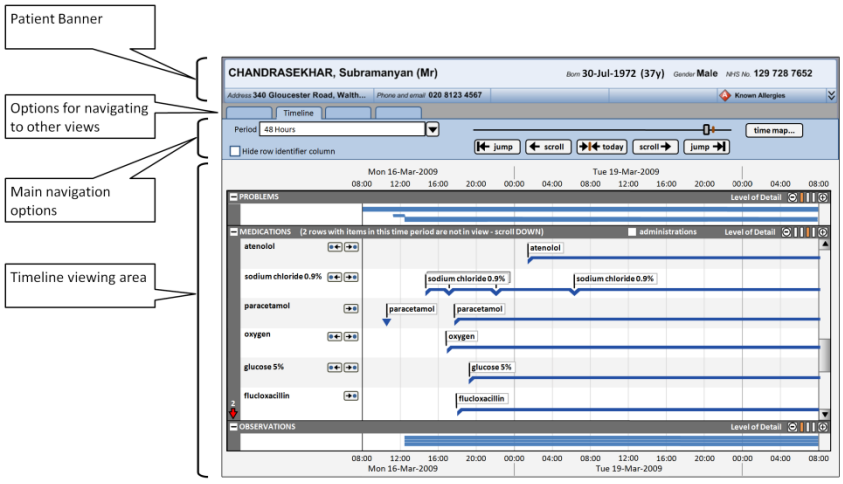
Evolving Standards:

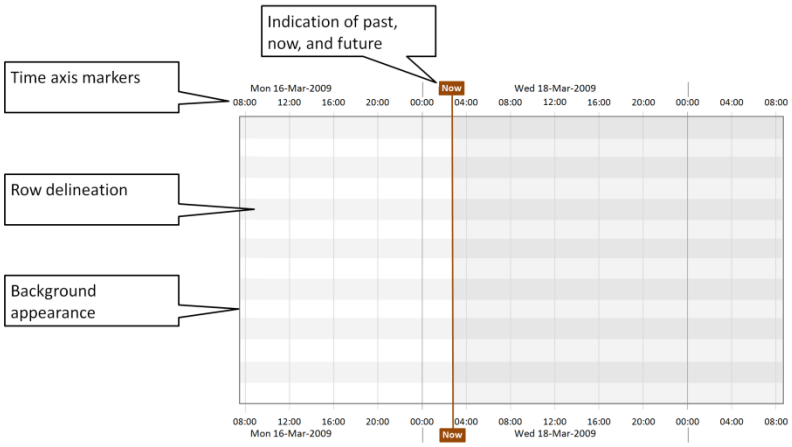
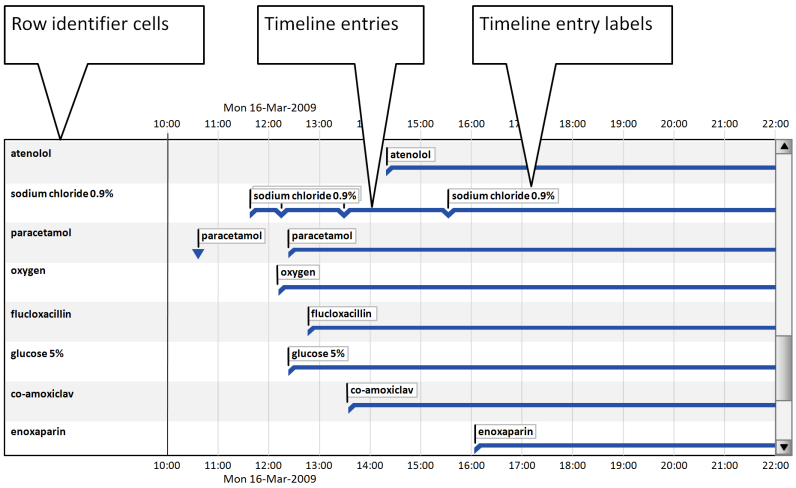
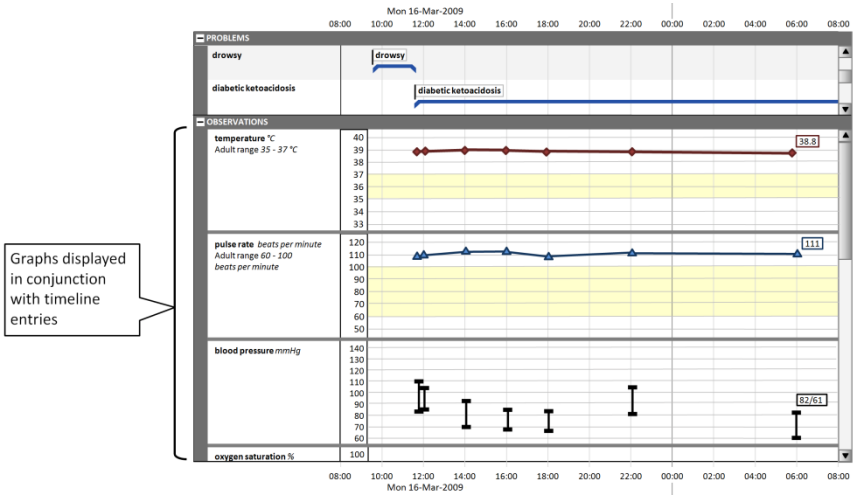
- *Design Guidance – Displaying Graphs and Tables* **{R4}**
- *Design Guidance – Drug Administration* **{R5}**
- *Design Guidance – Medication Line* **{R6}**

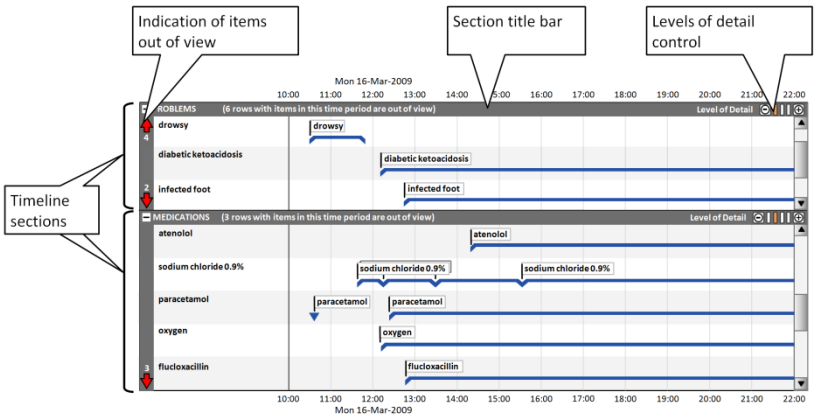
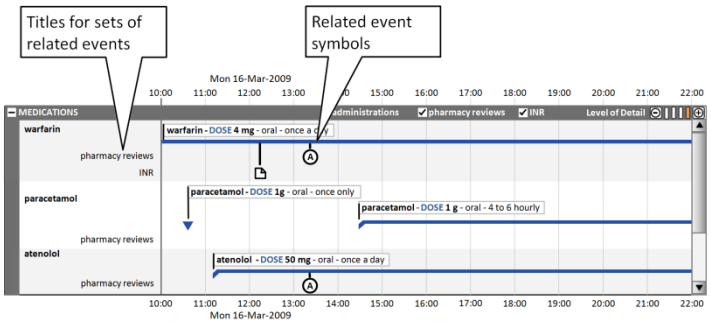
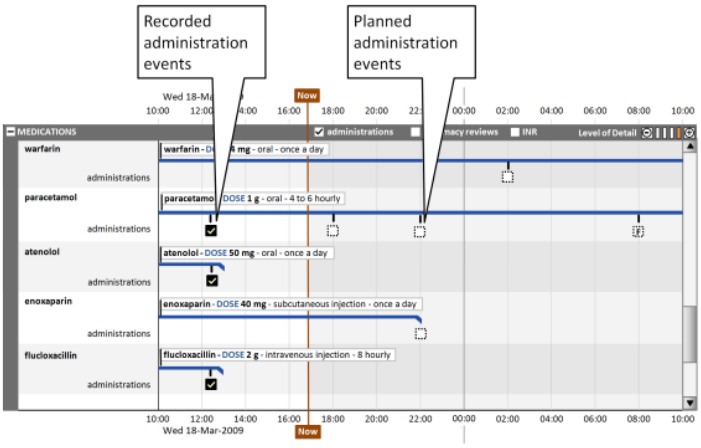
2.2 Summary of Guidance

Table 6 summarises the content of this document by outlining each area of guidance (along with a cross-reference to the relevant section) and providing a visual example to illustrate how it might be implemented.

> **Note**
>
> Design illustrations are best viewed on a screen in colour.

Areas of Guidance	Visual Summary
Section 3 provides guidance on the overall layout of the Timeline View, including the positioning of the patient banner, options to navigate to other views, and the main timeline navigation controls.	

Areas of Guidance	Visual Summary
Section 4 includes guidance on the appearance of the timeline viewing area, including background colours and row delineation, and time axis markers. The indication of past, present, and future time periods is also detailed.	
Section 5 provides guidance for timeline entries (including entries with no duration, known duration, and open duration), timeline entry labels, and row identifier cells.	
Section 5 also provides guidance on the display of graphs in conjunction with timeline entries. Some quantitative data is better represented as a graph (for example, observations such as temperature, blood pressure, and so on.) These can be viewed in conjunction with a timeline representation of other data to provide comprehensive patient data visualisations.	

Areas of Guidance	Visual Summary
Section 6 includes guidance on using timeline sections to group entries, and covers the display of section title bars, indication of any timeline entries within the chosen period that are out of view, and controlling the level of detail displayed in each section. When the level of detail displayed in each timeline section can be controlled by the user, they can make best use of the available viewing space for their particular task. For example, clinicians may wish to compare a medication's dose changes (requiring a high level of detail for the 'medications' section) with the patient's health issues (viewable at a lower level of detail for the 'problems' section).	
Section 7 provides guidance on the positioning and appearance of sets of events related to timeline entries (for example, Pharmacist Review events), including multiple sets.	
This section also covers the display of drug administrations as a related set of events.	

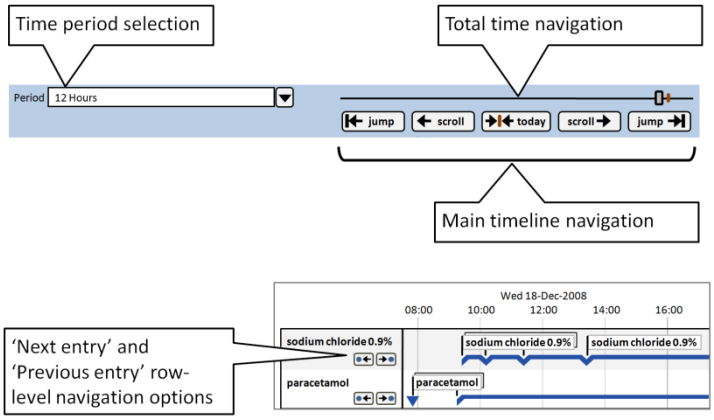
Areas of Guidance	Visual Summary
Section 8 contains guidance for the selection of the viewed time period, navigation to time periods adjacent to the current time period and larger scale navigation to time points throughout the total available time period.	

Table 6: Summary of Guidance

3 Guidance Details for the Timeline View Layout

3.1 Introduction

This section provides guidance on the overall layout of the Timeline View, including the positioning of the patient banner, options to navigate to other views, and the main timeline navigation controls. Figure 2 illustrates those features:

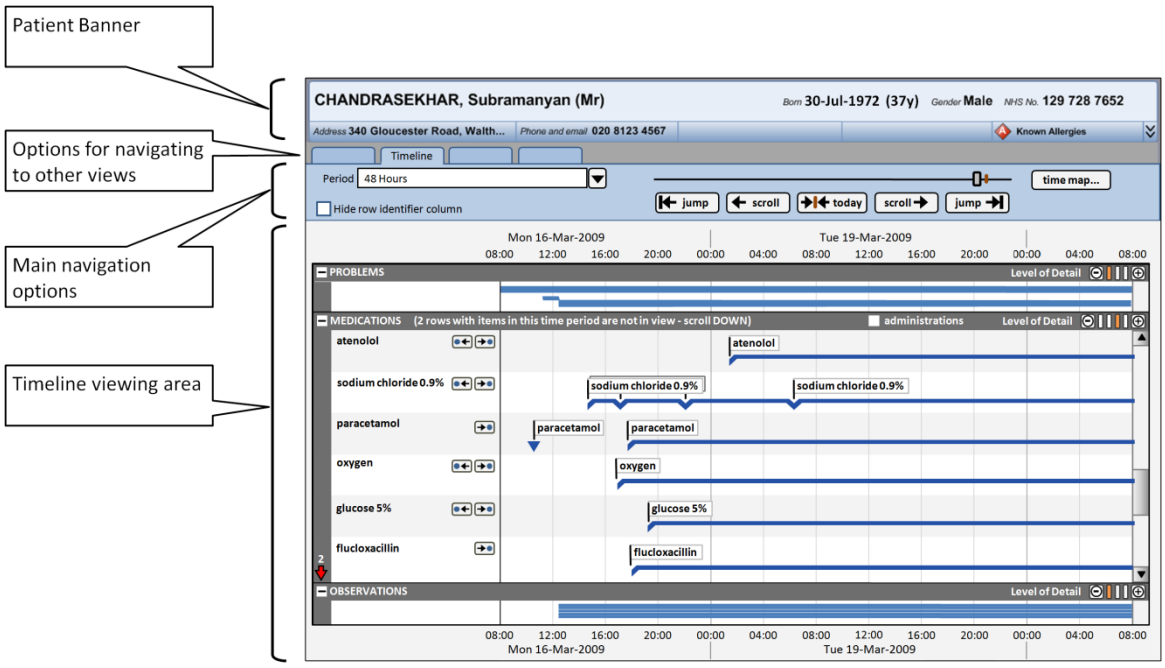


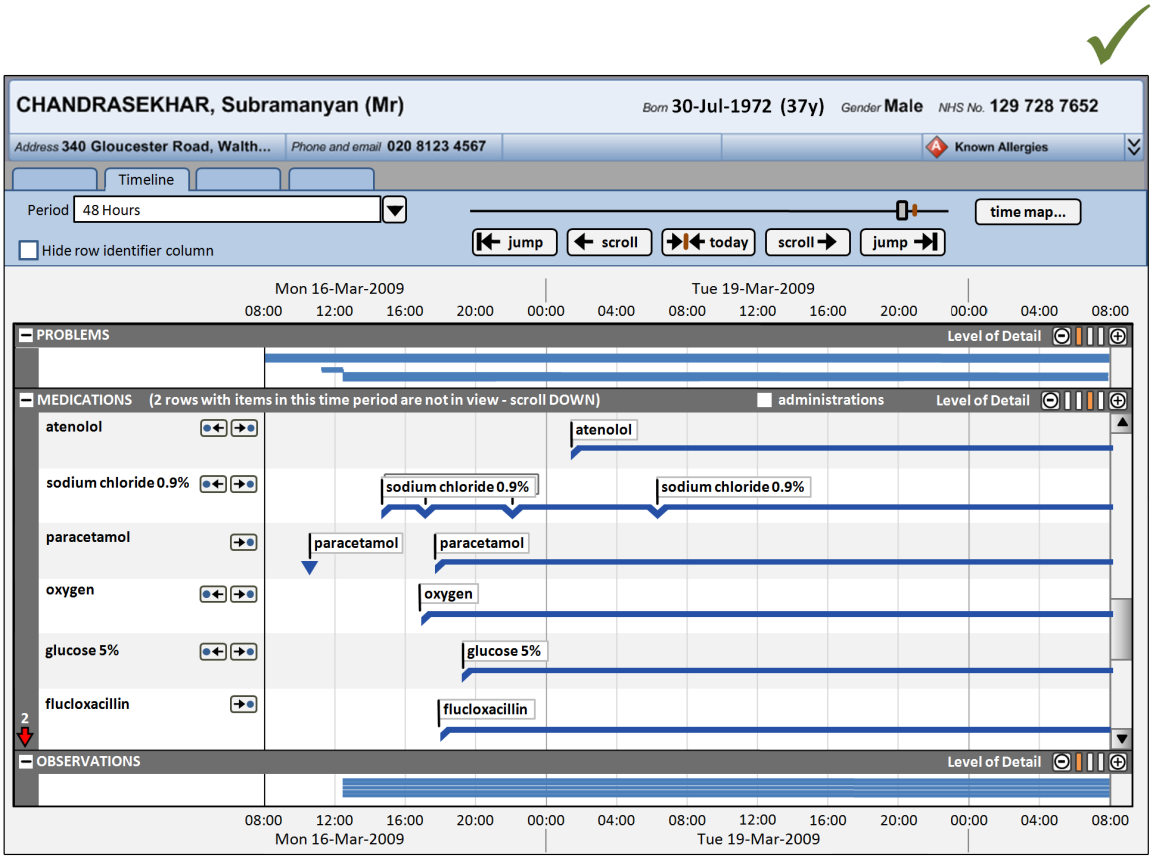
Figure 2: Timeline View Features Covered in this Section

3.2 Guidelines

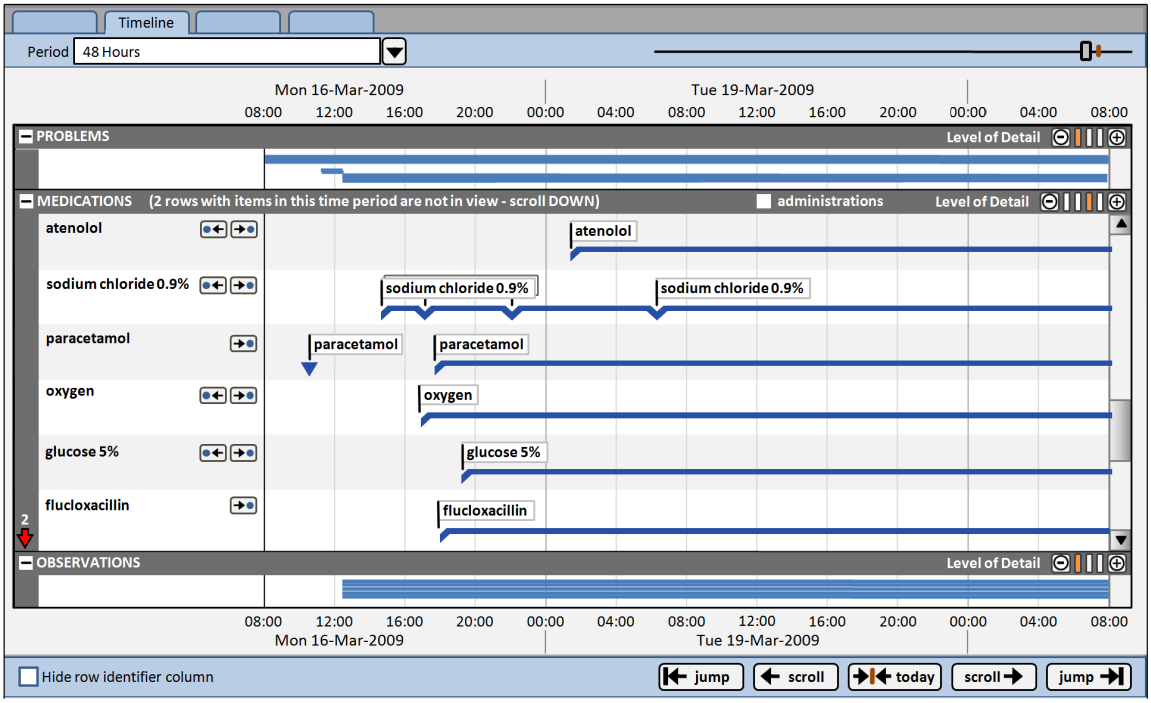
3.2.1 Timeline View Structure

ID	Guideline	Conformance	Evidence Rating
TLN-0010	Position all global timeline view navigation controls (such as time range selection, main timeline navigation controls) in close proximity to each other.	Recommended	Medium
TLN-0020	Locate the main timeline navigation area directly above the timeline viewing area.	Recommended	Medium
TLN-0030	Design the timeline viewing area so that it dynamically resizes to fill the available space if the application window is resized.	Recommended	Medium

Usage Examples



In this correct example, the patient banner is displayed across the top of the window, with tabbed options for selecting the current view (in this example image only the timeline tab is populated). The global Timeline View controls are co-located and positioned immediately above the timeline viewing area, and the timeline viewing area fills the remaining area. The design is based on a display size of 1024 pixels wide by 768 pixels high. (TLN-0010, TLN-0020)



In this incorrect example, the patient banner is absent (with a risk that the data will be mistakenly attributed to another patient) and the global Timeline View controls are located in several areas of the window, requiring unnecessary movement by the user. (TLN-0010, TLN-0020)

Rationale

Locating all the Timeline View's global controls together at the top of the view provides:

- A consistent place for controls to be found, and is consistent with the CUI guidelines for control positioning in *Design Guidance – Medications List* **{R7}** and *Design Guidance – Drug Administration* **{R5}**
- More economical use of screen space, leaving a larger rectangular area for timeline viewing. In particular maximising the vertical space is highly desirable in a Timeline View
- Reduces the movement required by the user if they are globally manipulating the Timeline View

Hazard Risk Analysis Summary:

No mitigated hazards recorded for this area

4 Guidance Details for the Display of the Timeline Viewing Area

4.1 Introduction

This section includes guidance on the appearance of the timeline viewing area, including background colours and row delineation, and time axis markers. Guidance on how to indicate past, present and future time periods is also included. Figure 3 illustrates those features:

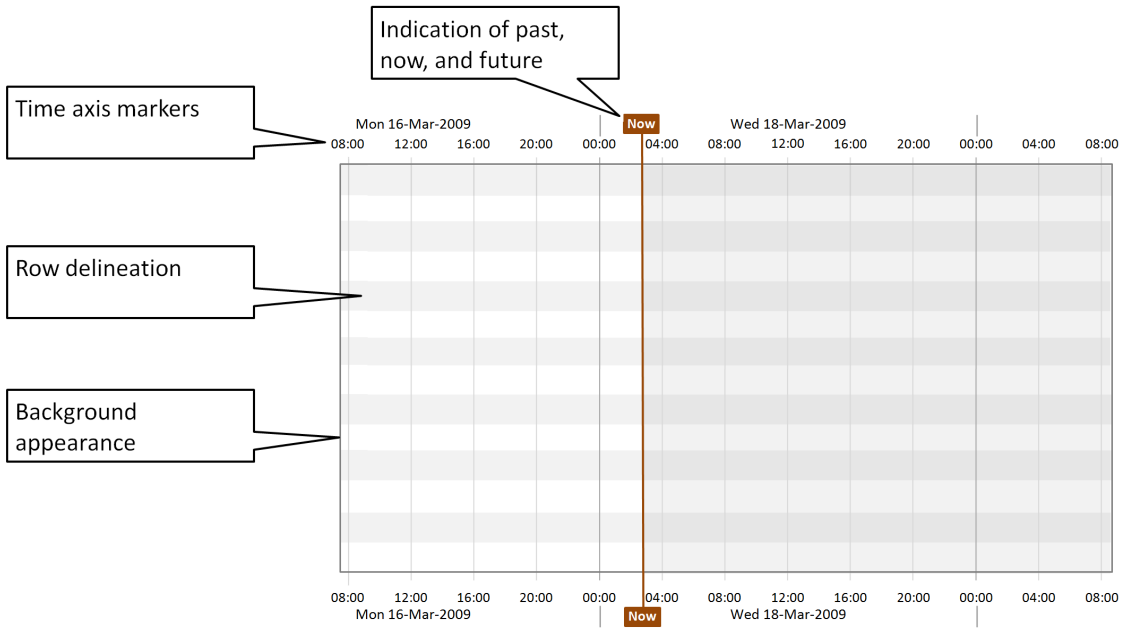


Figure 3: Timeline View Features Covered in this Section

4.2 Guidelines

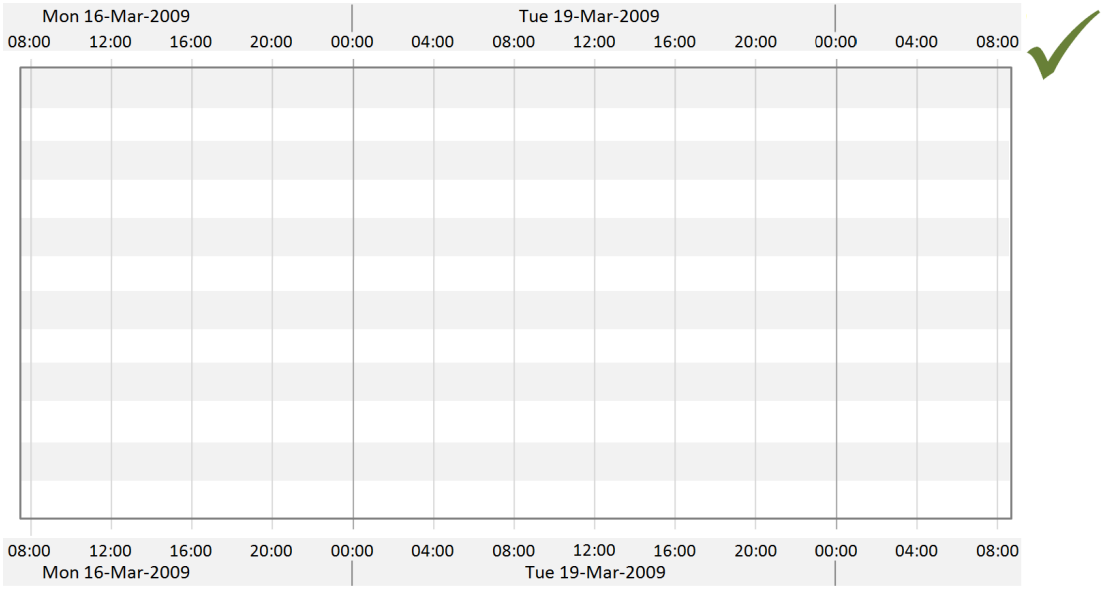
4.2.1 Timeline Viewing Area Canvas and Time Markers

Use these guidelines in conjunction with the time axis guidelines found in *Design Guidance – Displaying Graphs and Tables* **{R4}**.

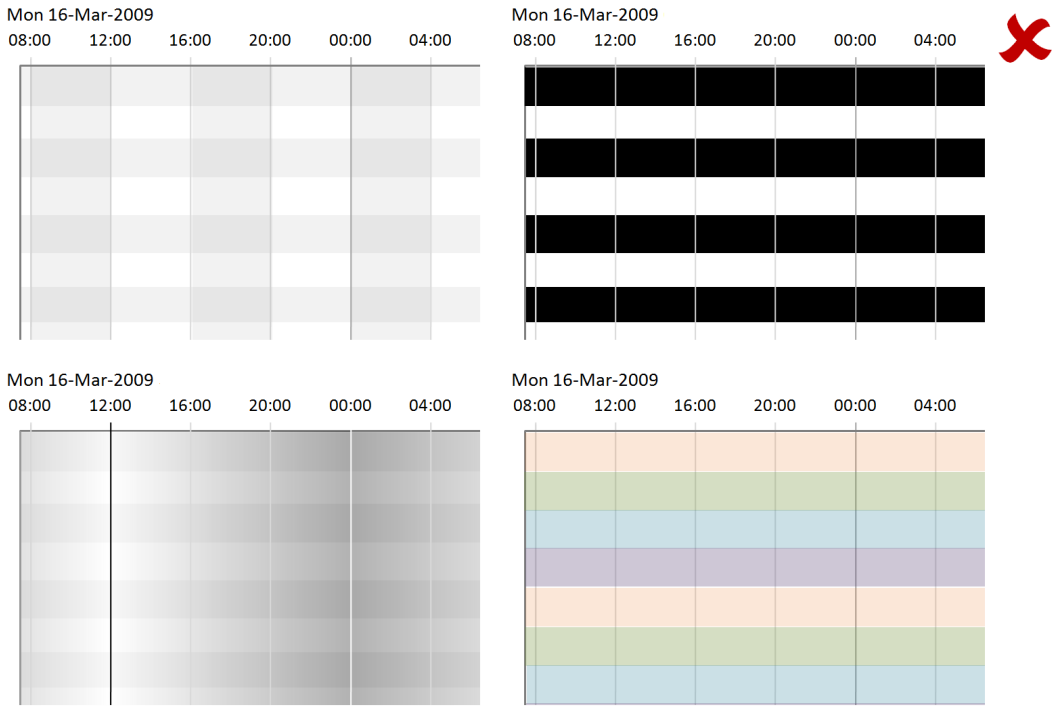
ID	Guideline	Conformance	Evidence Rating
TLN-0040	Divide the timeline canvas into visually marked horizontal rows extending across the width of the canvas	Mandatory	High
TLN-0050	Do not use gradient fills for the canvas background	Recommended	Medium
TLN-0060	Do not put watermarks or decorative patterns on the canvas background	Recommended	Medium
TLN-0070	Visually delineate each horizontal row on the timeline canvas by using two alternating background colours	Mandatory	Medium
TLN-0080	Choose colours that do not detract from the legibility of elements on the canvas (including gridlines), and are unlikely to have semantic meaning in that context	Mandatory	Medium
TLN-0090	One of these alternating row colours should be white	Recommended	Medium

TLN-0100	Use top and bottom margins within each row to ensure separation between adjacent timeline entries and other elements on the canvas	Recommended	Medium
TLN-0110	Provide a Timeline View where time is displayed proportionately; that is, each time interval (such as one hour) must be represented as the same distance (such as 10 mm).	Mandatory	Medium
TLN-0120	Use the same time axis for the entire timeline viewing area	Mandatory	Medium
TLN-0130	Mark the time intervals (that is, use hour marks, day marks, week marks and so on) across the top and bottom of the viewing area, and provide vertical gridlines between each pair of markers	Mandatory	Medium
TLN-0140	For time gridlines use a thin line and a colour that does not detract from the legibility of timeline entries and other elements on the canvas	Recommended	Medium
TLN-0150	Group the time intervals into higher units and distinguish these with more prominent markings and gridlines	Recommended	Medium

Usage Examples



In this correct example, each row is delineated by muted alternating colours that will not detract from the legibility of timeline entries and other elements that may be displayed. The time axis is clearly shown above and below the viewing area, with subtle gridlines and more prominent markings for the start of each day. (TLN-0040, TLN-0050, TLN-0070, TLN-0080, TLN-0090, TLN-0110, TLN-0120, TLN-0130, TLN-0140, TLN-0150)



Example 1: Selection of Incorrect Examples

In the first incorrect example, alternating columns have been used to delineate time markers. This disrupts the horizontal rows and leads to a confusing patchwork pattern. (TLN-0140)

The second example uses strong alternating colours which would detract from the legibility of any timelines displayed and would additionally require different colour schemes to be applied to timeline elements depending on the background colour of the row they are located on. (TLN-0080)

The third example uses a graduated fill to indicate time of day, but this will detract from the clarity of any timeline elements placed on it. (TLN-0050, TLN-0140, TLN-0150)

The fourth example uses a repeating set of four colours to delineate rows. Users may wrongly infer meaning from the row background colour. (TLN-0070, TLN-0080, TLN-0090)

Rationale

Emphasising horizontal rows facilitates reading along the line, allowing the user to better associate the elements within that line, For example, making it less likely that a label from one line will be associated with an event marker from another line.

Gradients and patterns on the canvas would reduce the clarity of elements on the canvas, and might mistakenly imply meaning.

If more than two colours are used to delineate rows, users may wrongly infer meaning from the row colour (as in the fourth example of Example 1). The use of strong alternating colours will detract from the legibility of any timelines displayed, and will also require different colour schemes to be applied to timeline elements depending on the background colour of the row they are located on.

Displaying time proportionally follows from the *Design Guidance – Displaying Graphs and Tables* **{R4}**. Using non-linear timescales is an interesting area of investigation that was out of scope for this work, and so cannot be ruled out.

Display of the timescales should follow guidance laid out in the *Design Guidance – Displaying Graphs and Tables* **{R4}**

Hazard Risk Analysis Summary:

Potential Hazards:

- MTI066 users do not have a sense of the time scale as no vertical time markers are used
- MTI067users find it hard to read along from left hand labels to the data plots (in order to match data to categories

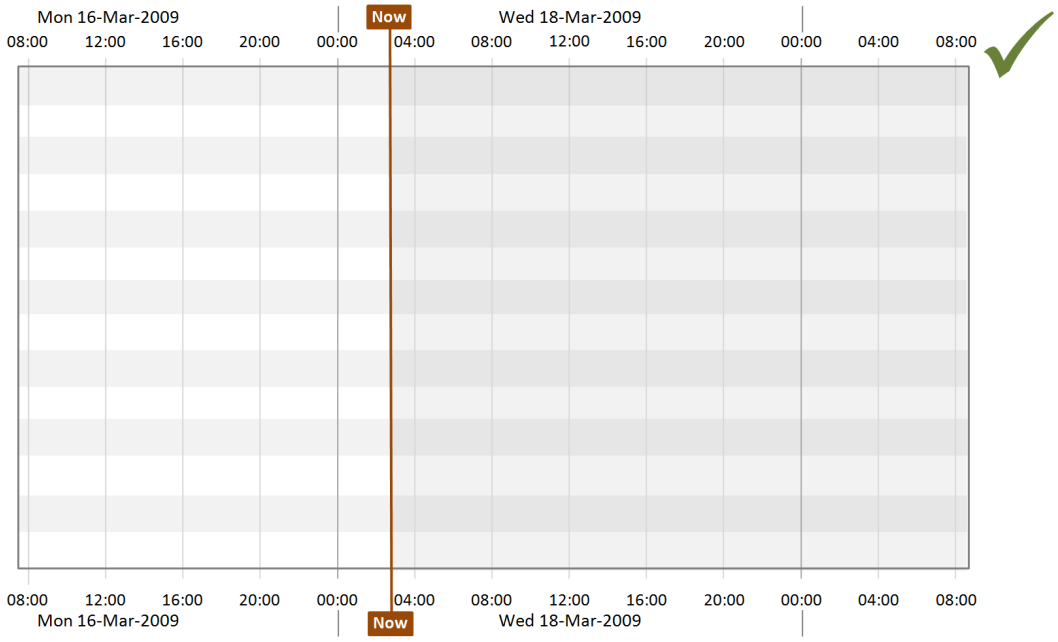
Mitigations:

- TLN-0130, TLN-0140, TLN-0150 (Location and format of time interval markings)
- TLN-0040, TLN-0070 (Horizontal delineation of timeline canvas)

4.2.2 Indication of Past, Now and Future

ID	Guideline	Conformance	Evidence Rating
TLN-0160	Extend a prominent vertical line across the viewing area aligned to the current time on the time axis, and display indicators at both ends of the line beyond the viewing area close to the time markers	Mandatory	Medium
TLN-0170	Differentiate between past and future time periods by using different background colours or different shades of the same background colour.	Mandatory	Medium
TLN-0180	The past should not have any additional background colour over its row banding	Recommended	Medium

Usage Examples



In this correct example, the 'now' point in time is displayed using indicators on each time axis between which a prominent vertical line is drawn. The future time period has a subtly darker background to provide visual differentiation while not impacting on any elements which may be display on the canvas. (TLN-0160, TLN-0170, TLN-0180)

Rationale

Hazard Risk Analysis Summary:

User research (see APPENDIX B) supported both the inclusion of, and design of the 'Now' indication. As described in the hazard below, not having a clear indication of 'Now' may lead to misinterpretation of the timescale, and provides an anchoring point when navigating the timescale.

User research (see APPENDIX B) showed support for using the background to give extra indication of future and past. Additionally, most clinicians felt that a colour such as grey was semantically better associated with the past. However, further analysis concluded that as most timeline elements would be displayed in the past, and the best background colour for readability and reducing visual noise was white, the past should be shown with a white background. Therefore the future should be the side with the subtle colour distinction.

User research (see APPENDIX B) suggested that changing the style of timeline elements between past and future might be misinterpreted as a status change. For example if a prescription was shown differently in the future and past, a clinician might assume that it had been administered according to plan, when in fact the administration status is independent from the time.

Potential Hazards:

- MTI130 If the view doesn't default to show 'Now', a clinician might not notice this and misinterpret time scale by, for example, mistakenly thinking medications in view are current medications

Mitigations:

- TLN-0160 (Display a prominent vertical line to indicate 'now'). Though TLN-0190 does not deal with defaulting to 'Now', if 'Now' is not clearly shown, then there would be the same problem with misinterpreting the time scale.

5 Guidance Details for the Display of Timeline Entries

5.1 Introduction

This section provides guidance for timeline entries (including entries with no duration, known duration, and open duration), timeline entry labels, and row identifier cells. Figure 4 illustrates those features:

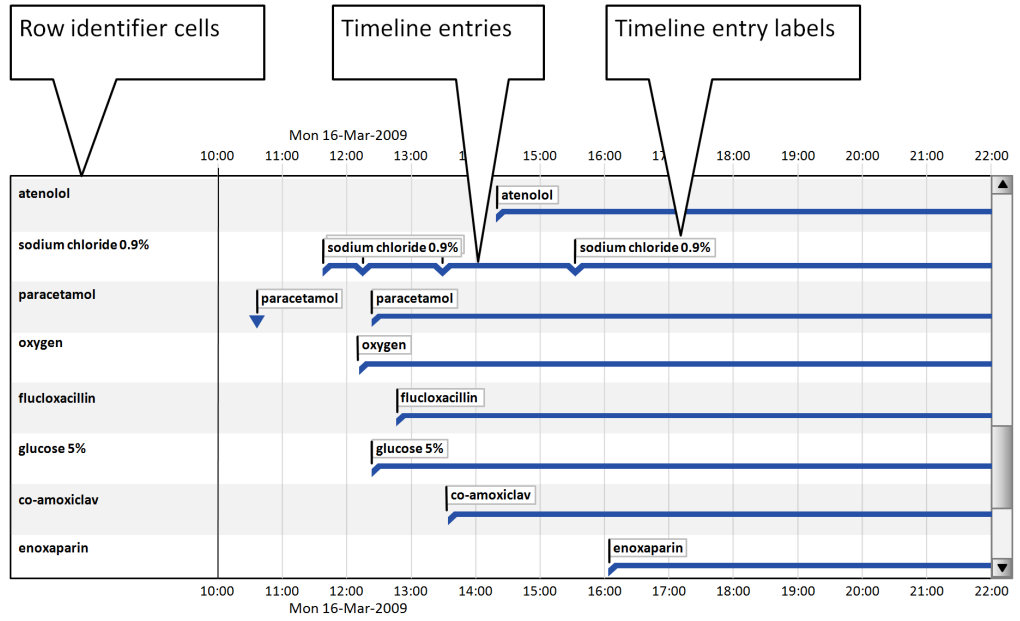


Figure 4: Timeline View Features Covered in this Section

This section also provides guidance on the display of graphs in conjunction with timeline entries, as shown in Figure 5:

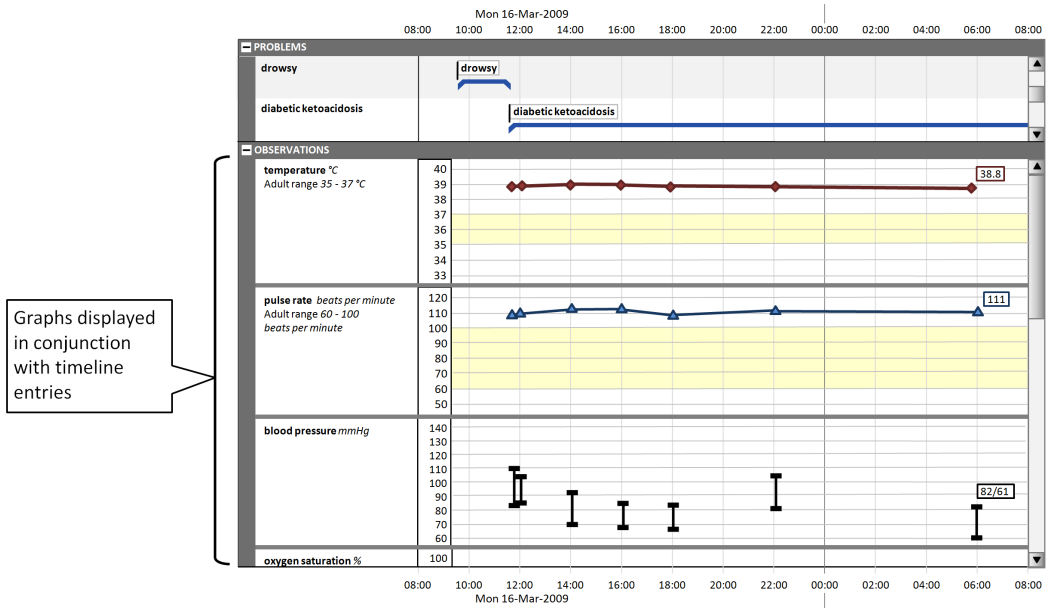


Figure 5: Display of Graphs with Timeline Entries

5.2 Guidelines

5.2.1 Timeline Entries: Generic Considerations

Timeline entries are visualisations of medical record entries plotted against time. They can represent data at a point in time or over a duration.

ID	Guideline	Conformance	Evidence Rating
TLN-0190	Provide a means for the user to navigate from an element of information (for example, a drug prescription) to alternative views of that information (for example, the drug administration view) and back again.	Recommended	Medium
TLN-0200	Apply context-specific rules supplied by the appropriate clinical authority regarding the line identity for medications, to ensure the safe display of timelines that represent medications (for example, in certain inpatient contexts it may be unsafe to locate multiple medication prescriptions on the same row if those prescriptions vary in dose, route, or frequency).	Mandatory	High

Usage Examples

No usage examples for these guidelines

Rationale

The usage examples in this and throughout this document show multiple prescriptions displayed on a single row, where the medication row identity is at the level of drug name (for example, all prescriptions for paracetamol are shown on the same row). This level of row identity is not Microsoft Health CUI guidance, but aims to make best use of the display space available while ensuring, through the clear display of timeline entry labels, that important differences between entries can be highlighted.

However, for some clinical contexts and applications, medication row identity at the level of drug name may be deemed unsafe by an appropriate clinical authority

Hazard Risk Analysis Summary:

No mitigated hazards recorded for this area

Significant Risks That Are Not Directly Mitigated by Guidance:

The following risks are not directly mitigated by the guidance in this document. Suppliers should be aware of these risks and design their applications to mitigate them accordingly:

Potential Hazards:	Cause:	Potential Consequences:
▪ MTI182 What if the row identifier is not easily changed and is set at a too low level of detail?	▪ How ISVs implement CUI Medications Timeline design guidance	▪ Actual changes (for example, to dose, route, frequency or strength) are missed. Depending on the context, the potential for inappropriate clinical treatment as a result is of varying severity. In this instance, user confusion, potential delays to clinical treatment and an inappropriate picture of clinical care understood by the user.
▪ MTI183 What if the row identifier is not easily changed and is set at a too high level of detail, eg. just the drug name?	▪ How ISVs implement CUI Medications Timeline design guidance	▪ For example, the user's ability to see all of the medication information at once would be compromised, leading to a potential for inappropriate treatment with varying consequences

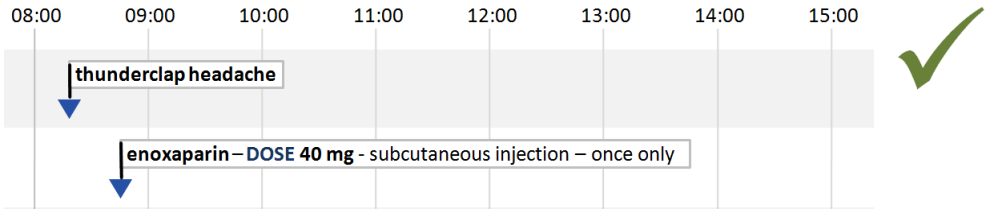
5.2.2 Timeline Entries with No Significant Duration

Some timeline entries occur at a point in time and have no duration. Examples of timeline entries with no duration are:

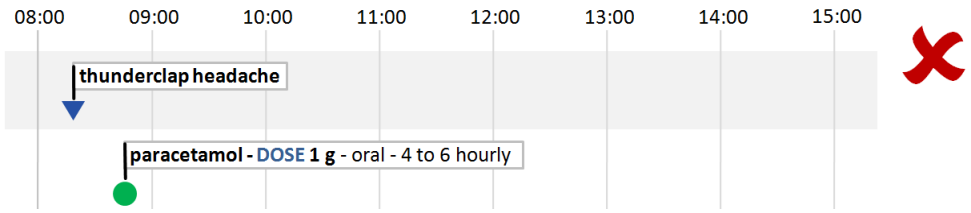
- 'Once only' prescriptions (other than once only infusions) that have no significant duration (for example, tablets)
- General notes recording (for example, 'past history of appendicectomy')

ID	Guideline	Conformance	Evidence Rating
TLN-0210	Use the same colour scheme for all timeline entries with no duration	Mandatory	Medium
TLN-0220	Avoid colour schemes that may have additional meanings which are unintended (for example, red and green may be misinterpreted as 'safe' and 'unsafe')	Mandatory	Medium
TLN-0230	Use the same symbol for all timeline entries with no duration	Mandatory	Medium
TLN-0240	Display the same size symbols for all timeline entries, regardless of the time period chosen	Mandatory	Medium
TLN-0250	For a timeline entry with no duration, use a symbol that visually aligns with the time axis	Mandatory	High
TLN-0260	For a timeline entry with no duration, use a symbol that is symmetrical along its vertical axis	Recommended	Medium
TLN-0270	Use a symbol for which the centre point is clearly indicated	Recommended	Medium
TLN-0280	Position the symbol so that its centre point is aligned with the time that it represents	Recommended	Medium
TLN-0290	To indicate a once only ('stat') medication that has an administration of no significant duration (for example, a tablet or injection), use a timeline entry with no duration. Align the symbol with the planned administration time.	Mandatory	Medium

Usage Examples



In this correct example, the blue arrowhead symbols align clearly with the times they indicate. The same symbol is used for the different data types shown (patient problem and drug prescription). The drug prescription represents a 'once-only' prescription. (TLN-0210, TLN-0220, TLN-0230, TLN-0250, TLN-0260, TLN-0270, TLN-0280, TLN-0290)



In this incorrect example, different symbols have been wrongly used, and the second symbol uses the colour green, which may have unintended semantic meaning. The second entry also incorrectly represents a prescription requiring more than one administration as a timeline event with no duration. (TLN-0220, TLN-0230)

In this correct example, the symbols are vertically symmetrical and their centres clearly align with the time axis. (TLN-0250, TLN-0260, TLN-0270, TLN-0280)

In this incorrect example, the symbols are not vertically symmetrical. (TLN-0250, TLN-0260, TLN-0270, TLN-0280)

In this incorrect example, the symbols are vertically symmetrical, but their centres do not clearly align with the time axis. (TLN-0250, TLN-0270, TLN-0280)

Rationale

There are a very large number of different data types and categories that could be displayed simultaneously in a Timeline View. Therefore, it is impractical to use different symbols and/or colours to distinguish these types and categories. For example, using red to indicate cardiovascular health issues and medications.(This guidance does not apply to patient observations displayed as graphs, guidelines for which can be found in section 5.2.8 of this document and in *Design Guidance – Displaying Graphs and Tables* **{R4}**)

User research found that items marked in red and green were confusing and misinterpreted to mean 'stop' and 'go'. Previous Microsoft Health CUI research has found that very few colour conventions are universal in healthcare and therefore should be avoided if possible in cases where it could mistakenly be interpreted as having meaning.

These guidance points follow the relevant guidance for plotting nodes described in *Design Guidance – Displaying Graphs and Tables* **{R4}**, as on a graph, minimising ambiguity as to an item's point in time is essential in a Timeline View. Clear centre points also emphasise the point-in-time nature of such entries.

Hazard Risk Analysis Summary:

Potential Hazards:

- MTI083 Colour is used to show linkage between data groups. If colour is not used consistently between patients, a user may make mistaken assumptions about what colour conveys for a patient. Also many grouping sets will have too many members to support a useful colour scheme

Mitigations:

- TLN-0210 (Use the same colour scheme for all timeline entries with no duration)

5.2.3 Timeline Entries with Known Duration

Many record entries have a period of validity determined by start and end times. Displaying entries with a known duration is one of the strengths of the timeline approach to data visualisation.

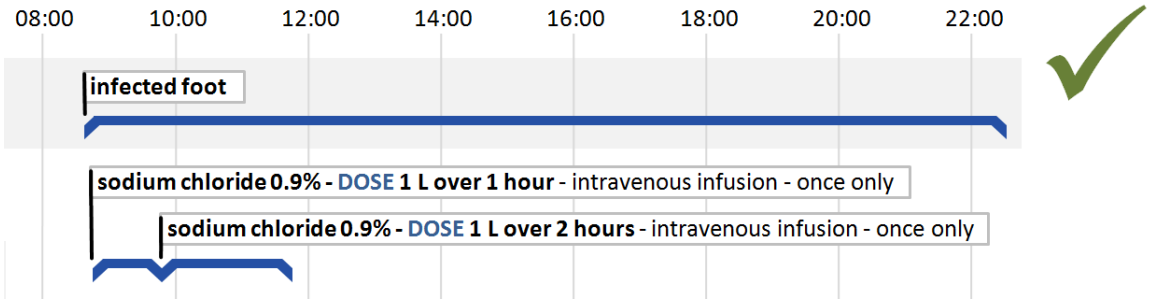
Examples are:

- Drug prescriptions that are for a defined period; for example, a prescription for an infusion over 12 hours, or a seven day course of tablets
- Patient conditions that have been noted and then recorded as resolved; for example, 'infected foot'

ID	Guideline	Conformance	Evidence Rating
TLN-0300	Use the same start and end symbols and style (including colour) of duration lines for all timeline entries with known duration.	Mandatory	High
TLN-0310	Display duration as a horizontal unbroken line with a thickness and colour that clearly distinguishes it from the background, with no fill colour.	Mandatory	Medium

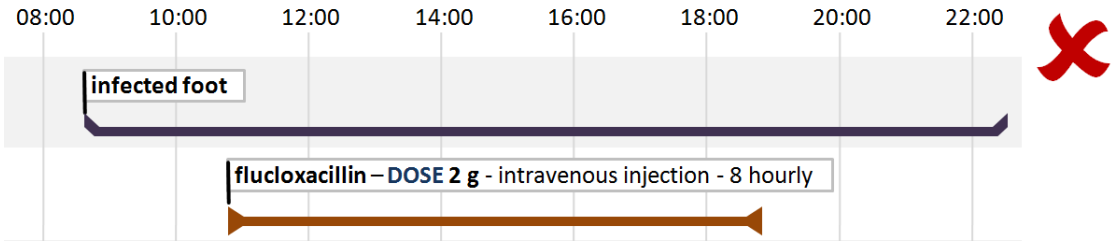
TLN-0320	Use different symbols for the start time and end time. Position the symbols and the duration line to form a continuous shape.	Mandatory	Medium
TLN-0330	Use start time and end time symbols that provide a clear visual interruption to the duration line, such that if two or more timeline entries with known duration are positioned end-to-end, there is a noticeable discontinuation of the duration lines.	Mandatory	High
TLN-0340	Use start time and end time symbols that extend downwards from the duration line.	Recommended	Medium
TLN-0350	Use a start time symbol with a left hand edge that clearly aligns with the time axis.	Mandatory	Medium
TLN-0360	Use an end time symbol with a right hand edge that clearly aligns with the time axis.	Mandatory	Medium
TLN-0370	Do not vary the style of timeline entries and labels between past and future time periods	Recommended	Medium
TLN-0380	For drug prescriptions, use a timeline entry with known duration to indicate a prescription requiring more than one administration. Align the start time symbol with the first planned administration time and the end time symbol with the last planned administration time.	Mandatory	High
TLN-0390	To indicate a once only ('stat') medication that has an administration with a significant duration (for example, an infusion), use a timeline entry with known duration. Align the start time symbol with the planned beginning of the administration time and the end time symbol with the planned end of the administration.	Recommended	Medium

Usage Examples

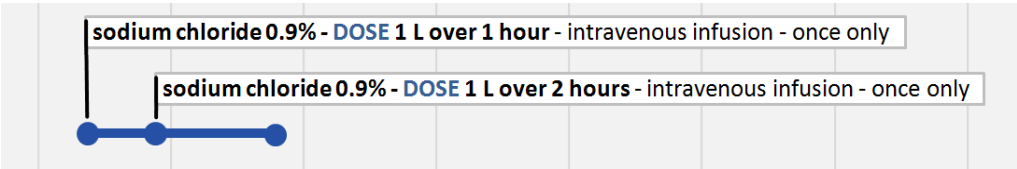


Example 2: Same Symbols and Duration Line Styles Used for all Timeline Entries

In this correct example, the same symbols and duration line style have been used for all the timeline entries of known duration. The start and end symbols have edges that clearly align with the time axis, and where two timelines share a row (the saline entries) there is a noticeable discontinuation of the duration lines. (TLN-0300, TLN-0310, TLN-0320, TLN-0330, TLN-0340, TLN-0350, TLN-0360, TLN-0390)



In this incorrect example, different symbols and duration line styles have been incorrectly used to differentiate between data types. Additionally, the second timeline style does not provide a noticeable discontinuation of the duration line if another timeline of this style where positioned end-to-end with it. (TLN-0300, TLN-0330)

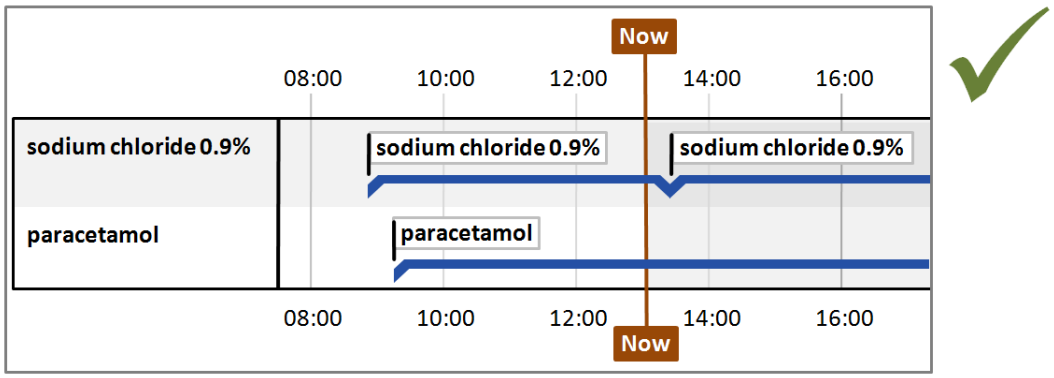


In this incorrect example, the same symbol has been incorrectly used for start and end times. Additionally, the mid-point of the symbol is incorrectly used to align with the time axis. As a result, the end point of the first entry overlaps the start point of the second entry, wrongly inferring a data series. As there is no noticeable discontinuation of the duration lines, this false inference is reinforced. (TLN-0320, TLN-0330)

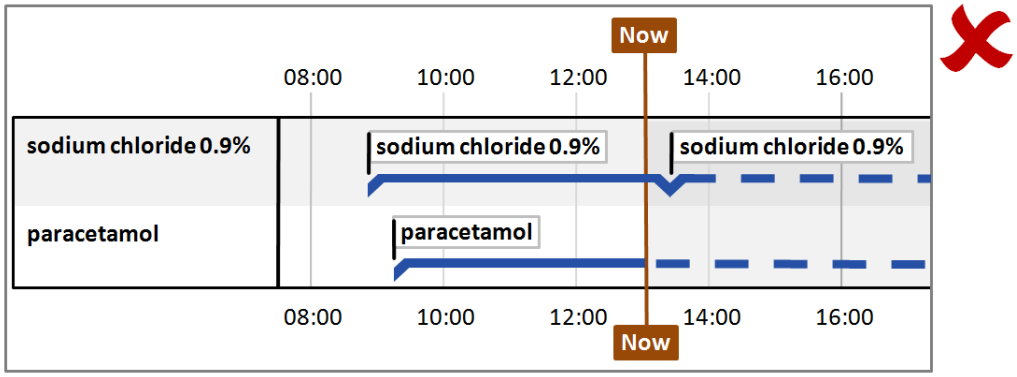
These correct examples of alternative designs all satisfy the guidelines. (TLN-0300, TLN-0310, TLN-0320, TLN-0330, TLN-0340, TLN-0350TLN-0360)

These incorrect examples of alternative designs do not provide a noticeable discontinuation of the duration lines. (TLN-0330)

A selection of incorrect examples. The first symbol incorrectly uses a thin duration line, which may not have enough prominence to be clearly distinguishable when positioned on a coloured background. The second symbol incorrectly uses a dotted line, which may falsely infer a temporary status. The third symbol incorrectly uses a bar with an internal fill colour, which adds unnecessary visual complexity. (TLN-0310)



In this correct example of timeline entry styling for future time periods, the entries do not change in style as they cross the 'Now' time point into the future time period. (TLN-0370, TLN-0300, TLN-0310, TLN-0320, TLN-0330, TLN-0340, TLN-0350, TLN-0360)



In this incorrect example of timeline entry styling for future time periods, the duration lines change style to use a dashed line. This can be mistakenly interpreted as representing a series of 'on-off' events, or that the status of the medication prescription has changed in some way. (TLN-0370, TLN-0310)

Rationale

Broken lines may be inferred as representing unconfirmed or varying status, and very thin lines may either be lost on the background or mistaken as horizontal gridlines. User research (see APPENDIX B) suggested that internal fill colours might contribute to a mistaken assumption that the duration items are 'progress bars', conveying status such as administration status. Redundant use of fill colour was also perceived to contribute to overall visual complexity of the timeline.

Start, end and duration should form a continuous shape so that they can be unambiguously associated.

When timeline entries share rows, individual entries must be clearly discernable from each other. This is particularly important when entries that have been grouped onto a shared row using one attribute (for example, drug name) have other important attributes that may significantly differ (for example, dose.) In these circumstances if individual entries are not clearly discernable from each other, the viewer of the timelines may mistakenly infer a false continuity (for example, continuity of dose) between entries.

In addition, user research showed that in designs without a clear start symbol, users can misinterpret the occlusion of the duration items by the left hand edge of the screen as the starting point of those items (when they actually extend off-screen leftwards).

When timeline items share rows, it may be common for duration items to follow on from each other; such as when a prescription's dose is changed when the line summarises all of the prescriptions a patient has had for a particular drug (see Example 2). As the end time of one item and start time of another are shared, having symbols that do not overlap makes the start and end of each item clearer. Shared start / end points are also a problem if durations can be 'moused-over' to highlight them, as indicated in potential hazard MTI153.

Hazard Risk Analysis Summary:

Potential Hazards:	**Mitigations**:
▪ MTI073 dashed line misinterpreted as something else, such as on / off	▪ TLN-0300 (Display duration as a horizontal unbroken line with a thickness and colour that clearly distinguishes it from the background., with no fill colour)
▪ MTI079 Only 'discrete' items are displayed – no items with duration. Users forget that some events may imply a persistent condition (such as a diagnosis of asthma) and therefore do not factor in things like co-occurrence	▪ TLN-0300 (Display duration as a horizontal unbroken line with a thickness and colour that clearly distinguishes it from the background with no fill colour). Risk is mitigated by displaying any items that have a duration
▪ MTI153 If you 'mouse over' a shared prescription start/end blob (that is, shares two durations) - which duration is highlighted?	▪ TLN-0350 (Use a start time symbol with a left hand edge that clearly aligns with the time axis) and TLN-0350 (Use an end time symbol with a right hand edge that clearly aligns with the time axis)
▪ MTI176 If two duration items one the same line have been stopped and started in quick succession (e.g. a medication dose is changed by stopping one and starting another) then it is quite likely that the two 'blobs' will occlude and so turn the 'crowding' UI on (which might make it harder to notice that items are separate?)	▪ TLN-0330, TLN-0350, TLN-0360 (Start and end items do not occlude each other)
▪ MTI072 User mistakenly thinks that past events HAVE occurred, or that future events WILL occur	▪ TLN-0370 (Do not vary the style of timeline entries and labels between past and future time periods)

▪ MTI073 What if the dashed line (representing future items) is misinterpreted as something else, such as on / off?	▪ TLN-0370 (Do not vary the style of timeline entries and labels between past and future time periods)
▪ MTI162 The clinician mistakenly assumes that the solid and dotted line on prescriptions refers to administration status	▪ TLN-0370(Do not vary the style of timeline entries and labels between past and future time periods)
▪ MTI163 The clinician is confused as to why the prescription line (a plan) changes to a dotted in the future - as the PLAN to give it doesn't change, and that it might (incorrectly) be seen as a status change (such as an administration status change)	▪ TLN-0370 (Do not vary the style of timeline entries and labels between past and future time periods)

5.2.4 Timeline Entries with Open Duration

Sometimes the end time of a timeline entry is unknown, indeterminate or infinite.

Examples are:

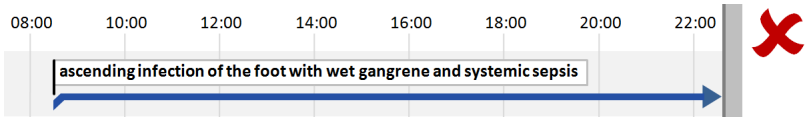
- Current medical conditions which may (or may not) be resolved at some undetermined time in the future
- Drugs prescribed on an 'ongoing basis
- Amputations or congenital conditions which the patient will have for the duration of their life

> **Note**
>
> These examples, with the exception of amputations and congenital conditions, may be updated to timeline entries with known duration if end times are later provided. Therefore, there is a need to represent timeline entries with an open duration.

ID	Guideline	Conformance	Evidence Rating
TLN-0400	For a timeline with open duration, use the same design for the start time symbol and the duration line as used for timelines with known duration.	Mandatory	Medium
TLN-0410	For a timeline with open duration, extend the duration line to the right hand margin of the viewing area	Mandatory	Medium
TLN-0420	For a timeline with open duration, do not use any symbol on the right hand end of the duration line	Recommended	Low
TLN-0430	For drug prescriptions, use a timeline entry with open duration to indicate an 'ongoing' prescription. Align the start time symbol with the first planned administration time.	Mandatory	High

Usage Examples

This correct example shows the duration line extending to the last viewable time, with no symbol on the right hand end of the duration line. (TLN-0400, TLN-0410, TLN-0420)



This incorrect example shows a symbol which interrupts the duration line before it reaches the right margin of the viewing area. (TLN-0420)

Example 3: Duration Line Incorrectly Using a Symbol at the End

This incorrect example shows a duration line that correctly extends to the right margin of the viewable area, but incorrectly uses a symbol at the end. (TLN-0420)

Rationale

During user research, some clinicians interviewed were unsure of the distinction between duration items that had no end date (open items), and those that had a future end date that was not currently visible.

Symbols that interrupt a duration line, such as in Example 3, may be mistakenly interpreted as end symbols.

Hazard Risk Analysis Summary:

Potential Hazards:

- MTI076 If probably (or certainly) persistent durations are not represented persistently (in that, they are not represented past the 'current' time), then a user might forget that a condition could be persistent

Mitigations:

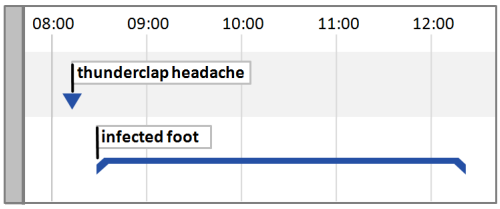
- TLN-0410 and TLN-0420 (Durations where the future end date is unknown (for example asthma in a child) shown as extending into the future, rather than ending at the current time).

5.2.5 Timeline Entry Labels

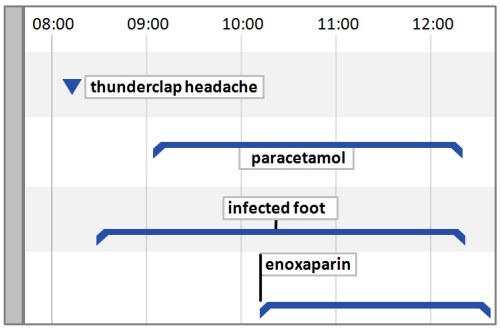
ID	Guideline	Conformance	Evidence Rating
TLN-0440	Position the timeline entry label above the related timeline entry.	Mandatory	Medium
TLN-0450	Extend a vertical line from the left hand edge of the label down to the related timeline entry.	Mandatory	Medium
TLN-0460	Ensure the vertical space between the top of the label and the row above is sufficient to avoid mistaken association of the label with entries in that row.	Mandatory	Medium
TLN-0470	For timeline entries with duration, if the start of the timeline entry is in view, align the left hand edge of the label with the start time symbol.	Mandatory	Medium
TLN-0480	For timeline entries with duration, when the entry extends past the left edge of the viewing area (that is, the start time symbol is not visible), align the left hand edge of the label with the left edge of the viewing area.	Mandatory	Medium
TLN-0490	For a timeline entry with no duration, align the left hand edge of the label with the time of occurrence.	Mandatory	Medium
TLN-0500	If the label extends beyond the right edge of the viewing area, shorten it to fit in the available space and provide a symbol to indicate truncation. Provide an alternative means (for example a tooltip) to view the full label text.	Mandatory	Medium
TLN-0510	Provide an ellipsis symbol to indicate where truncation has occurred.	Recommended	Medium
TLN-0520	When multiple timeline entries share a row and the labels contain identical text, if the labels overlap then hide the labels that are obscured. Maintain the vertical lines up to (but not over) the label.	Recommended	Medium
TLN-0530	When multiple timeline entries share a row and the labels do not contain identical text, display the labels in such a way as to avoid overlap (for example, by repositioning the labels to different distances directly above the timeline entries and extending their vertical lines to maintain the visual linkage.)	Recommended	Medium

TLN-0540	Apply context-specific rules supplied by the appropriate clinical authority to the truncation and overlap of labels, to ensure the safe display of timeline labels (for example, in inpatient contexts it may be unsafe to truncate full drug prescription details).	Mandatory	High
TLN-0550	Do not partially display medication names	Mandatory	High
TLN-0560	Do not partially display the individual fields (for example, dose, route and frequency) of each medication's set of drug details.	Mandatory	Medium
TLN-0570	When drug prescriptions are displayed as timeline entries, the facility to display full prescription details in the labels must be provided (the format for which is detailed in *Design Guidance – Medication Line* **{R6}**).	Mandatory	High
TLN-0580	When drug prescriptions are displayed as timeline entries, the facility to display only the drug name in the labels may be provided as an additional viewing option to displaying full prescription details. **Note** Determining what is shown for the drug name is outside the scope of this guidance.	Recommended	High
TLN-0590	When full drug prescription details are displayed in timeline entry labels, the complete label text must be displayed (that is, not truncated or hidden). The only exception is labels that extend beyond the right hand edge of the viewing area (which will need to be truncated).	Mandatory	High
TLN-0600	When drug prescriptions are displayed as timeline entries, if the option to display shortened labels (for example, only the drug name) is provided, then when this option is active the full prescription details must be available for the user to view for each entry by an alternative mechanism (for example by revealing the full prescription on mouse hover, or by selecting a greater level of detail).	Mandatory	High

Usage Examples



In this correct example, the label for the timeline entry with no duration is left aligned to the time of occurrence. The label for the timeline entry with duration is left aligned with the start time. For both entries a vertical line extends down to the related timeline entry. (TLN-0440, TLN-0450, TLN-0460, TLN-0470, TLN-0490)

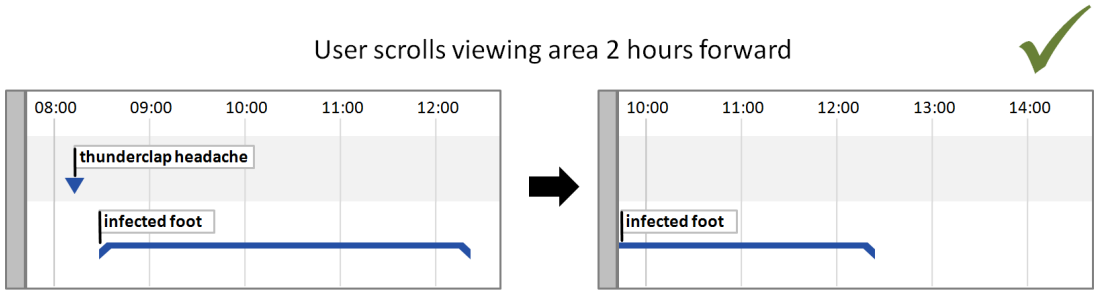


In this incorrect example, the label for the first entry ('thunderclap headache') is not positioned above the entry and does not have a line to visually associate it with the entry. If there were another entry to the right of the label it would not be clear which entry the label is associated with. (TLN-0440, TLN-0450, TLN-0490)

The label for the second entry ('paracetamol') is also centrally aligned, but positioned under the duration line. This position may lead to the label obscuring the start and end point symbols for entries which have a duration line that is shorter than the label. (TLN-0440, TLN-0450, TLN-0470)

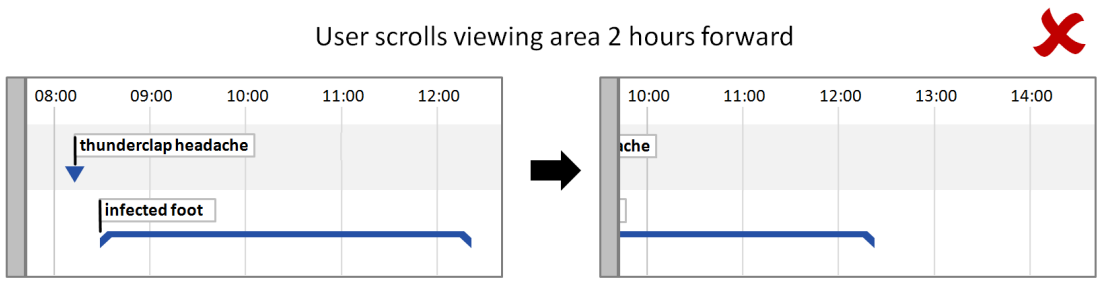
The label for the third entry ('infected foot') is centrally aligned with the duration line, which gives undue prominence to this mid-point time. In this example, the user may wrongly infer that the mid-point time 10:20 has special relevance to the 'infected foot' entry. (TLN-0440, TLN-0450, TLN-0470)

The label for the fourth entry ('enoxaparin') is so close to the row above it that the user may mistakenly associate the label with the third entry. (TLN-0460)

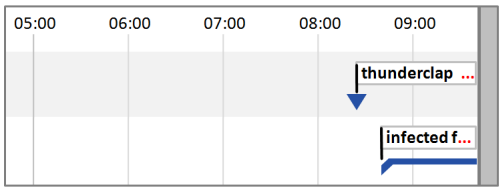


Example 4: Correct Scrolling Behaviour

In this correct example, when the user scrolls the viewing area two hours forward, the timeline entry with no duration is not visible and so the label is not displayed. The timeline entry with duration is still visible, and so its label aligns with the left hand edge of the viewing area. (TLN-0480)

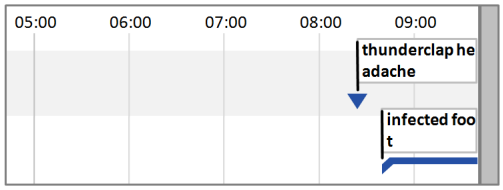


In this incorrect example, when the user scrolls the viewing area two hours forward, the labels stay positioned relative to the starting points of the timeline entries, and are partially obscured. (TLN-0480)



Example 5: Correct Label Truncation

In this correct example, the user has scrolled the viewable area so that the text in the two timeline entry labels extends past the right hand edge of the viewing area. The labels are adjusted to terminate at the right hand edge, and red ellipsis symbols are used to provide clear indication that the label text has been truncated. (TLN-0500, TLN-0510)

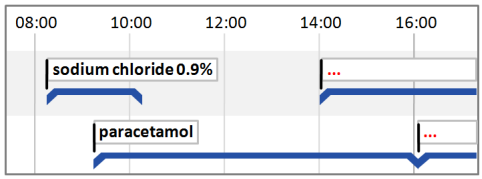


Example 6: Incorrect Label Truncation

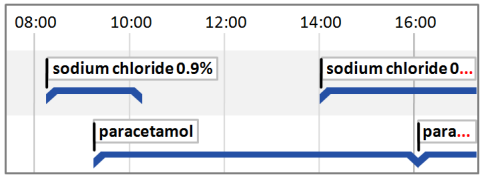
In this incorrect example, the labels have been wrapped onto multiple lines within the horizontal space available. (In the worst case, if the available horizontal space was one character wide and the label was 25 characters in length, this would result in a label with 25 rows of single characters.) (TLN-0500)

Example 7: Incorrect Label Truncation

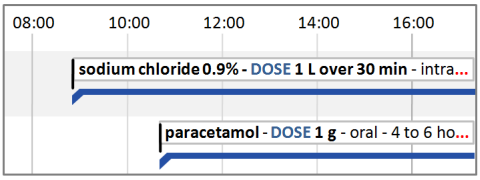
In this incorrect example, the labels have been repositioned so that their right hand edge aligns with the right hand edge of the viewing area. This approach produces misalignment with the timeline entries: the user may wrongly infer that the first entry has duration starting at about 07:50. (TLN-0470, TLN-0490, TLN-0500)



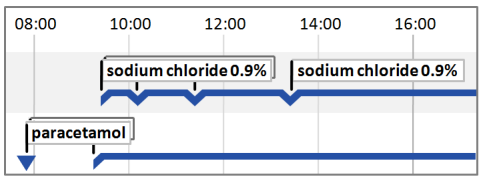
In this correct example, on both rows the medication names extend beyond the right edge of the viewing area. To avoid partial display, the medication names have been removed and a truncation symbol is displayed instead. (TLN-0550)



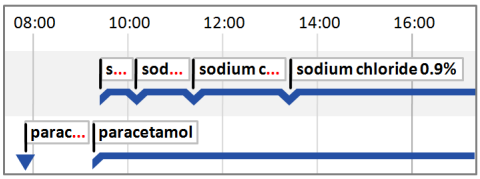
In this incorrect example, in both rows the medication names extend beyond the right edge of the viewing area. The medication names have wrongly been partially displayed. (TLN-0550)



In this incorrect example, in both rows the drug details extend beyond the right edge of the viewing area. The drug details have wrongly been partially truncated at points which show the maximum text in each label. (TLN-0560)

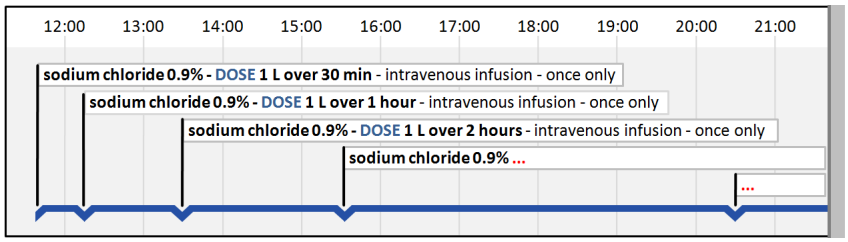


In this incorrect example, the label of the first entry on the first row extends beyond the starting point of the next two entries, and so the overlapped labels are not displayed. The label of the first entry on the second row extends beyond the starting point of the next entry, which is similarly not displayed. The vertical lines of the hidden labels extend to the lower edge of the labels above, and additional visual indication is provided in the form of a 'shadow' label decoration. (TLN-0520)



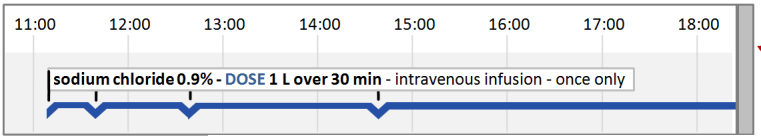
Example 8: Incorrect Label Overlap Behaviour

In this incorrect example, labels on both rows are truncated by other labels. In a situation where many entries sharing a line have labels that truncate each other, the user may not be able to see any complete label text and could make wrong assumptions based on the truncated text. (TLN-0520)

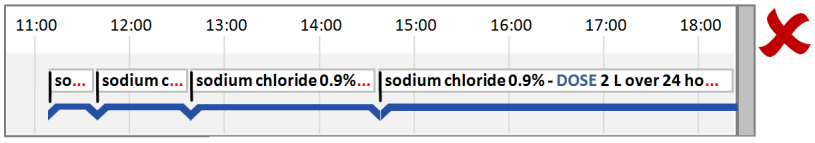


Example 9: Correct Display of Full Drug Prescription Details

In this correct example of displaying full drug prescription details (the format of which is detailed in *Design Guidance – Medication Line* **{R6}**), the option to view all labels is shown. (TLN-0530, TLN-0560, TLN-0570)



In this incorrect example, of displaying full drug prescription details, the first label overlaps the other three labels, and the system has hidden those labels. The user may wrongly infer that the first prescription details (dose, frequency, and so on) are valid for the other three timeline entries. (TLN-0530, TLN-0570)



Example 10: Incorrect Display of Full Drug Prescription Details

In this incorrect example of displaying full drug prescription details, the first three labels are truncated by the next label in the sequence. This makes it very difficult for the user to read the information. (TLN-0530, TLN-0560, TLN-0570)

Rationale

Positioning the label above the timeline item allows items to run up against one another without having to move the labels. Other examples of the benefits of positioning the label above the timeline item are given in Example 4. Preferences and rationale from user research (see APPENDIX B) supported labels displayed simultaneously on/near the items and in a static column (see the next section).

The guidance points encourage the correct association of label and item. This is especially important when the label cannot be positioned exactly next to the timeline item as a result of TLN-0530 (see Example 9)

The behaviour of the labels allows for a consistent placement of labels relative to the item's starting point, and allows the user to always see a label for items in view.

In this case, truncating labels that extend off the right hand side of the screen is preferable to either wrapping (as shown by Example 5 and Example 6) or repositioning the label (as shown by Example 7).

As shown in Example 8, in situations with many closely arranged labels, overlapping labels from the left gives the best possible chance that at least one full label will be shown in view. Maintaining the vertical line from the overlapped label gives a reminder that some aspect of the item has changed.

As shown in Example 10, overlapping labels which are NOT the same may lead the user to wrongly infer that the details displayed in the label for the first item are valid for the overlapped items as well.

Hazard Risk Analysis Summary:

Potential Hazards:	Mitigations:
▪ MTI097 What if the labels change position relative to the line? (makes it harder to learn associations)	▪ TLN-0440, TLN-0450, TLN-0460, TLN-0470, TLN-0480, TLN-0490,(Timeline formatting)
▪ MTI098 What if labels overlap?	▪ TLN-0520, TLN-0530, TLN-0540, TLN-0550, TLN-0560, TLN-0570, TLN-0580, TLN-0590, TLN-0600 (Timeline label positioning)
▪ MTI099 What if the label is out of view?	▪ TLN-0440, TLN-0450, TLN-0460, TLN-0470, TLN-0480, TLN-0490, TLN-0500 (Timeline formatting and truncation at right-hand screen edge)

5.2.6 Row Identifier Cells

Additional to timeline labels, row identifier cells provide a means for the user to identify what is displayed in a row. This is particularly useful when, for the viewed time period, a row does not contain any timeline entries. Row identifier cells also provide the user a means for quickly assimilating the information that is being displayed. Figure 6 illustrates row identifier cells:

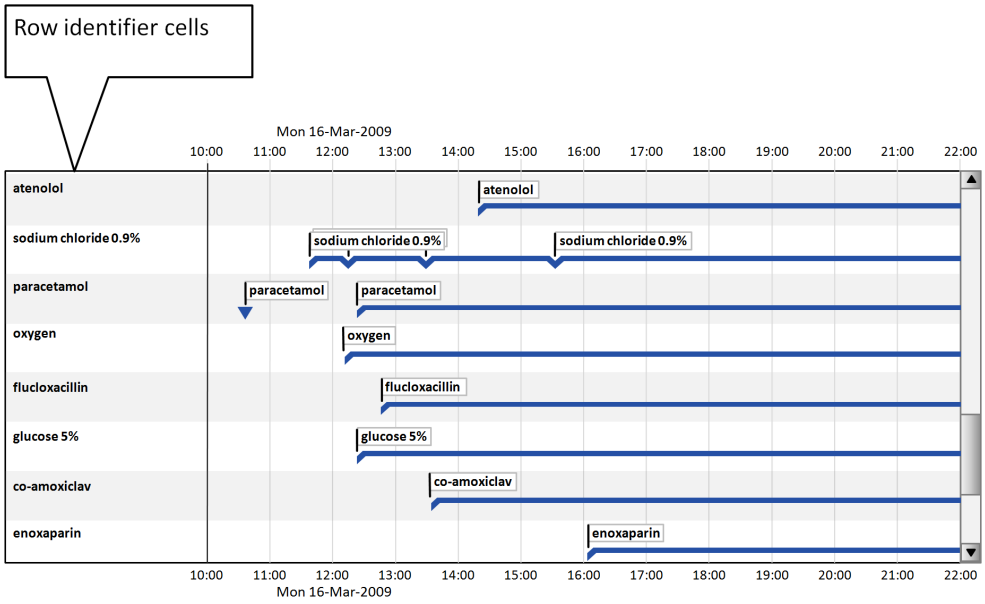
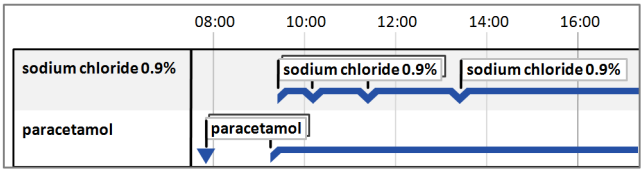


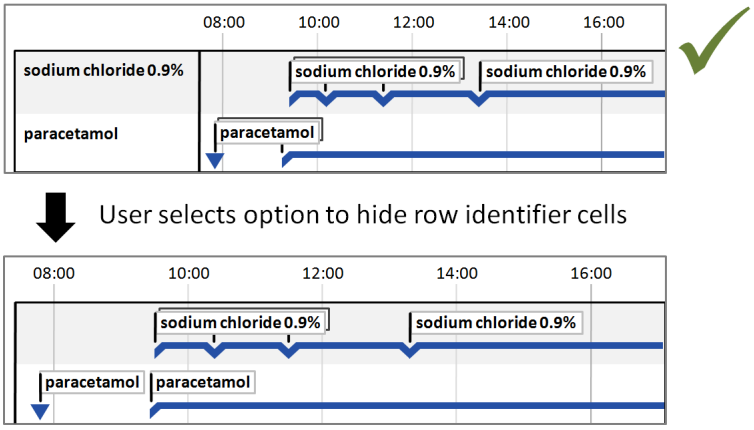
Figure 6: Row Identifier Cells

ID	Guideline	Conformance	Evidence Rating
TLN-0610	Provide the facility to display row identifier cells down the left edge of the viewing area, aligned with (and using the background colour of) the associated timeline rows.	Mandatory	Medium
TLN-0620	For each row, position the identifier text at the top left within the row identifier cell.	Mandatory	Medium
TLN-0630	If the option for an alternative display of labels which avoids overlap is provided, and this option can be performed at the row-level, locate the control for this option within each row identifier cell.	Mandatory	Medium
TLN-0640	Ensure the row identifier text has a clear relationship with the timeline entry labels on that row. For example, make the row identifier text the same as the timeline entry labels or, when labels vary, provide row identifier text that represents all the entries.	Mandatory	Medium
TLN-0650	If the option to hide timeline entry labels is provided, when timeline entry labels are hidden, row identifier labels must be displayed. When row identifier labels are hidden, timeline entry labels must be displayed.	Mandatory	Medium
TLN-0660	Provide an option to show or hide the column of row identifier cells. When the row identifier column is collapsed, widen the viewing area but maintain the same visible time period.	Recommended	Medium
TLN-0670	When row-level options are provided, locate them along the top right edge of each row identifier cell. When the row identifier cell is collapsed, provide an alternative means to access the options (for example, display enough of the collapsed row identifier cell to provide a menu control).	Recommended	Medium

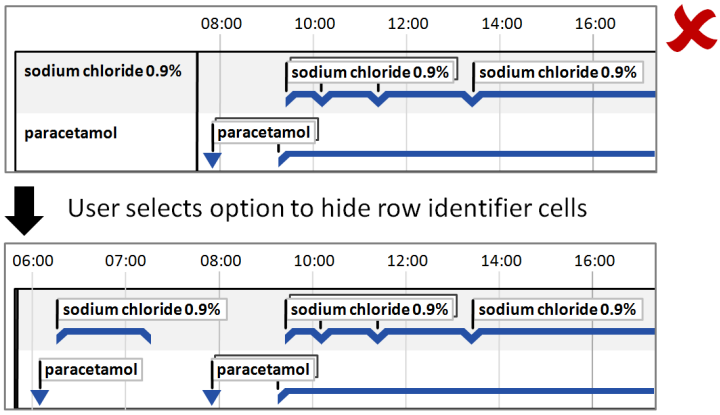
Usage Examples



In this correct example, the row identifier cells are positioned to the left of the viewing area and share the background colour of the rows they are aligned with. The identifier text is positioned at the top left within the row identifier cell. (TLN-0610, TLN-0620, TLN-0640)

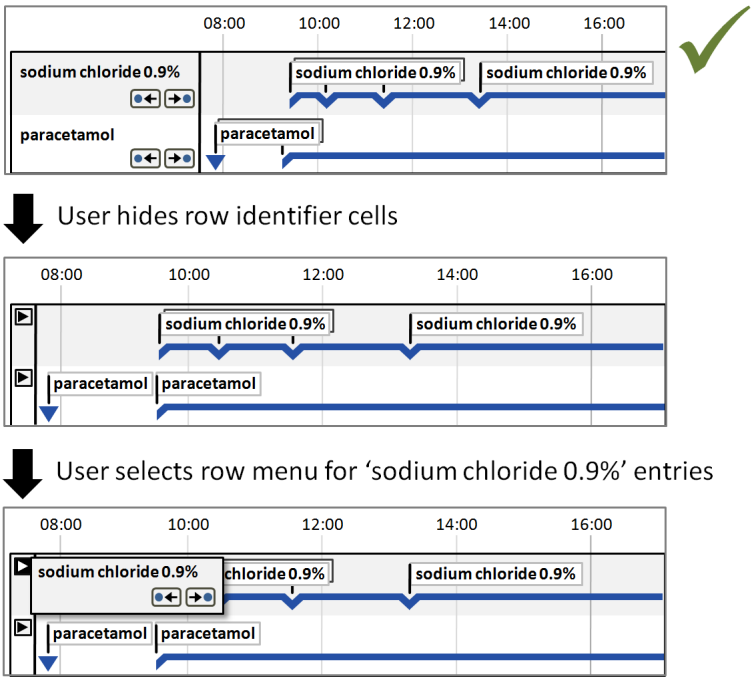


In this correct example, the time span (approximately 07:50 to 16:50) is maintained. As the time is spread over a wider area, the labels that were previously hidden no longer overlap and so are displayed. (TLN-0660)



In this incorrect example of viewing area expansion when row identifier cells are hidden, the time span is increased (that is, the earliest viewable time has changed from 07:50 to 06:30).

As the user will have previously selected a specific time span (see section 8) this may mislead the user (who may not have noticed the time span has increased, in the above example from about 5 hours to about 6.5 hours) into thinking that more events have occurred within the original time period than is the case. (TLN-0660)



In this correct example of correctly managing row-level options that are located within row identifier cells, the options 'Go to previous entry' and 'Go to next entry' (arrow-and-dot symbols) are shown (see section 8 for more details of the 'Go to...' options).

When the user selects an option to hide the row identifier cells, they shrink in width and a row menu icon is displayed for each row. When the user selects the row menu for 'saline' entries, the row identifier text and row options appear in a pop-up dialog box. (TLN-0660, TLN-0670)

Rationale

User research (see APPENDIX B) showed strong clinician preference and rationale for the ability to view labels in/on the timelines and in a static column to the far left of the Timeline View. This column of 'row identifiers' allows users to scan down the items on the timeline more easily, both to find a particular item and to ensure they are aware of the presence of all items on the Timeline View. Clinicians felt there was a particular precedent here when displaying a patient's medications, which are traditionally displayed as lists.

Though row identifiers may often have the same label as the timeline items, they can also be used to describe a higher level group that defines the 'line identity', which may make navigation and gaining an 'overview' from the timeline easier. For example a row identifier might be 'co-amoxiclav', where the corresponding line shows the patient's co-amoxiclav prescriptions. Or a row identifier might be 'insulin', where the corresponding line shows the different insulin that the patient has been prescribed.

Participants in user research (see APPENDIX B) suggested the option to show and hide the row identifier column. This function is familiar from other similar non-clinical software applications, and allows the user to view the same data in a wider area if desired.

Hazard Risk Analysis Summary:

Potential Hazards:

- MTI178 What if you hide the title column and there are no labels inline?

Mitigations:

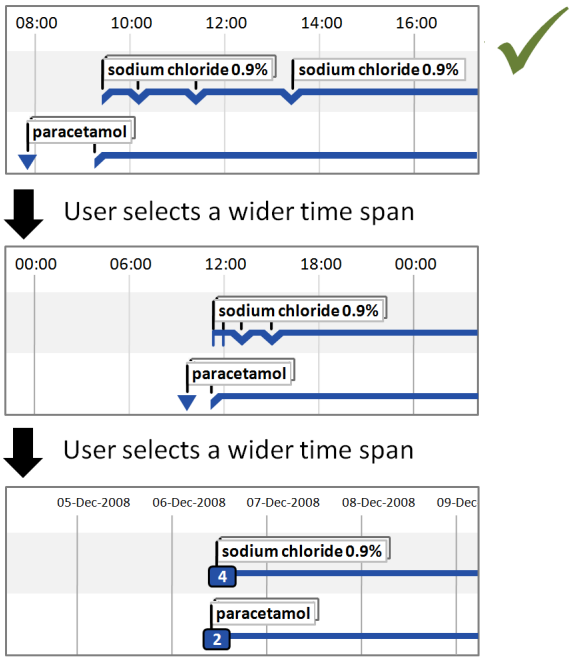
- TLN-0650 (If the option to hide timeline entry labels is provided, when timeline entry labels are hidden row identifier labels must be displayed. When row identifier labels are hidden timeline entry labels must be displayed.)

5.2.7 Displaying Crowded Timeline Entries and Labels

When multiple timeline entries are displayed on a shared row and the user chooses a greater time period, the entries will be displayed closer together. As the chosen time period is increased, it is highly likely that the entries will become crowded.

ID	Guideline	Conformance	Evidence Rating
TLN-0680	When the time period is changed, do not change the size of the symbols or the thickness of duration lines for timeline entries.	Mandatory	High
TLN-0690	For multiple timeline entries with known open duration that are so crowded on a shared row that their symbols overlap or are indistinguishable, replace the symbols with vertical lines of the same height in order to accommodate more information within the available space.	Mandatory	High
TLN-0700	For multiple timeline entries with no duration that are so crowded on a shared row that they overlap or are indistinguishable, replace the symbols with vertical lines of the same height in order to accommodate more information within the available space.	Mandatory	High
TLN-0710	When multiple timeline entries on a shared row become so crowded that individual entries cannot be discerned even when reduced to vertical lines, replace the vertical lines with an indication symbol and provide a (for example, hover-over) message that displays a recommendation to view the data at a more granular level.	Recommended	Medium

Usage Examples



In this correct example, as the user increases the viewable time period, the entries are positioned closer together. After the first time period change, the first two saline entries are so close together that they would overlap, so the symbols have been replaced with vertical lines. After the second time period change, even using vertical lines all the individual entries are too close together to be discerned, and so indicator symbols with a count of the entries are used instead. (TLN-0680, TLN-0690, TLN-0700, TLN-0710)

Rationale
Changing the size of symbols and thickness of duration lines when the timescale is changed would make the timeline difficult (and unsafe) to interpret at anything other than at a pre-chosen time 'resolution'. As a Timeline View would be used differently for different purposes, it is very unlikely that a pre-chosen time resolution will be optimal for all uses. Clinicians in user research felt icons were vulnerable to misinterpretation if shrunk or squashed. Reducing items to uniform vertical lines then summarising with a symbol is the guidance from *Design Guidance – Displaying Graphs and Tables* **{R4}**. This attempts to minimise the chance that items are missed (such as would be the case if they were not shown when 'too small', or if they overlapped), or misinterpreted. **Hazard Risk Analysis Summary:** **Potential Hazards:** ▪ MTI173 if you only have a single location for warning icons then you might not know WHERE the problems occur, resulting in increased time taken looking for cause of a warning **Mitigations:** ▪ TLN-0710(Indication of crowding (that is, 'warning icons') appear in-context)

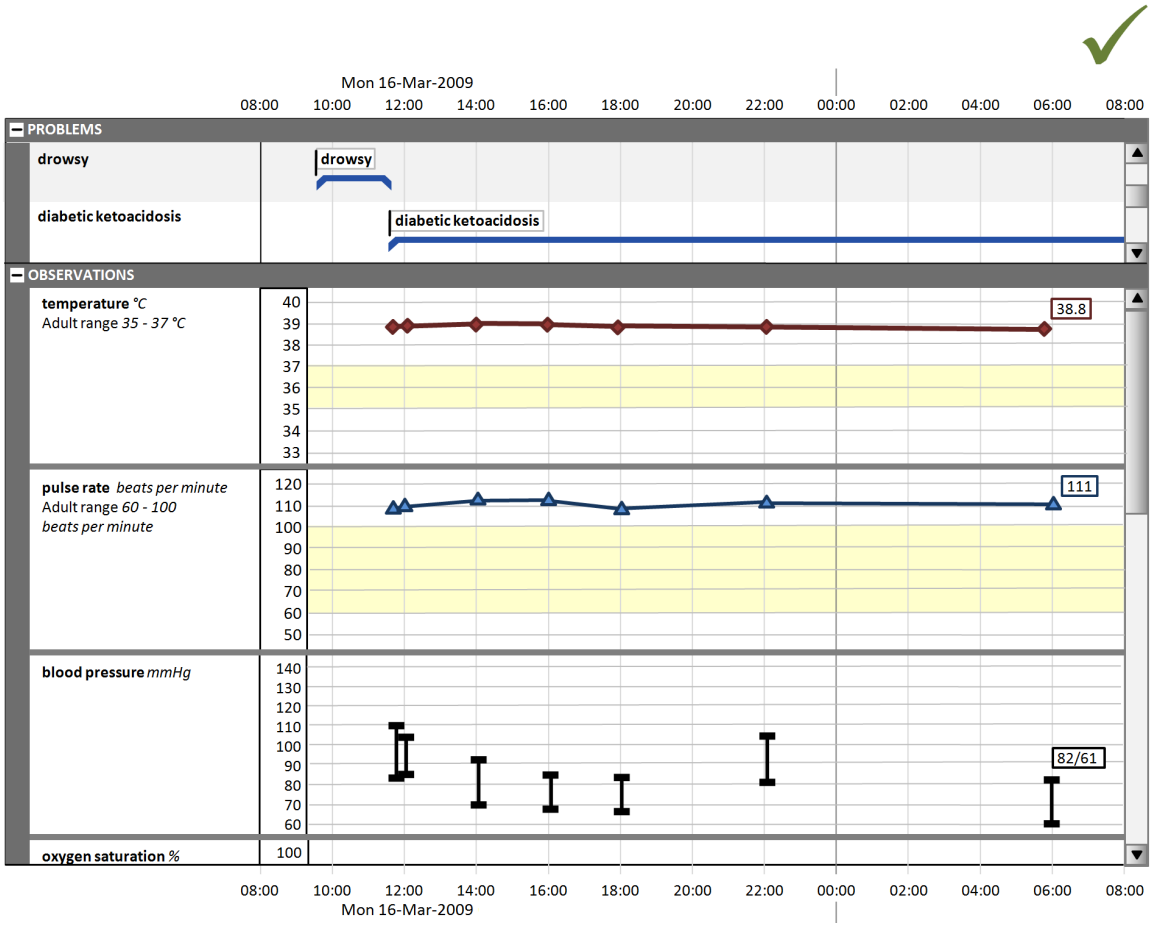
5.2.8 Displaying Graphs in Conjunction With a Timeline View

Some quantitative data is better represented as a graph (for example, observations such as temperature, blood pressure, and so on). These can be viewed in conjunction with a timeline representation of other data to provide comprehensive patient data visualisations.

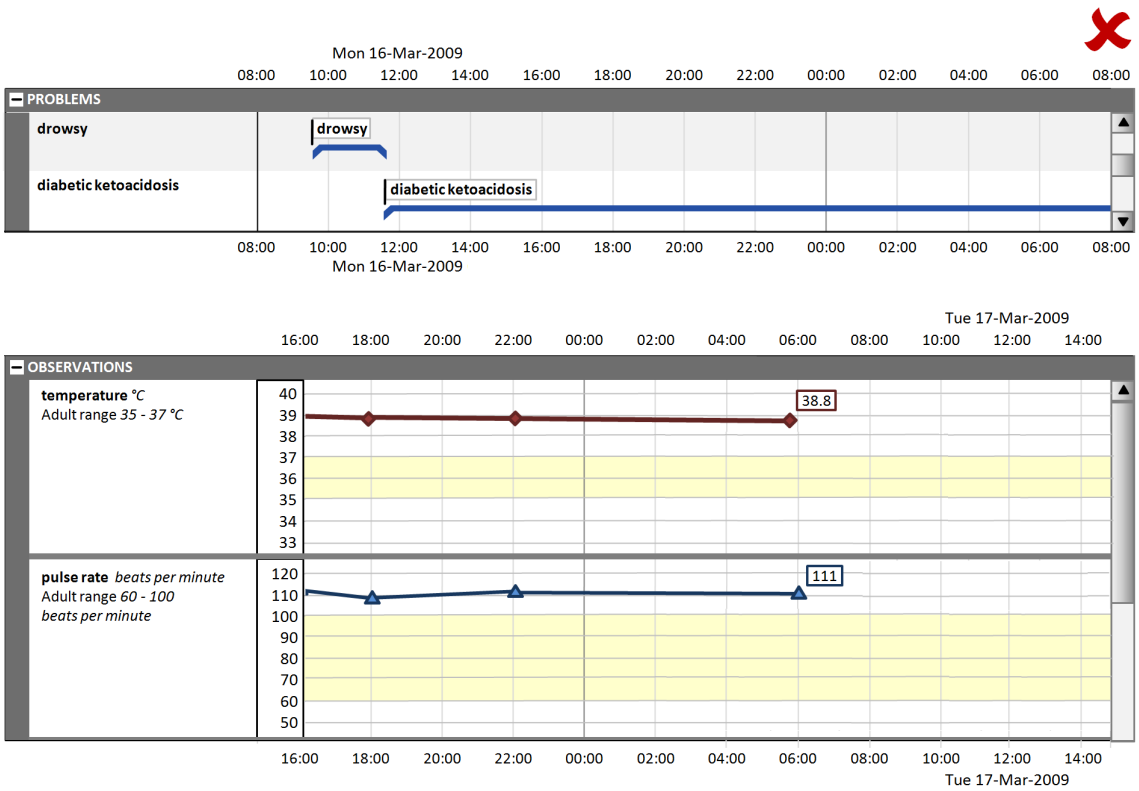
Use the guidelines below in conjunction with the graph guidelines found in *Design Guidance – Displaying Graphs and Tables* **{R4}.**

ID	Guideline	Conformance	Evidence Rating
TLN-0720	When graphs are displayed in a Timeline View, do not locate both timeline entries and graphs in the same timeline section.	Recommended	Medium
TLN-0730	Arrange multiple graphs in separate timeline rows, and display a prominent horizontal dividing line between each row.	Mandatory	Medium
TLN-0740	When a graph is displayed in a timeline row, persist the display of the graph (title, value scale, horizontal gridlines, and so on) even if the user navigates to a time period that contains no graphical data.	Mandatory	Medium
TLN-0750	Use the same horizontal time axis for graphs as used for the timeline canvas	Mandatory	Medium
TLN-0760	Display the graph label in the row identifier cell.	Mandatory	Medium
TLN-0770	Display the graph vertical value scale on the left hand edge of viewing area. Ensure that the value scale is always in view (even if the row identifier cells are hidden).	Mandatory	Medium
TLN-0780	If the row identifier cells are hidden, display the label information next to the last visible data point on the right hand side of the viewing area	Mandatory	Medium
TLN-0790	Extend horizontal scale gridlines across the width of the viewing area, aligned with the value scale of the graph.	Mandatory	Medium

Usage Examples



In this correct example, the graphs are located within a dedicated 'observations' section (for more information on timeline sections, see section 6.2.1.) The horizontal time axis is shared with other timeline sections (in this case, 'medications'). The row identifier cells contain the graph labels. The value scales are located within the viewing area to the immediate right of the row identifier cells. The appearance and positioning of the data series, value gridlines, and 'reference range' shading conform to guidance in *Design Guidance – Displaying Graphs and Tables* **{R4}.** (TLN-0720, TLN-0730, TLN-0750, TLN-0760,TLN-0770, TLN-0790)



In this incorrect example, the graphs have their own independent time axis that does not align with the time axis used for the timeline. This can lead to confusion and incorrect cause-effect relationship hypotheses. (TLN-0750)

Rationale

Displaying different data series graphs on the same row (at different time periods) may lead the user to misinterpret which data series they are looking at as they navigate the timescale. As described in *Design Guidance – Displaying Graphs and Tables* **{R4}** overlaying of different data series is only permitted in very few circumstances.

Display of a graph even when there are no data points for the visible time period is consistent with the *Design Guidance – Displaying Graphs and Tables* **{R4}**. In some circumstances the absence of recorded measurement for a value in a given time period will be an important fact.

Knowing which data series has no recorded measurement in a given time period will be an important fact in some circumstances.

Hazard Risk Analysis Summary:

Potential Hazards:

- MTI065 Confusion between horizontal and vertical gridlines between timeline and graphs

Mitigations:

- TLN-0720, TLN-0750, TLN-0790 (Graphs displayed on a Timeline View are aligned with the canvas vertical (time axis) gridlines. Horizontal gridlines are used only for graphs, and have dedicated scale information)

6 Guidance Details for Navigating Timeline Entries Within a Chosen Time Period

6.1 Introduction

This part of the document includes guidance on using timeline sections to group entries, and covers the display of section title bars, indication of any timeline entries within the chosen period that are out of view, and controlling the level of detail displayed in each section. Figure 7 illustrates those features:

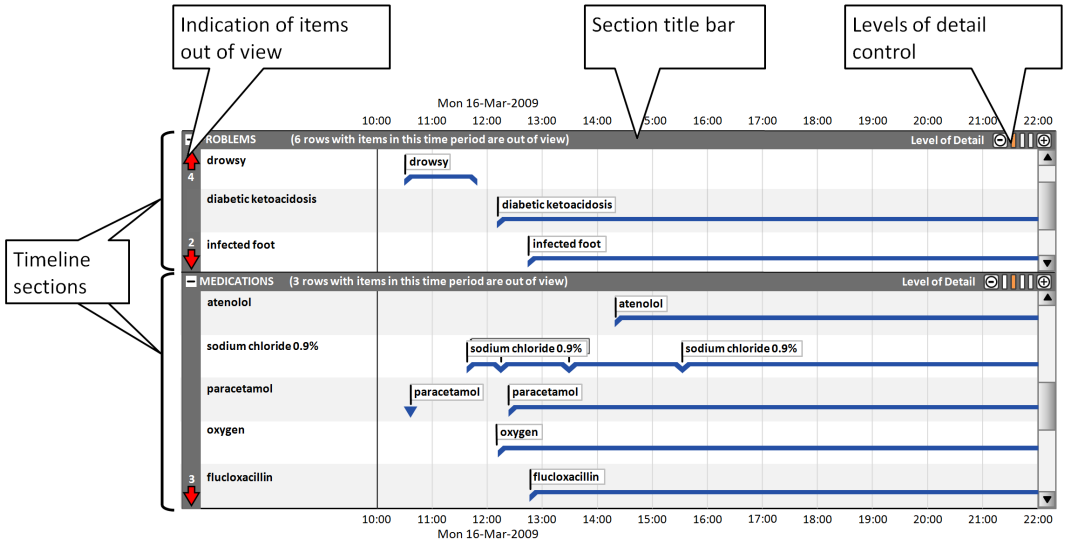


Figure 7: Timeline View Features Covered in this Section

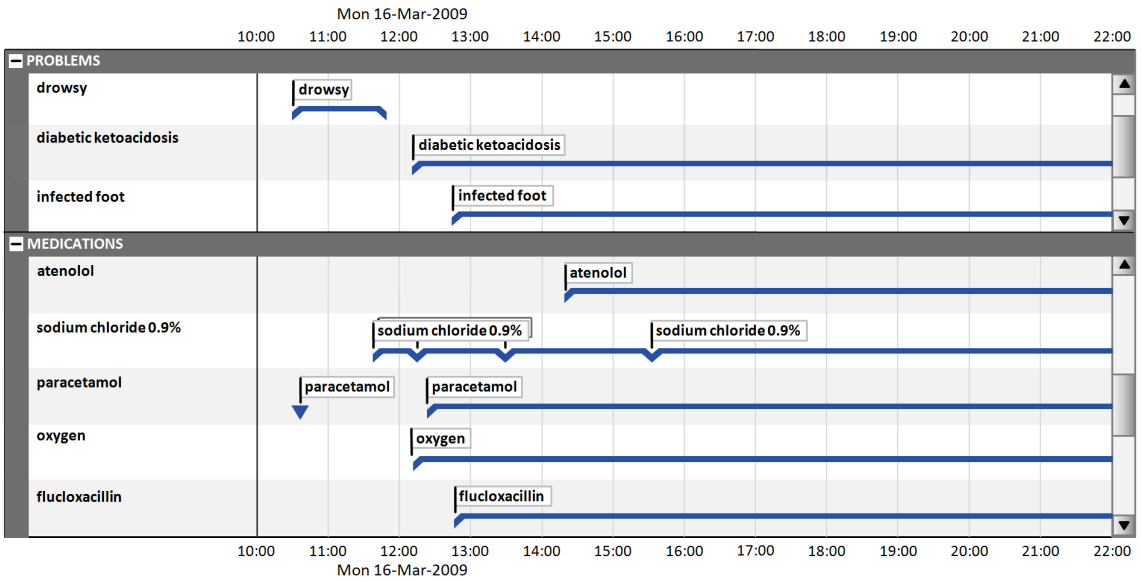
6.2 Guidelines

6.2.1 Timeline Sections

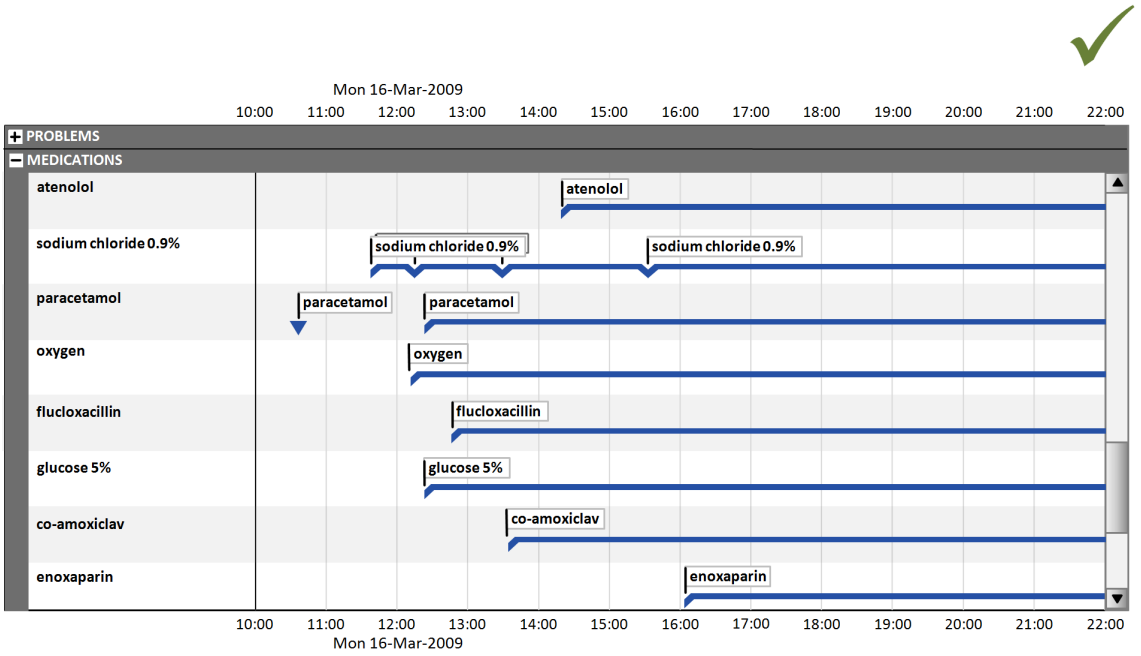
Timeline sections provide a means of partitioning different information into related sets, giving users better control over what parts of the overall timeline canvas they can see at one time within the limitations of the display size.

ID	Guideline	Conformance	Evidence Rating
TLN-0800	Provide the facility to divide the timeline viewing area horizontally into sections. Enable users to vertically resize each section to best display the information they wish to view within the area available.	Mandatory	Medium
TLN-0810	Provide a section title bar positioned at the top of each section, extending across the width of the section.	Mandatory	High
TLN-0820	Provide a control to expand and collapse each section, and position it on the left in the section title bar. On collapsing a section, persist the section title bar but hide the level of detail control and any related event display options and proportionately resize the other sections to fill the available space.	Mandatory	High
TLN-0830	When displaying a complete set of medications for a patient, show them in a dedicated section	Mandatory	Medium
TLN-0840	When displaying graphs, show them in a dedicated section	Recommended	Medium

Usage Examples



In this correct example, two sections ('Problems' and 'Medications') are displayed. Each section has a section heading bar in which the expand/collapse control and section title are located. (TLN-0800, TLN-0810, TLN-0820, TLN-0830)



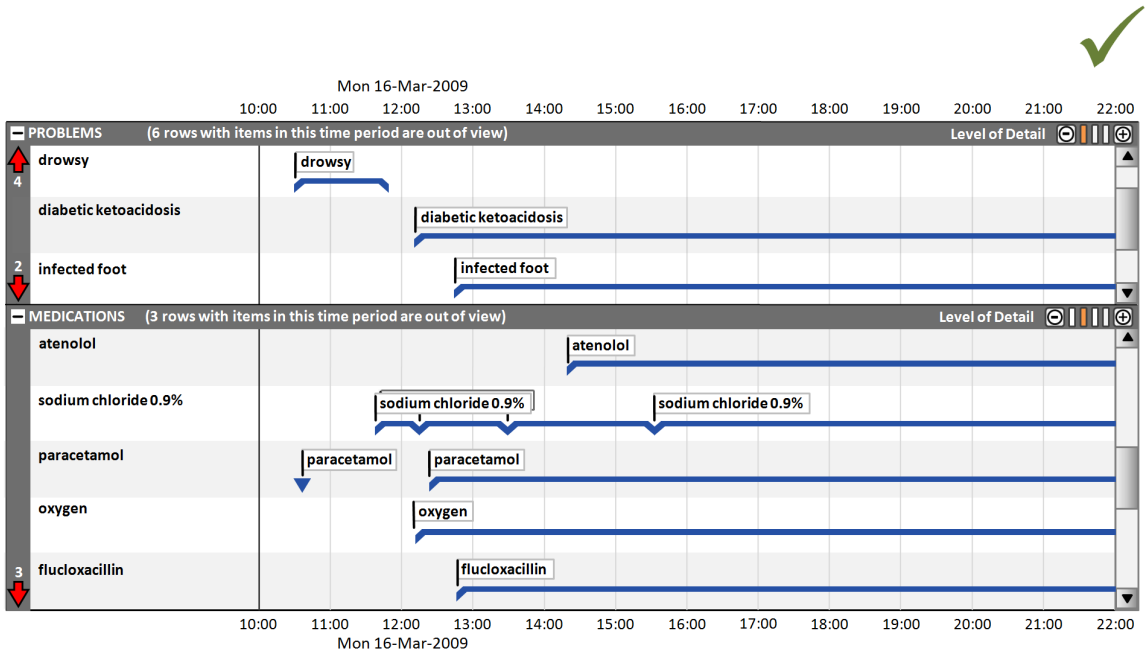
In this correct example, the user has collapsed the 'problems' section that was visible in the previous example. The 'medications' section has moved up to maximise the available space, and three more medication rows are now in view. (TLN-0820)

Rationale
Dividing the viewing area into sections which can then be collapsed and expanded allows the user to quickly focus on different sets of information in a dataset without having to 're-query' the dataset (such as by re-configuring it to show only medications data). It also reduces the need to navigate a large data display (as data displayed will very often be larger than the available viewing window) and facilitates comparison between different sections. Alternative means of achieving these aims are out of scope. However, these would include: filtering, sorting and grouping, and adding, moving or removing data series. **Hazard Risk Analysis Summary:** No mitigated hazards recorded for this area

6.2.2 Indicating Timeline Entries Within the Chosen Time Period That Are Out of View

ID	Guideline	Conformance	Evidence Rating
TLN-0850	When timeline entries within the chosen time period are out of view above or below the currently viewed section, use symbols (for example, up and down arrows) to indicate the direction the user will need to scroll to view the timeline entries that are out of view. Position the symbols towards the upper and lower borders of the section and off the viewing area to avoid obscuring visible timeline entries.	Mandatory	Medium
TLN-0860	Display the number of rows that have entries out of view next to the out-of-view symbols.	Recommended	Medium
TLN-0870	Display the total number of rows that have entries out of view in the section title bar.	Mandatory	High

Usage Examples



In this correct example, in the 'problems' section, the out-of-view arrow symbols indicate that there are four rows above and two rows below the current viewing area that have timeline items in the chosen time period.

In the 'medications' section the out-of-view arrow symbols indicate that there are three rows below the current viewing area that have timeline items in the chosen time period.

The text in each section title bar reinforces the out-of-view indicators. (TLN-0850, TLN-0860, TLN-0870)

Rationale
Given the large amount of data that will be available and the relatively small screen spaces of normal desktop monitors, it will be common to have more data to display vertically than space allows. Previous Microsoft Health CUI work (*Design Guidance – Medications List* **{R7})** concluded that in certain circumstances (such as for a list of medications), a scroll bar is not sufficient indication that data is out of view. The indicators provide a supplementary indication that data is out of view, positioned at the opposite side of the screen to the scroll bar, near to a user's vertical scan line down the row identifier column. The indicator differs from the look-ahead examples in *Design Guidance – Medications List* **{R7}** because: ▪ Summarising entries that are out of view in a horizontal line (such as a list of drug names) is likely to be impractical for many data sets in a Timeline View as they will potentially have hundreds of line items. These items also may not be able to be summarised safely ▪ The medications look-ahead indicator only operates on one list in a view, so it only takes up a maximum of two lines of vertical space (at the top and the bottom of the scrollbar). The Timeline View may have many sections, most of which may have data vertically out of view. If each also had two extra lines of 'data out of view' indicators this would take up a lot of vertical space and further interrupt the vertical scanning of the view. As described in TLN-0840 the timeline indicator already has a means to interrupt a user's vertical scan and alert them to the presence of out of view items Displaying a count of entries out of view is consistent with *Design Guidance – Medications List* **{R7}**. An indication that extends horizontally across the view is more likely to be noticed when user's are scanning down the middle section of the view, and as such is also consistent with the risk mitigation behind the *Design Guidance – Medications List* **{R7}.** **Hazard Risk Analysis Summary:** **Potential Hazards:** ▪ MTI068 User is not aware that data is contained within a category (as it is scrolled out of view) **Mitigations:** ▪ TLN-0850, TLN-0860, TLN-0870 (Indicating timeline entries within the chosen time period that are out of view)

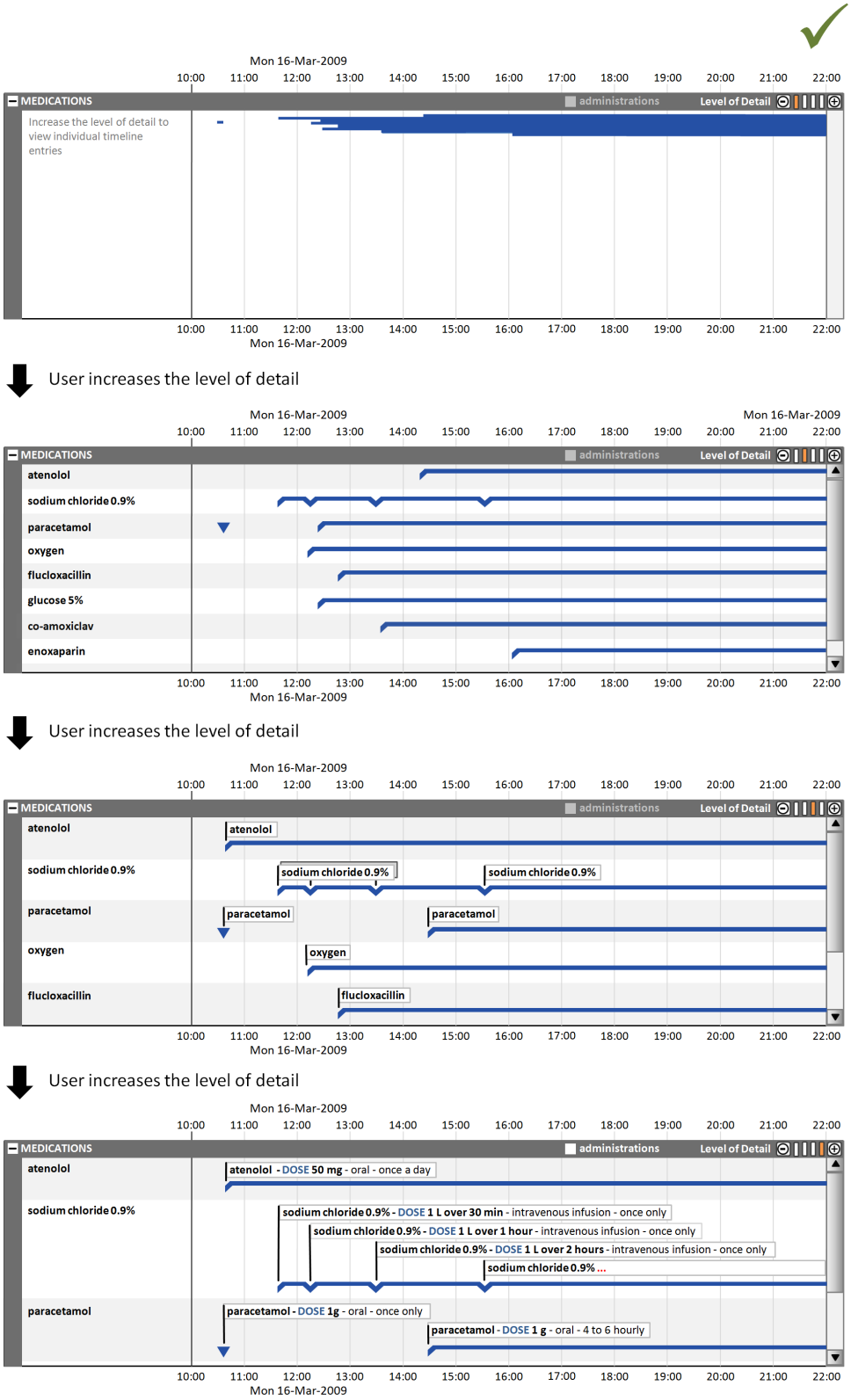
6.2.3 Timeline Section Levels of Detail

Clinicians can make best use of the viewing space available for their task when they can control the level of detail displayed in each timeline section.

For example, clinicians may wish to compare a medication's dose changes (requiring a high level of detail for the 'medications' section) with the patient's health issues (viewable at a lower level of detail for the 'problems' section).

ID	Guideline	Conformance	Evidence Rating
TLN-0880	Provide options to vary the level of detail displayed within each section.	Mandatory	Medium
TLN-0890	Enable the level of detail for each section to be controlled independently of the other sections.	Mandatory	Medium
TLN-0900	Provide a top level of detail that displays a 'thumbnail' of the timeline entries in that section for the chosen time period. For example, construct the thumbnail by using thin horizontal lines for each timeline entry, displayed without any vertical space between them.	Recommended	Medium
TLN-0910	Locate the level of detail control on the right in the section title bar.	Recommended	Low
TLN-0920	Other than for a 'thumbnail' level of detail, always display identifying text for the timelines, either by displaying the timeline entry labels, the row identifier cells, or both.	Mandatory	High
TLN-0930	Apply context specific rules supplied by the appropriate clinical authority to specify the default level of detail for a given data type	Mandatory	Medium

Usage Examples



In this correct example, showing just the 'medications' section from the previous example for clarity, four levels of detail can be seen:

1. Provides an overview of the quantity of medication timeline entries within the chosen time period.
2. Displays the timeline entries and the row identifier cells, but not the timeline labels. This maximises the number of timelines displayed within the available area.

3. Adds timeline labels showing the medication name for further viewing clarity (at the expense of the number of timelines displayed)
4. Adds full medication course details in the labels, and positions the labels in a vertically stacked arrangement to avoid overlap.

(TLN-0880, TLN-0890, TLN-0900, TLN-0910, TLN-0920)

Rationale

Being able to vary the level of detail of timeline item labels was strongly supported by clinician preference and rationale in user research (see APPENDIX B) as the timeline would be used for a variety of purposes. Among other reasons, this was supported for:

- Gaining an overview of past medications in an outpatient consultation
- Seeing how doses of medication have changed during the past 24 hours in an outpatient context

Level of detail can be varied independently per section because:

- Different sections (that is, data types) will have different levels of detail
- Clinicians may wish to compare sections at different levels (for example, comparing a medication's dose changes (high detail) against high-level patient health issues (low detail))

Individual line items are too small to resolve in the 'thumbnail' and so label text would not be appropriate. The 'thumbnail' is intended to provide an indication that data is present in the section not what that data is.

Hazard Risk Analysis Summary:

No mitigated hazards recorded for this area

Significant Risks That Are Not Directly Mitigated by Guidance:

The following risks are not directly mitigated by the guidance in this document. Suppliers should be aware of these risks and design their applications to mitigate them accordingly:

Potential Hazards:	Cause:	Potential Consequences:
▪ MTI181 What if important clinical changes were missed?	▪ Notation for change does not distinguish between 'administrative changes', in which the actual prescription details do not change, and situations in which the actual prescription details do change and the user is not aware	▪ Actual changes (for example, to dose, route, frequency or strength) are missed. Depending on the context, the potential for inappropriate clinical treatment as a result is of varying severity. This could result in: ▪ User confusion, potential delays to clinical treatment and inappropriate picture of clinical care understood by the user ▪ Patient death

7 Guidance Details for Displaying Sets of Related Events

7.1 Introduction

This section provides guidance on the positioning and appearance of sets of events related to timeline entries, including multiple sets.

Often, information related to timeline entries is usefully represented as a set of related events. Figure 8 illustrates how, for medications, three sets of events could be visualised:

- Administrations
- Pharmacy reviews
- International Normalised Ratio (INR) results

By having access to these additional layers of information, the clinician can review the sequence of events and explore potential cause-effect relationships at a more granular level.

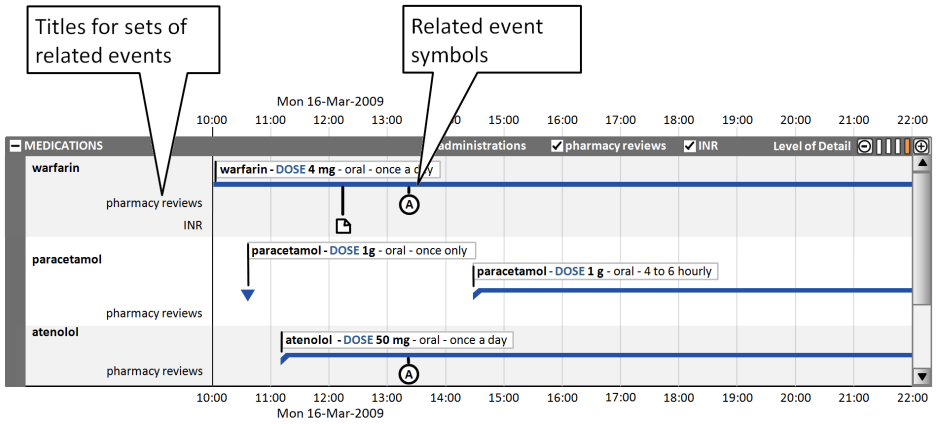


Figure 8: Visualisation of Three Sets of Events for Medications

This section also covers the display of drug administration status as a related attribute set, as shown in Figure 9:

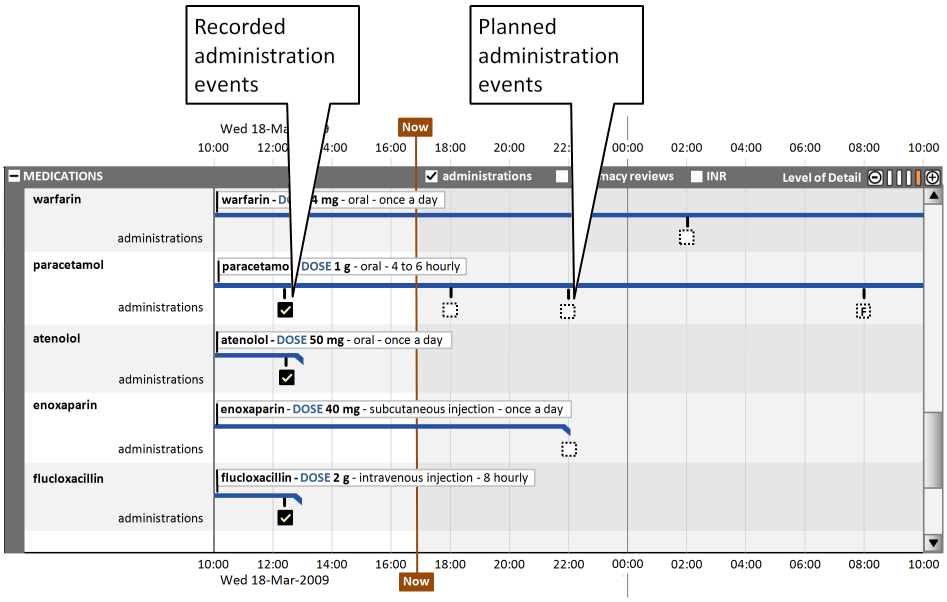


Figure 9: Display of Drug Administration Status as a Related Attribute Set

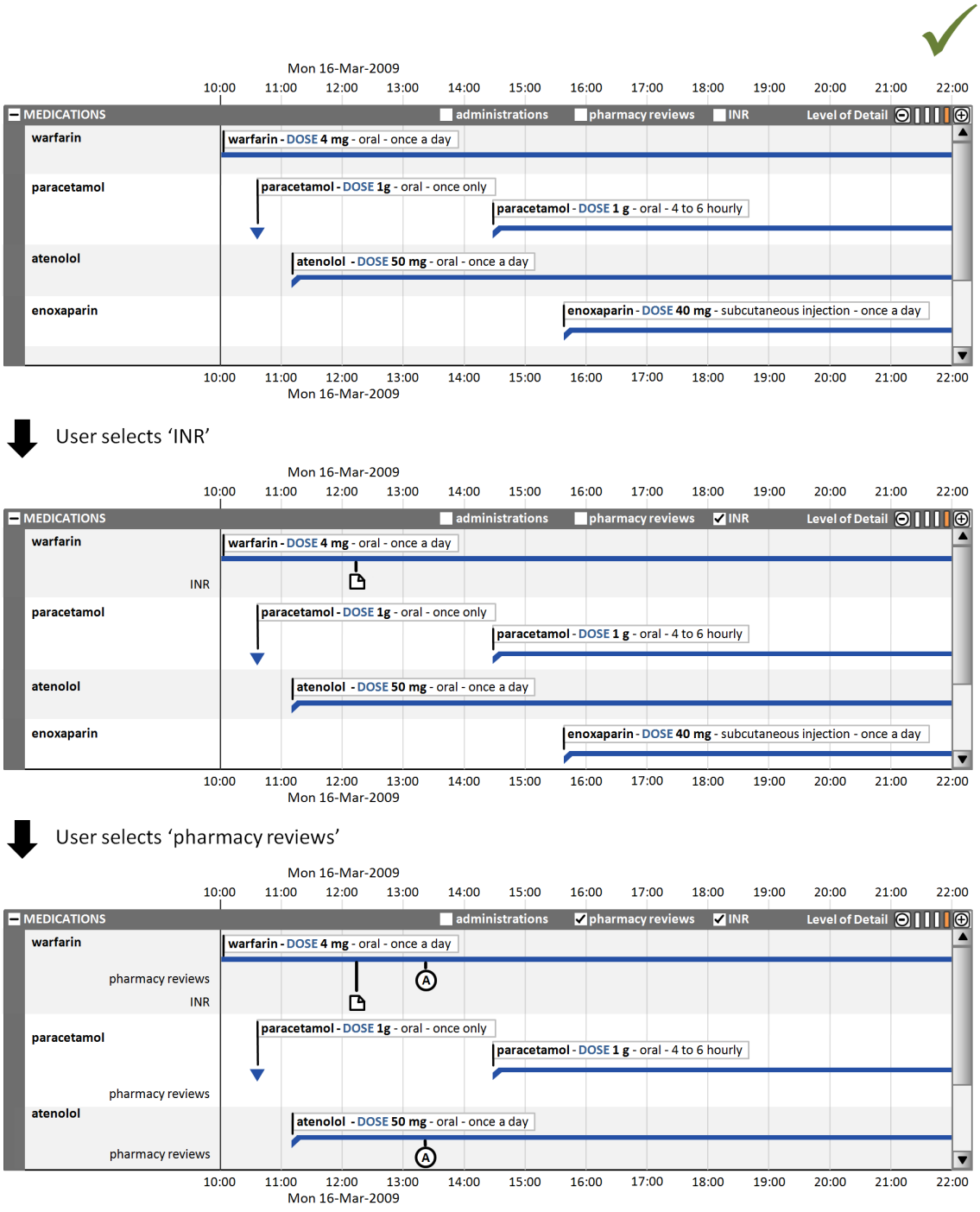
7.2 Guidelines

7.2.1 Displaying Related Events

ID	Guideline	Conformance	Evidence Rating
TLN-0940	When the option to display timeline entry related event sets is supported, group the timeline entries to which the events apply into a timeline section. Provide the facility to reveal or hide the related event sets as a section-wide option. This does not mean that sections can only contain timeline entries that share exactly the same set of related event sets.	Recommended	Medium
TLN-0950	Provide access to event value information (for example, in tooltip help).	Recommended	Medium
TLN-0960	Arrange the related events in a horizontal line below their associated timeline entries. Align the middle of each icon with the time of occurrence of the attribute it represents. Extend a vertical line from the middle of the icon up to the associated timeline.	Mandatory	Low
TLN-0970	When event icons become crowded, apply guidelines TLN-0690, TLN-0700 and TLN-0710.	Mandatory	Low
TLN-0980	Where multiple event sets are displayed in the same timeline section, locate each set on a separate line underneath the associated timeline entry. Extend a vertical line from the middle of the icon up to the associated timeline.	Recommended	Low
TLN-0990	Display each event set name within the row identifier cells, aligned to the attribute icons.	Recommended	Low
TLN-1000	Where the safe display of related event sets is tied to a particular level of detail, when that level of detail is not selected de-select the related event set and disable the control.	Recommended	Low
TLN-1010	Only display medication administration events when the level of detail selected for medications timeline entries has displayed the 'minimum' detail required by the *ePrescribing Functional Specification*[1]	Mandatory	Medium
TLN-1020	Only allow the display of related event sets for timeline entries that have a label displayed in the main timeline viewing area (in that, not just in the row identifier cells)	Recommended	Low

[1] ePrescribing Functional Specification **{R15}**:
http://www.connectingforhealth.nhs.uk/newsroom/news-stories/eprescfunctspec

Usage Examples



In this correct example, the user selects 'INR' and the event for this set is displayed in the warfarin timeline row (INR is only related to warfarin) The document symbol indicates the time of the INR report and could provide further information within associated hover-help.

When the user selects 'pharmacy reviews' the events for this set are displayed under each timeline entry. The circled A symbols indicate the timing of the pharmacy reviews and could also provide an indication of the review conclusion (for example, 'A = accepted'). (TLN-0940, TLN-0960, TLN-0980, TLN-0990).

Rationale

Rationale for being able to show or hide related event sets is the same as for changing the level of detail, in that clinicians may want to use the timeline for a variety of purposes, and therefore change the display to suit their needs. Information that applies 'once' to the whole timeline entry should be displayed as a level of detail (the dose of a medication), whereas information that applies (or may apply) at multiple time points should be displayed in a related event set (for example, the various administrations of that dose). One exception to this example would be where the prescription's dose is defined as 'variable', and a dose calculated, administered and recorded per administration.

The ability to access secondary information about the item without having to leave the Timeline View allows the user to explore the data without the associated disruption (and potential waiting time) of being taken to other record views.

The consistent positioning of the related items relative to the timeline line, and the vertical joining line, reduces the possibility that the user may mistakenly associate the two items. For example, the user might mistakenly associate the successful administration on one medication with another medication.

Hazard Risk Analysis Summary:

Potential Hazards:	Mitigations:
▪ MTI049 What if there is too much information on screen?	▪ TLN-0940 (As with level of detail, showing and hiding attribute sets allows users to customise the display to suit their particular purpose)

Significant Risks That Are Not Directly Mitigated by Guidance:

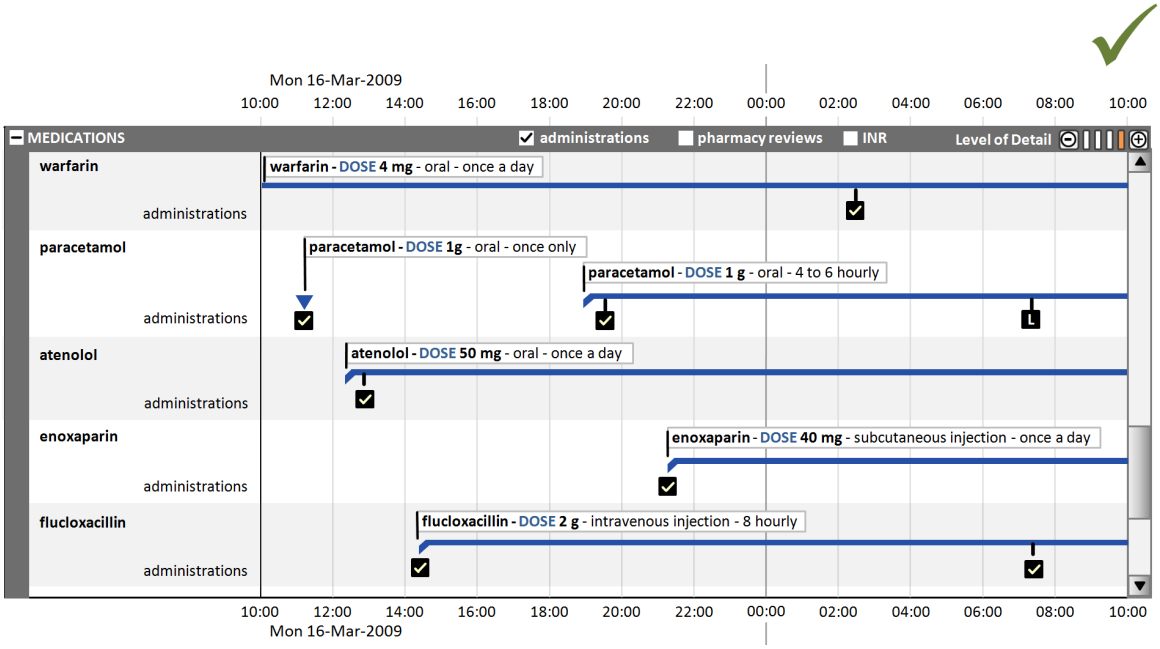
The following risks are not directly mitigated by the guidance in this document. Suppliers should be aware of these risks and design their applications to mitigate them accordingly:

Potential Hazards:	Cause:	Potential Consequences:
▪ MTI184 What if the related events sets (and clues as to their status) are not shown, eg. medication administrations, pharmacy reviews, etc	▪ Guidance does not explicitly contain references to statuses. ISV interpretation and implementation of CUI Medications Timeline design guidance	▪ Statuses, key events are missed. Depending on the context, the potential for inappropriate clinical treatment as a result is of varying severity. In this instance, user confusion, potential delays to clinical treatment and an inappropriate picture of clinical care understood by the user
▪ MTI185 What if the related events sets are shown, eg. medication administrations, pharmacy reviews, etc	▪ Guidance does not explicitly contain references to statuses. ISV interpretation and implementation of CUI Medications Timeline design guidance	▪ For example, the user's ability to see all of the medication information at once would be compromised, leading to a potential for inappropriate treatment with varying consequences

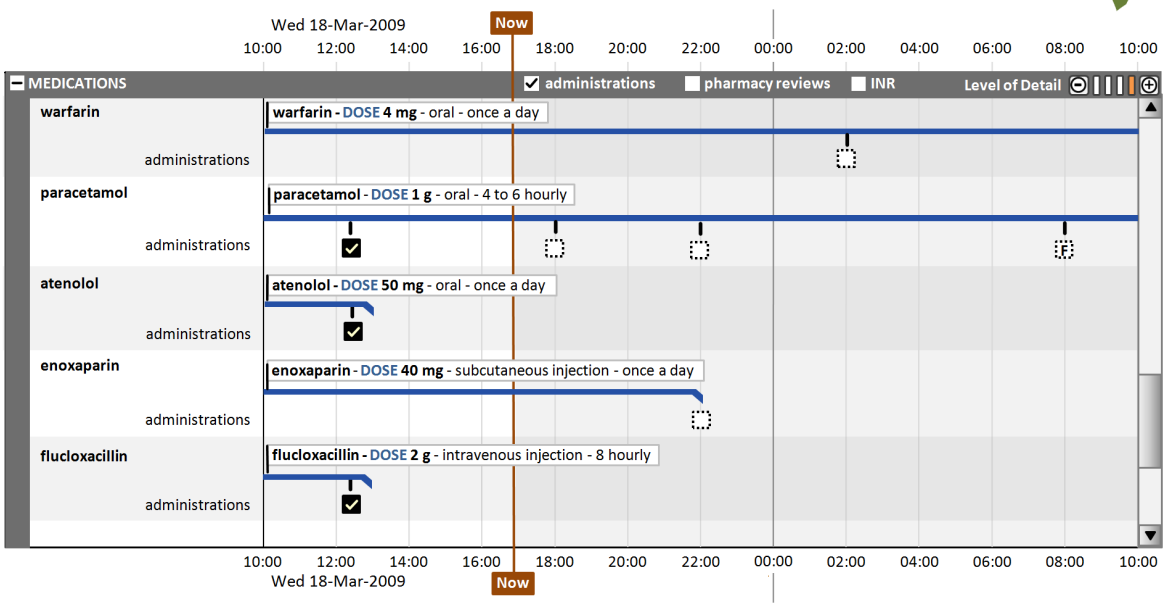
7.2.2 Displaying Drug Administration Information As a Related Set of Events

ID	Guideline	Conformance	Evidence Rating
TLN-1030	Do not use the Timeline View to record medication administrations data. Use the Drug Administration View for this purpose (see *Design Guidance – Drug Administration* **{R5}**)	Mandatory	High
TLN-1040	When displaying drug administration events on a timeline, use iconography and behaviour consistent with that shown in the Drug Administration view (more guidance for this area can be found in *Design Guidance – Drug Administration* **{R5}**).	Mandatory	High
TLN-1050	Position the administration events at the time of actual administration (rather than the time the events were entered into the system). Planned administration events should be positioned at their intended administration time.	Mandatory	Medium
TLN-1060	When the option to display drug administration events as a related set of events is provided, only enable this option when the selected level of detail displays full medication details.	Mandatory	Medium

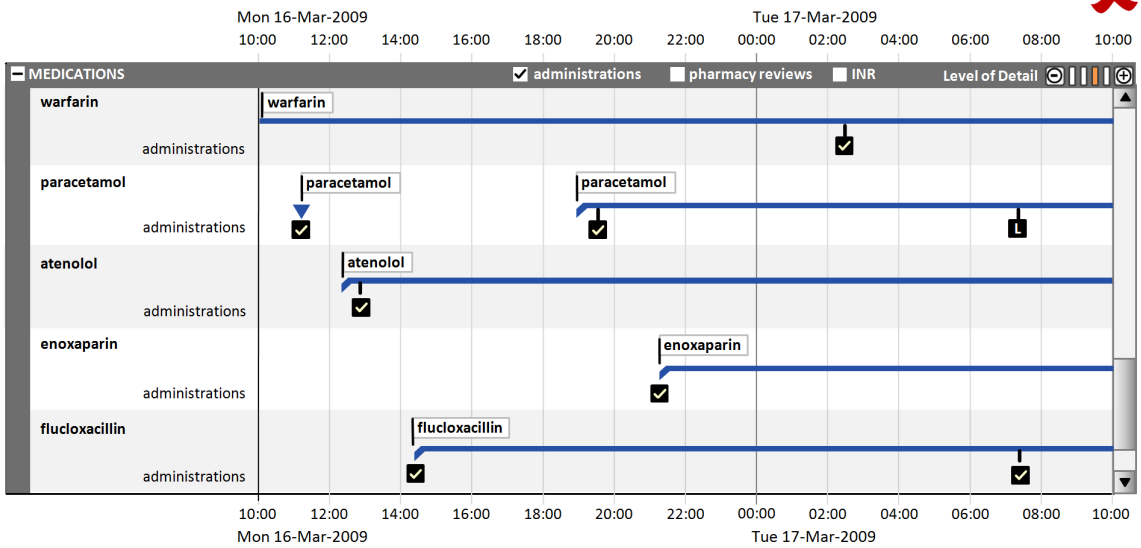
Usage Examples



In this correct example, the 'administrations' event set has been selected. The square icons indicate administration events such as oral doses. The ticks indicate that the drug has been administered on time, whereas the icon with the letter 'L' indicates an administration that occurred later than planned. (TLN-1040, TLN-1050, TLN-1060)



In this correct example, the chosen time period includes past and future. In the future time period, planned drug administrations are shown by their dashed outline. This is consistent with sample iconography guidelines in *Design Guidance – Drug Administration* **{R5}.** (TLN-1040, TLN-1050, TLN-1060)



In this incorrect example, the 'administrations' event set is displayed at a level of detail that does not provide full medication details. This could mislead clinicians into false assumptions (for example, that the three administrations of paracetamol were of equal dose when this might not be the case). (TLN-1060)

Rationale

User research (see APPENDIX B) strongly supported the ability to view medication administration events on a timeline. This allows the clinician to:

- View the real time differences between administrations, something that is more difficult in traditional representations of medication administration information
- View administrations events against patient values, such as inpatient observations. This allows the clinician to see the temporal relationship between the two; for example, to see whether the administrations of antibiotics correspond to a drop in patient temperature, or change in white cell count
- View more medications simultaneously on screen, compared to traditional representations of medication administration

If the data is available, medication administration information must also be made available in a display that complies with *Design Guidance – Drug Administration* **{R5}**.

By following the iconography used in the medications administration view, users will be less likely to mistake the timeline item (such as items with duration) for administration statuses. Users are likely to become more familiar with both views more quickly if the iconography and behaviour is consistent between the views.

Hazard Risk Analysis Summary:

Potential Hazards:

- MTI013 If viewing medications (in an inpatient context), you need to be aware of whether it has been administered or not
- MTI155 If (completed) administration events were plotted at the intended time of administration instead of the actual time of administration, this would give a misleading impression of when medications were administered

Mitigations:

- TLN-1030, TLN-1040, TLN-1050, TLN-0930 (In an inpatient context, it will be necessary to consider whether administration information should be shown by default whenever medication timeline items are displayed)
- TLN-1050 (Position the administration events at the time of actual administration (rather than the time the events were entered into the system). Planned administration events should be positioned at their intended administration time)

8 Guidance Details for Navigating Time

8.1 Introduction

This section contains guidance for adjusting the time range displayed in the timeline viewing area and navigating across the total time range

Whereas previous sections of this document have provided guidance on how to best display and navigate timeline entries for a selected time period, this section considers navigation across the total time period that is available for display.

This guidance covers the selection of the viewed time range, navigation to time periods adjacent to the current time period and larger scale navigation to time points throughout the total time period. Figure 10 illustrates those features:

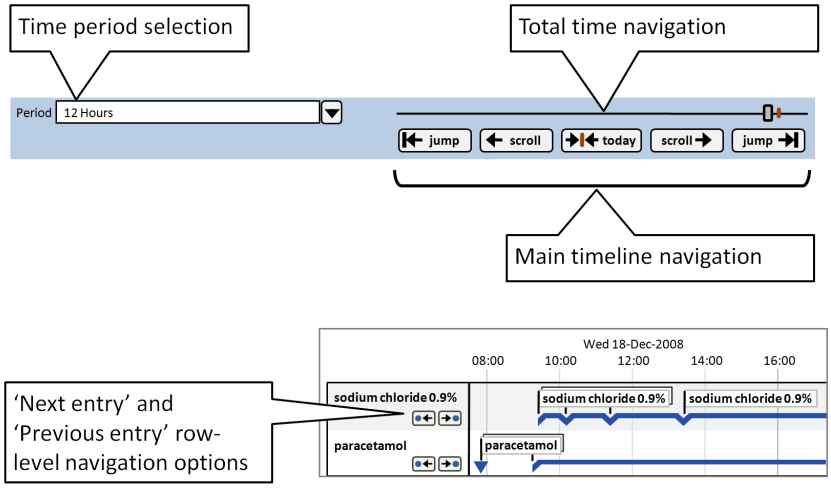


Figure 10: Timeline View Features Covered in this Section

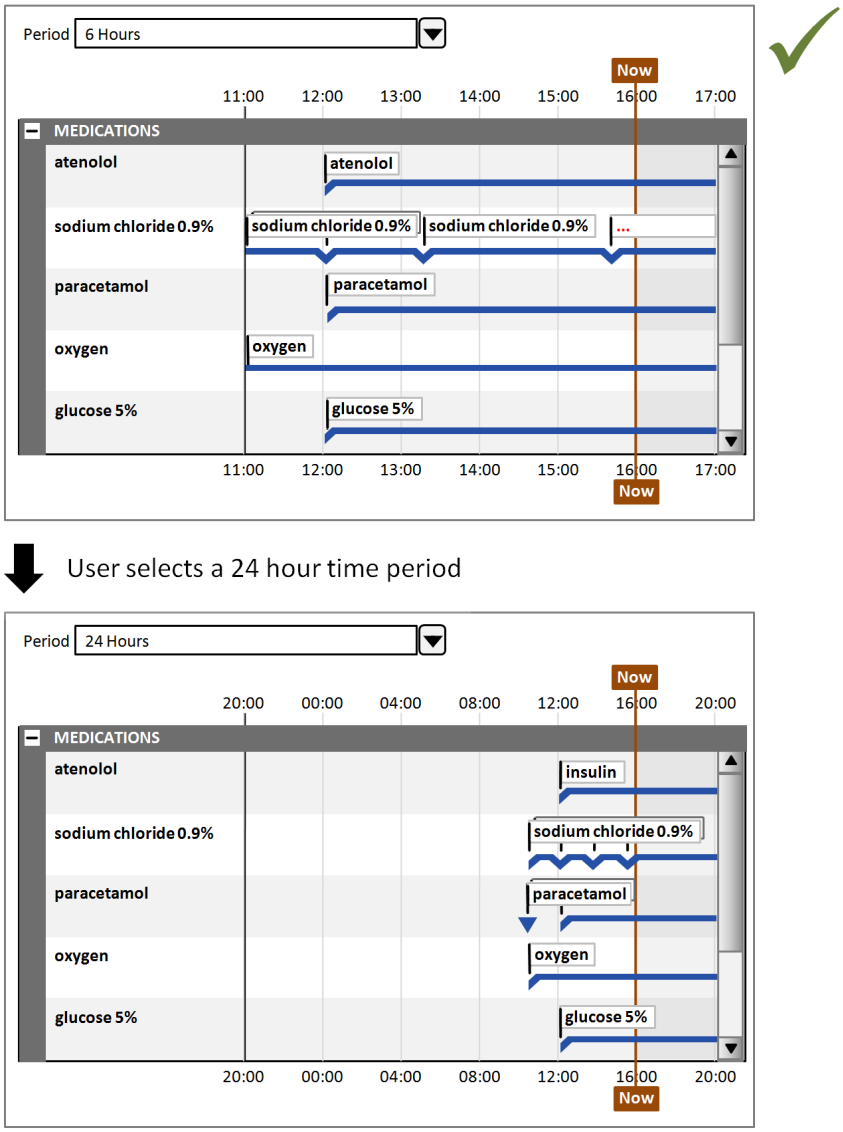
8.2 Guidelines

8.2.1 Adjusting the Viewed Time Period

ID	Guideline	Conformance	Evidence Rating
TLN-1070	Provide a control to select the time period that is displayed in the timeline viewing area. Provide defined time periods that best suit the intended audience (for example, 2 hours, 4 hours, 6 hours, 12 hours, 24 hours, 5 days, 10 days, 1 month, 3 months and so on).	Mandatory	Medium
TLN-1080	When the user selects a new time period, and the 'now' time point is in view, expand or contract the new viewable time period around the 'now' time point, such that it stays in the same position.	Recommended	Medium
TLN-1090	When the user selects a new time period, and the 'now' time point is not in view, expand or contract the new viewable time period around the middle time point in the previously viewed time period.	Recommended	Medium

Usage Examples

In this correct example, when the user changes the time period from 6 hours to 24 hours, the visible time period expands around the middle time point of 12:00. (TLN-1070, TLN-1090)



In this correct example, when the user changes the time period from 6 hours to 24 hours, the visible time period expands around the 'Now' time point (16:00), which stays in the same position. (TLN-1070, TLN-1080)

Rationale

User research (see APPENDIX B) and elicited hazards (below) strongly supported the need to be able to change the time period of the Timeline View, in order to cope with differing uses and data on the timeline. It is also a feature consistent with the *Design Guidance –Displaying Graphs and Tables* **{R4}.**

Hazard Risk Analysis Summary:

Potential Hazards:

- MTI110 The user can't alter the default timescale
- MTI111 The user is not aware how to / is not sufficiently motivated to zoom the relevant part of the timeline, as zooming on a section of data is via a complex mechanism

Mitigations:

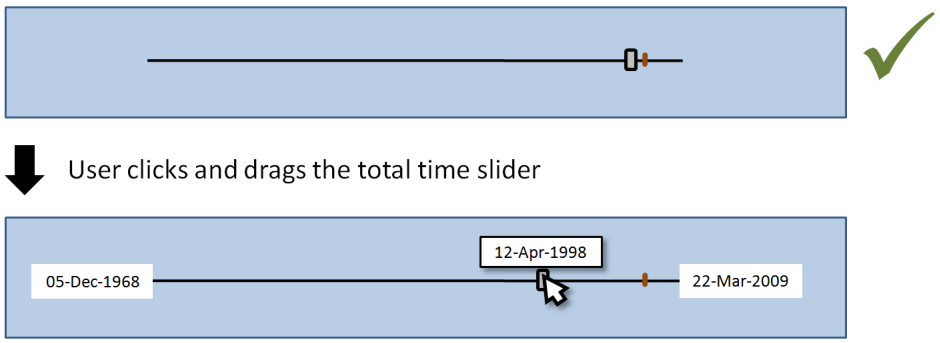
- TLN-1070 (Provide a control to select the time range that is displayed in the timeline viewing area)
- TLN-1070 (Provide a control to select the time range that is displayed in the timeline viewing area)

8.2.2 Timeline Global Navigation Options

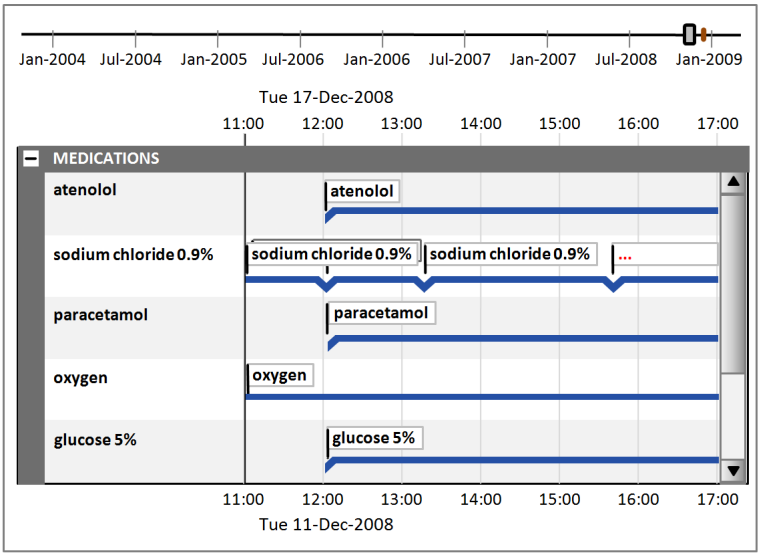
ID	Guideline	Conformance	Evidence Rating
TLN-1100	When the Timeline View is displayed for the first time during a user session, default the displayed time period to include the 'now' time point.	Recommended	Medium
TLN-1110	Provide main time navigation controls that include the facility to scroll earlier or later, to tab in increments equivalent to the chosen time range (for example, 12 hours earlier or later), and to jump to the 'now' time point.	Recommended	Medium
TLN-1120	Provide a 'total time range' navigation control (such as a slider) that gives the user quick access to time periods across the entire time range that the source data spans.	Recommended	Medium
TLN-1130	Do not permanently display time axis labels for the 'total time range' navigation control. Instead, display time axis labels only while the user is interacting with the control.	Mandatory	Medium
TLN-1140	Position the 'total time range' navigation control so that it is not immediately adjacent to the timeline viewing area's time axis	Mandatory	Medium

Usage Examples

In this correct example, main navigation controls are shown with options to scroll, to tab a time period forward or back (labelled 'jump') and to navigate to the 'now' time point (labelled 'today'). The 'total time navigation control' above the main navigation controls does not permanently display its time axis labels. (TLN-1110, TLN-1120, TLN-1130)



In this correct example, when the user interacts with the total time range navigation control, time axis labels are temporarily displayed at each end of the control. Hover-help is also displayed for the position of the control handle. (TLN-1120, TLN-1130)



In this incorrect example, the 'total time navigation control' has a labelled time axis. The user can become confused by the presence of two time scales and may refer to the wrong labels when determining the timing of timeline entries. (TLN-1130, TLN-1140)

Rationale

The ability to navigate the time in view, either by scrolling or tabbing in increments, allows both fast time navigation (by scrolling), and systematic, more cautious or fine-grained movement (by tabbing in increments). Scrolling a dataset (particularly a very large data set) may lead to problems of accidentally overlooking items, or finding it hard to move to exactly the right position without fine motor control. In other words, the scale of the scroll causes the user to continually 'overshoot' his or her target position. This is similar to problems experienced when navigating a vertical list of items in email applications and spreadsheets.

Some interactive timelines from non-clinical domains have the 'total time' axis and the 'time in view' axis displayed vertically adjacent, with time/date values displayed simultaneously. Analysis concluded that this posed a potential source of error where the user mistakenly reads the wrong timescale. Therefore, guidance requires that the two time scales are not shown immediately adjacent, and that the time values for the 'total time' axis are only shown when the user interacts with the control.

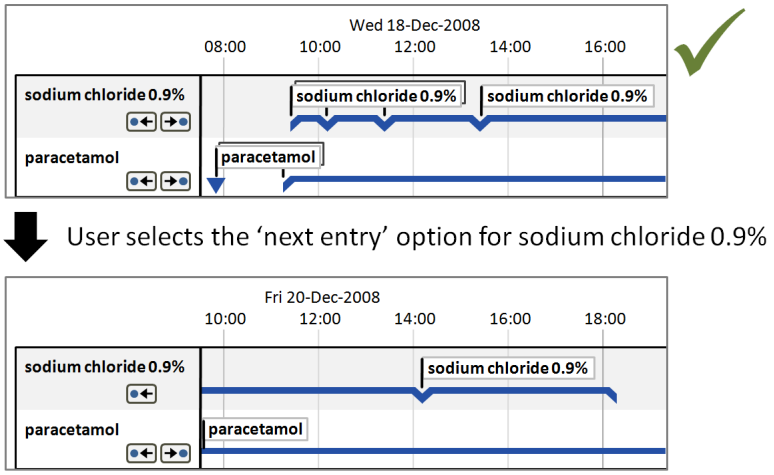
Hazard Risk Analysis Summary:

Potential Hazards:	**Mitigations**:
▪ MTI109 What if the user misinterprets the time of an event on the timeline as they confuse the time navigation control timeline for the real timescale of the Timeline View?	▪ TLN-1130 (By only showing a timescale when it is being interacted with, the navigation timescale is much less likely to be misinterpreted as the real timescale)
▪ MTI115 What if the clinician is unsure what the scale for the timeline navigation control is? (as there is no scale on it)	▪ TLN-1130 (The scale appears when the user interacts with it)
▪ MTI116 What if the clinician is unsure which time period is referred to in the time range control, as there are two timescales (the real view's timescale and the time navigation control's)	▪ TLN-1130 (The scale appears when the user interacts with it)
▪ MTI130 If the view doesn't default to 'now' the clinician may misinterpret the timeline data	▪ TLN-1100 (When the Timeline View is displayed for the first time during a user session, default the displayed time period to include the 'now' time point.)

8.2.3 Timeline Row-Level Navigation Options

ID	Guideline	Conformance	Evidence Rating
TLN-1150	Provide options for each row to navigate to 'next entry' and 'previous entry' beyond the visible time period. This should change the time displayed of the whole Timeline View, not just the row selected.	Recommended	Medium
TLN-1160	Locate the 'next entry' and 'previous entry' options in the row identifier cells. Only display these options when there are horizontally out-of-view timeline entries to navigate to in that row.	Recommended	Medium
TLN-1170	When the user selects a 'next entry' navigation option, refresh the timeline viewing area to show the start of the next timeline entry in the middle of the time period. When the user selects a 'previous entry' navigation option, refresh the timeline viewing area to show the start of the previous timeline entry in the middle of the time period.	Recommended	Medium

Usage Examples



In this correct example, the user selects the 'next entry' option on the 'sodium chloride 0.9%' row, and the visible time period moves forward to display the next entry (at 14:10 two days later) in the middle of the viewing area. In this example there are no later 'sodium chloride 0.9%' entries so the 'next entry' option for this row is hidden. (TLN-1150, TLN-1160, TLN-1170)

Rationale

The ability to navigate in time based on the data per row enables the clinician to quickly answer questions like:

- "When did the patient previously have a prescription for ampicillin?" (if there is a prescription for ampicillin in view)
- "What medication was the patient prescribed the last time they came in with ketoacidosis?" (by navigating from a current health issue to a previous occurrence then comparing to the medications prescribed at the same time)

Hazard Risk Analysis Summary:

Potential Hazards:

- MTI131 What if the 'previous entry' row navigation jumps the user to the previous item and the user mistakenly thinks both are part of one long continuous one?

Mitigations:

- TLN-1150 (The navigation moves to the start and end points of each timeline item rather to always the start or always the end, thereby showing up any discontinuity in the lines)

9 Document Information

9.1 Terms and Abbreviations

Abbreviation	Definition
CUI	Common User Interface
EMS	Event Management System
ENT	Ear, Nose and Throat
HCP	Health Care Professional
INR	International Normalised Ratio
ISMP	The Institute for Safe Medication Practices
ISO	International Organization for Standardization
LoD	Level of Detail
NHS	National Health Service
NHS CFH	NHS Connecting for Health
NPfIT	National Programme for Information Technology
NPSA	National Patient Safety Agency
UI	User Interface
VDT	Visual Display Terminal
WHO	World Health Organization

Table 7: Terms and Abbreviations

9.2 Definitions

Term	Definition
Conformance	In the guidance tables, indicates the extent to which you should follow the guideline when defining your UI implementation. There are two levels: ▪ **Mandatory** – An implementation should follow the guideline ▪ **Recommended** – An implementation is advised to follow the guideline
Current best practice	Current best practice is used rather than best practice, as over time best practice guidance may change or be revised due to changes to products, changes in technology, or simply the additional field deployment experience that comes over time.

Evidence Rating	In the guidance tables, summarises the strength of the research defining the guideline and the extent to which it mitigates patient safety hazards. There are three ratings (with example factors used to determine the appropriate rating):
	▪ **Low:**
	  ▪ Does not mitigate specific patient safety hazards
	  ▪ User research findings unclear and with few participants
	  ▪ Unreferenced usability principles indicate the design is not significantly better than alternatives
	▪ **Medium:**
	  ▪ Mitigates specific patient safety hazards
	  ▪ User research findings clear but with few participants

Term	Definition
	▪ References old authoritative guidance (for example, from the UK-based National Patient Safety Agency (NPSA), Institute for Safe Medication Practices (ISMP) or World Health Organization (WHO)) that is potentially soon to be superseded ▪ Referenced usability principles indicate the design is significantly better than alternatives ▪ **High:** ▪ Mitigates specific patient safety hazards ▪ User research findings clear and with a significant number of participants ▪ References recent authoritative guidance (for example, from the UK-based NPSA, ISMP or WHO) ▪ Referenced usability principles indicate the design is significantly better than alternatives

Table 8: Definitions

9.3 Nomenclature

This section shows how to interpret the different styles used in this document to denote various types of information.

9.3.1 Body Text

Text	Style
Code	`Monospace`
Script	
Other markup languages	
Interface dialog names	**Bold**
Field names	
Controls	
Folder names	Title Case
File names	

Table 9: Body Text Styles

9.3.2 Cross-References

Reference	Style
Current document – sections	Section number only
Current document – figures/tables	Caption number only
Other project documents	*Italics* and possibly a footnote
Publicly available documents	*Italics* with a footnote
External Web-based content	*Italics* and a hyperlinked footnote

Table 10: Cross-Reference Styles

9.4 References

Reference	Document	Version
R1.	Nielsen, J: Usability Engineering, 1993	1993
R2.	Shneiderman, B: Designing the User Interface – Strategies for Effective Human-Computer Interaction, 1998	Third Edition
R3.	British Standards Institute, BS EN ISO 9241-10: 1996 Ergonomic requirements for office work with visual display terminals (VDTs) – Part 10: Dialogues principles	1996
R4.	Design Guidance – Displaying Graphs and Tables	2.0.0.0
R5.	Design Guidance – Drug Administration	2.0.0.0
R6.	Design Guidance – Medication Line	2.0.0.0
R7.	Design Guidance – Medications List	1.0.0.0
R8.	Aligning temporal data by sentinel events: discovering patterns in electronic health records. In Proceeding of the Twenty-Sixth Annual SIGCHI Conference on Human Factors in Computing Systems – Wang, T. D., Plaisant, C., Quinn, A. J., Stanchak, R., Murphy, S., and Shneiderman, B. 2008	2008
R9.	Gaining New Medical Insights through Interactive Visual Exploration – Aigner, Miksch	
R10.	LifeLines: Using Visualization to Enhance Navigation and Analysis of Patient Records - HCIL Technical Report 1998 – Plaisant, Mushlin, Snyder, Heller, Shneiderman	1998
R11.	LifeLines: Visualizing Personal Histories – ACM CHI 1996 – Plaisant, Milash, Rose, Widoff, Shneiderman	1996
R12.	TimeLine: Visualizing Integrated Patient Records – IEEE Trans. On Information Technology in Biomedicine, Vol. 11, No. 4, July 2007 – Bui, Aberle, Kangarloo	July 2007
R13.	Viewing personal history records: A comparison of Tabular format and graphical presentation using LifeLines – Alonso, Rose, Plaisant, Norman	1997
R14.	Design Guidance – Search and Prescribe	1.0.0.0
R15.	ePrescribing Functional Specification: http://www.connectingforhealth.nhs.uk/newsroom/news-stories/eprescfunctspec	1.0

Table 11: References

APPENDIX A USABILITY PRINCIPLES

A.1 Nielsen's Usability Heuristics

See *Usability Engineering* **{R1}** for more information on these principles:

- Visibility of system status
- Match between system and the real world
- User control and freedom
- Consistency and standards
- Error prevention
- Recognition rather than recall
- Flexibility and efficiency of use
- Aesthetic and minimalist design
- Help users recognise, diagnose, and recover from errors
- Help and documentation

A.2 Shneiderman's Eight Golden Rules of Interface Design

See *Designing the User Interface – Strategies for Effective Human-Computer Interaction* **{R2}** for more information on these principles:

- Strive for consistency
- Enable frequent users to use shortcuts
- Offer informative feedback
- Design dialogs to yield closure
- Offer error prevention and simple error handling
- Permit easy reversal of actions
- Support internal locus of control
- Reduce short-term memory load

A.3 ISO 9241: Characteristics of Presented Information

See *Ergonomic requirements for office work with visual display terminals (VDTs) -- Part 10: Dialogues principles* **{R3}** for more information on these principles:

- Clarity (the information content is conveyed quickly and accurately)
- Discriminability (the displayed information can be distinguished accurately)
- Conciseness (users are given only the information necessary to accomplish the task)
- Consistency (the same information is presented in the same way throughout the application, according to the user's expectation)
- Detectability (the user's attention is directed towards information required)
- Legibility (information is easy to read)
- Comprehensibility (meaning is clearly understandable, unambiguous, interpretable and recognisable)

APPENDIX B STUDY ID 33: EXECUTIVE SUMMARY

B.1 Abstract

The UK National Health Service (NHS) Common User Interface (CUI) programme is a partnership between Microsoft® and NHS Connecting for Health (NHS CFH), which is part the NHS National Programme for Information Technology (NPfIT).

As part of CUI, the Clinical Applications and Patient Safety (CAPS) Project has the goal of ensuring that software applications used by the NHS enhance patient safety. To achieve this, CAPS provides software developers with user interface design guidelines derived through a user-centric development process that includes explicit patient-safety evaluations.

This summary describes key findings from user research carried out in April 2009 by the CUI CAPS team on the display of clinical data in a Timeline View. These findings are a subset from a larger internal report prepared for the CUI CAPS Timeline team.

Purpose:

To gain clinical feedback on design concepts for Timeline Views of clinical data (primarily medications) in electronic systems.

Method:

Interviews: structured interviews with 13 Health Care Professionals (HCPs) eliciting HCP preferences and qualitative feedback on design alternatives.

Key Results:

Based on clinician preference and rationale:

- The distinction between prescription item and medication administration items should be clearer
- Options for alternative marking of future duration items should be considered, including having the same representation for past and future
- The canvas background should mark a distinction between past and future. However, this should be subtle and take into account readability of all the elements on the canvas (including gridlines)
- The ability to view labels both inline and in a left column should be considered
- The ability for the clinician to vary the level of detail and line identity should be retained (for example, the ability to aggregate prescriptions to the 'drug name' level)
- Further methods for reorganising large datasets and indicating data out of view should be explored

B.2 Research Objectives

To gather HCP design preferences and qualitative feedback on, and to identify possible patient safety hazards with, CUI Timeline View designs.

B.3 Research Design

Interviews were structured, lasted one hour and carried out in person or by telephone. Participants were taken through wireframe design alternatives for each area of investigation and a Microsoft® Office Excel® mock-up, and then asked for preference based on patient safety criteria. Other qualitative feedback was elicited covering:

- Rationale for preference
- Design fit with current and best practice
- Design understandability
- Any potential hazards resulting from the designs.

Detailed notes from the interviews were qualitatively analysed using thematic coding.

B.4 Results

B.4.1 Participant Description

13 participants were interviewed separately. Each had either volunteered through the NHS CFH Event Management System (EMS) signup or had been recruited by an HCP who had volunteered. Four out of 13 participants had previously taken part in CUI clinical engagement for other work areas. Table 12 shows a summary of the participants' profiles:

Session	Job Role	Specialty	Level	Site	Systems Used
389	Nurse Practitioner	Emergency	Senior	Walk-in centre	Various
390	Nurse Practitioner	Renal Outpatients	Senior	Large Hospital A	PAS, Path, PACS
391	Doctor	Surgery	CT1	Teaching Hospital A	PAS, Path, PACS, eTTAs
392	Pharmacist and Analyst	Systems	Senior	Teaching Hospital B	PICS and various
393	Doctor	Obstetrics and Gynaecology	F1	Teaching Hospital C	PAS, Path, PACS, eTTAs, iSOFT® Synergy, EMIS® LV™,
394	Doctor	Obstetrics and Gynaecology	F1	Teaching Hospital C	PAS, PACS, Path, iSOFT i.Clinical Manager
395	Doctor	Obstetrics and Gynaecology	F1	Teaching Hospital C	PAS, PACS, Path
396	Doctor	Obstetrics and Gynaecology	F2	Teaching Hospital C	PAS, PACS, Path, EMIS, INPS Vision
397	Pharmacist	?	Senior	Teaching Hospital C	PAS, PACS, Path, eTTAs, iMDsoft® MetaVision
398	Nurse	Stroke	?	DGH	PAS
399	Doctor	Ear, Nose and Throat (ENT)	Research Fellow	DGH	PAS, PACS, Path
400	Doctor	Clinical Pharmacology	Research fellow	Large hospital B	PAS, PACS, Path, eTTAs, an ePrescribing system
401	Nurse	ENT	Sister	DGH	PAS

Table 12: Interview Participants

All participants were clinical staff who had experience of viewing clinical data such as medications in an inpatient setting. Participants were scoped to hospital and acute care (and mainly inpatient care) as per the scope and example datasets for the CUI timelines work.

The 10 hospital and acute care participants were from a number of different trusts different trusts, with diverse geographical locations.

All participants had used some kind of electronic patient record, though only one (participant 397) had used electronic timeline displays of clinical data before. The majority had medium computer experience, where high experience includes items such as being familiar with spreadsheet calculation functions and having an understanding of databases.

B.4.2 Design Areas

Bullet text *in italics* represents researcher recommendations or comments in order to distinguish them from user feedback.

Duration Items – General

- Participants made various errors in misinterpreting the 'prescription' duration items as medication administration status indicators:
  - *Therefore, continue to allow the display of medication administration items (to clarify the ambiguity)*
  - *Consider how the ambiguity could be further clarified (for example, with a default setting for inpatient contexts that showed medication administration whenever showing medication data)*
- One participant assumed an item start date was when the item appeared on screen on the left:
  - *Ensure it is clear where items start or stop*

Duration Items – Future Items

- Examples of different styling for 'future' items raised a variety of feedback, with concerns raised about items potentially being mistaken as 'progress bars', or wide-dotted items as separate events, and more complex styling resulting in an overly 'busy' view
- Several participants suggested that planned items (such as prescriptions) should not look different in the past and future as the *plan* to have them was certain, even though the future is by nature uncertain:
  - *Therefore, consider the potential risks of misinterpretation. If the line does change it might be more likely to be misinterpreted as a status indicator*
  - *Consider the balance between redundant cues and overall visual weight (that is, if future is already conveyed by a canvas background change, is line styling change necessary?)*

Discrete Items

- Some icons are potentially confusable with others:
  - *Reduce sharing of visual attributes between icon types*
- Neither option presented for dealing with crowded icons was deemed to be that clear:
  - *Continue to explore, incorporating 'squashing tolerance' work from the* Displaying Graphs and Tables – User Interface Design Guidance **{R4}** *document*
- *Though the indication of overdue items was commented on favourably, further consistency with the* Medications Management – Drug Administration – User Interface Design Guidance **{R5}** *should be explored*

Canvas Background

- 11 of 12 participants supported having a background shade distinction between past and future. This was both to draw attention to 'now' and to provide extra cues as to whether an item was past or future:
  - *Continue to provide a background shade distinction*
- Opinion was divided on what shades to use for current and past, mainly based on metaphorical reasoning "the future is a blank slate":
  - *Consider readability implications for using shaded and/or coloured background (for example, darker backgrounds may make it harder to read items and hide gridlines)*

Labels

- Most participants preferred having labels both 'inline' (to improve the association between the lines and labels) AND in a left column (to allow for ease of scanning the list and familiarity with current representations of medication lists):
  - *Strongly consider ability to display both 'inline' AND 'left' labels*

Continuous Administration

- Participants made various errors due to the word 'continuous':
  - *ePrescribing team to consider naming issue*

Thumbnail

- Two participants initially assumed the thumbnail indicated medications started 20 years before they had:
  - *Consider how to mitigate this error*
  - *The thumbnail also continually takes up space, which might be better used for the main data display*

Active and Inactive

- Participants mistakenly interpreted the red and green colours representing active and inactive:
  - *Do not use red and green to indicate status change*
- Several participants mistakenly assumed only a few medications were current and/or active:
  - *Consider how to indicate that other medications are out of view*
  - *Consider visual distinction of active and inactive items*

Level of Detail and Line Identity

- All participants felt that Level of Detail (LoD) 2 (aggregating lines to the drug name level with full prescription details hidden) was a useful addition to LoD 4 (seeing each prescription as a separate line with full drug details):
  - *Continue to allow the line identity and level of detail to be varied by the clinician*
- Some participants were concerned at being able to see medications without administration information as this is not current practice in inpatient hospital and acute care:
  - *Consult with the CUI medications team*

Item Changes

- Though 5 of 10 participants did not initially understand the meaning of the markers to indicate item change (in this case, a change in prescription), once understood all supported the need to clearly mark this:
  - *Continue to display markers of item change when line identity is shrunk*

Representing 'Health Issues'

- Many issues were raised about the representation of patient problems/health issues, especially regarding line identity, '?' problems and the differences between symptoms and diagnoses:
  - *Consider these issues in future clinical noting work*
- Being able to vary line identity helped participants understand the nature of the problems:
  - *Consider these issues in future clinical noting work*

Navigation and Large Datasets

- Navigating the large (and arguably more realistic) dataset was very problematic for the few participants it was shown to:
  - *Consider guidance on minimising the amount of vertical space each row takes up to get more in a single screen*
  - *Continue to explore other methods for reorganising data (for example, filtering, sorting and grouping) and for indicating data out of view*