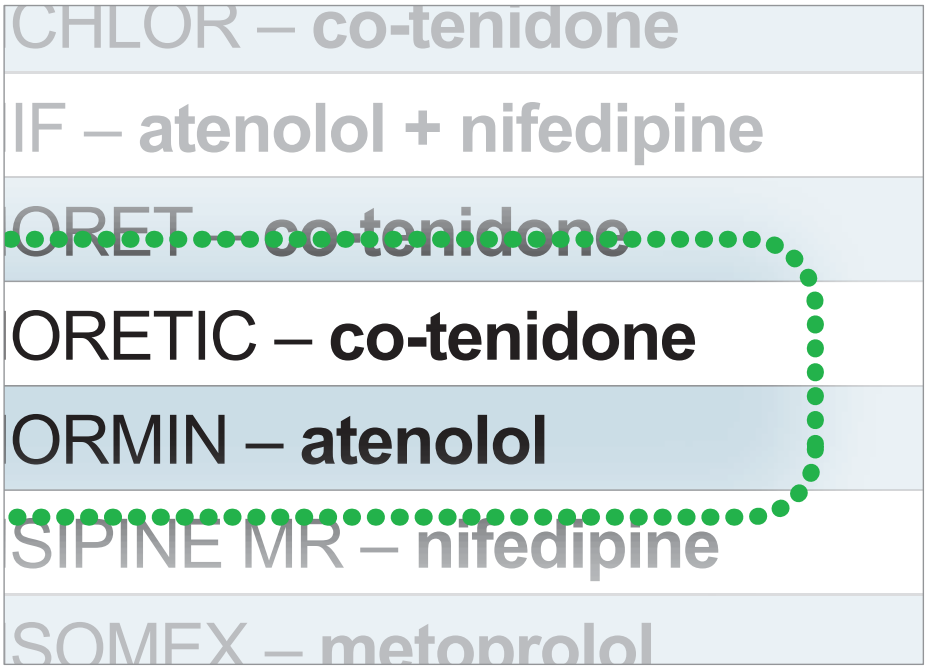
NHS
National Patient Safety Agency
National Reporting and Learning Service

Design for patient safety

Guidelines for safe on-screen display of medication information

Edition 1
2010



NHS
Connecting for Health

About this publication

This booklet is one of a series of design publications produced by the National Patient Safety Agency (NPSA).

This booklet is the result of a collaboration between the NPSA, NHS Connecting for Health (NHS CFH) Electronic Prescribing (ePrescribing) programme and the Common User Interface (CUI) programme (run jointly by NHS CFH and Microsoft).

Its purpose is to allow those developing, assessing and procuring IT systems for medications management and electronic prescribing to:

- quickly and easily understand how good design can contribute to patient safety;
- apply the recommendations during software development and iteration;
- evaluate systems during procurement.

A wide range of stakeholders contributed to the review process, including pharmacists, doctors, nurses, NHS agencies and experts in the field of IT usability and user interface design.

The text was written by Ann Slee (Clinical Lead, NHS CFH ePrescribing programme) and Kit Lewis (User Experience Lead, NHS CFH ePrescribing programme).

The illustrations (produced by Kit Lewis) are fictitous depictions of how a hospital-based electronic prescribing system might look if based on NHS CFH ePrescribing and CUI guidance, using data from the NHS Dictionary of Medicines and Devices (dm+d).

Contents

Foreword

At times when reading this booklet, you may wonder 'Will anyone ever really misread or misinterpret this? It looks perfectly clear to me.' But, in many cases, we see what we expect to see because we've already seen those things many times before, and we may overlook minor visual differences as a result.

In everyday life, in the vast majority of situations, a misreading error will only ever have very minor consequences. However, this is not the case in healthcare where, because of the context and situations, it can be more challenging to avoid misreading errors. Often practitioners are under pressure to multi-task and have competing demands on their time. They must operate in emotionally charged environments, making key decisions rapidly and without the benefit of full information.

Even though the chances of an individual misreading error may be very low, the consequences of one may (with a combination of other mishaps) be severe, even fatal. Taken together with the huge volume of activity (200 million prescriptions in hospitals in England per annum), even an error with a very low probability will result in tens or hundreds of patients being harmed each year.

This is perhaps the main reason for the existence of this booklet and all the existing research and guidance it summarises. It underpins why such minute precautions should be taken with the design and usability of computer systems displaying safety-critical medications information.

Martin Stephens
National Clinical Director for Hospital Pharmacy, Department of Health, England

Medication errors are all too common in healthcare, and can result in harm. Many countries are at some point in the transition to electronic prescribing, which has the potential to dramatically improve medication safety, both inside the hospital and outside it. However, simply prescribing electronically does not ensure that prescribing errors will not occur. Electronic prescribing systems must be designed well to minimise the likelihood of these errors. However, our group's research, as well as that of others, demonstrates that such errors are still all too frequent with early electronic prescribing applications.

A key precept of improving safety is that it should be easy to do the right thing, and enabling this demands that systems follow the principles of human factors. This set of design recommendations – if taken up – has the potential to eliminate a host of errors which occur in today's systems. Most systems today do not adhere to all these principles. Doing so will not eliminate many of the most important errors – for example choosing too high a dose (which will require additional checks) – but it will represent a very important step in the right direction, and make a large number of errors much less likely to occur.

David W. Bates
Director, Center for Patient Safety Research and Practice, Brigham and Women's Hospital, Boston, US

External Program Lead for Research, World Alliance for Patient Safety, World Health Organization

Introduction

Healthcare Information Technology (HIT) has great potential to improve the way in which medicines information is communicated among healthcare professionals, and between healthcare professionals and patients.

However, a variety of confounding factors can hinder this potential from being fully realised. One of these is the way that information held within HIT systems is displayed on-screen. Unclear, incomplete or confusing displays can increase the possibility of people making mistakes, potentially resulting in harm to patients.

The aim of this booklet is to present, in an easily-accessible format, guidance for the on-screen display of medicines information.

The recommendations are intended for use primarily by the following groups working within the NHS in England, however, they are intended wherever possible to be applicable in the rest of the UK and internationally:

- HIT software vendors;
- groups evaluating, procuring and configuring HIT software;
- patient safety and risk management professionals.

The material within this booklet is based on background material assembled from a broad variety of sources (see 'Further reading' for a complete list):

- A review of existing research and guidance in the field of medication information design;
- Design guidance published by the NHS Common User Interface (CUI) Clinical Applications and Patient Safety programme (subsequently referred to as 'CUI guidance');
- Good practice for prescription writing as detailed in the British National Formulary (BNF);
- Guidance issued by the NHS Connecting for Health (NHS CFH) Electronic Prescribing (ePrescribing) programme;
- Existing publications, policies and standards.

It should be noted that this booklet supplements the detailed guidance contained within many of these sources. It is not intended as a replacement for them.

The illustrations use the NHS Dictionary of Medicines and Devices (dm+d) as the standard formulary and terminology for all medicines information, including drug names, descriptions of routes of administration, formulations and other components of a prescription. They comply with both CUI guidance and NHS CFH guidance for the implementation of dm+d in hospital settings within the NHS in England. However, the recommendations themselves are intended to be applicable across all care settings.

The issues and recommendations demonstrate how to avoid misinterpretation of electronic prescriptions. They address known errors identified from both handwritten and electronic prescriptions, and suggest ways in which these can be avoided in future.

Readers are cautioned that the design of HIT systems is a rapidly-evolving discipline, and guidance such as this will need to be amended and added to over time as experience in the use of electronic prescribing systems grows. This is particularly true in hospital settings within the NHS, where use of HIT is (at the time of writing) still relatively limited.

For more information and guidance on the design of electronic prescribing systems:
www.connectingforhealth.nhs.uk/eprescribing

For more information on guidance and alerts issued by the National Patient Safety Agency (NPSA): **www.nrls.npsa.nhs.uk/resources**

Checklist of design recommendations

1. Drug names

Key to sources
CUI - NHS Connecting for Health Common User Interface programme (England) **www.cui.nhs.uk**
DH - Department of Health (England) **www.dh.gov.uk**
FDA - Food and Drug Administration (US) **www.fda.gov**
ISMP - Institute for Safe Medication Practices (US) **www.ismp.org**
MDU - Medical Defence Union (UK) **www.the-mdu.com**
NPSA - National Patient Safety Agency (England and Wales) **www.npsa.nhs.uk**
WHO - World Health Organization (International) **www.who.int/en**

Checklist of design recommendations

2. Text and symbols

Item	Description	Source	Page
Issue	Confusion caused by use of abbreviations		20
Recommendation	**Avoid abbreviating routes, sites, frequencies, forms or any other text element (except for standard units of measure)**	NPSA	**21**
Issue	Misreading symbols as numbers		22
Recommendation	**Display prescription details in full and use full English words in place of symbols**	ISMP	**23**
Issue	Confusion caused by use of symbols in place of words		24
Recommendation	**Use full English words in place of symbols**	ISMP	**25**

Checklist of design recommendations

3. Numbers and units of measure

Checklist of design recommendations

4. General information display

Item	Description	Source	Page
Issue	Confusion caused by lack of differentiation between adjacent elements of a prescription		46
Recommendation	**Use separators between adjacent elements of the prescription**	CUI	**47**
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Recommendation	**Follow CUI guidance on how to wrap prescriptions so that related data and labels are properly positioned**	CUI	**49**
Issue	Misinterpretation caused by part of the prescription not being visible		50
Recommendation	**Never truncate any part of the prescription within a cell**	CUI	**51**
Issue	Misinterpretation caused by part of the prescription not being visible		52
Recommendation	**Never allow any part of the prescription to scroll horizontally off-screen, and use a look-ahead scroll notification**	CUI & usability best practice	**53**

Design recommendations

1

Drug names

In general, drug names may be confused with each other because of inevitable similarities due to the large number of names in use. There are approximately 2,100 generic and 4,200 trade names in use in the UK alone.

Confusion can also be caused by trade names being very similar to the 'parent' generic name, and by non-standard naming of drugs within electronic prescribing systems. Also, clinicians may not be familiar with the active ingredients of branded products, which they encounter infrequently.

Actual errors resulting from these confusions are well-documented in patient safety literature. Electronic prescribing systems can help reduce the likelihood of these errors occurring by following these simple design recommendations when displaying drug names.

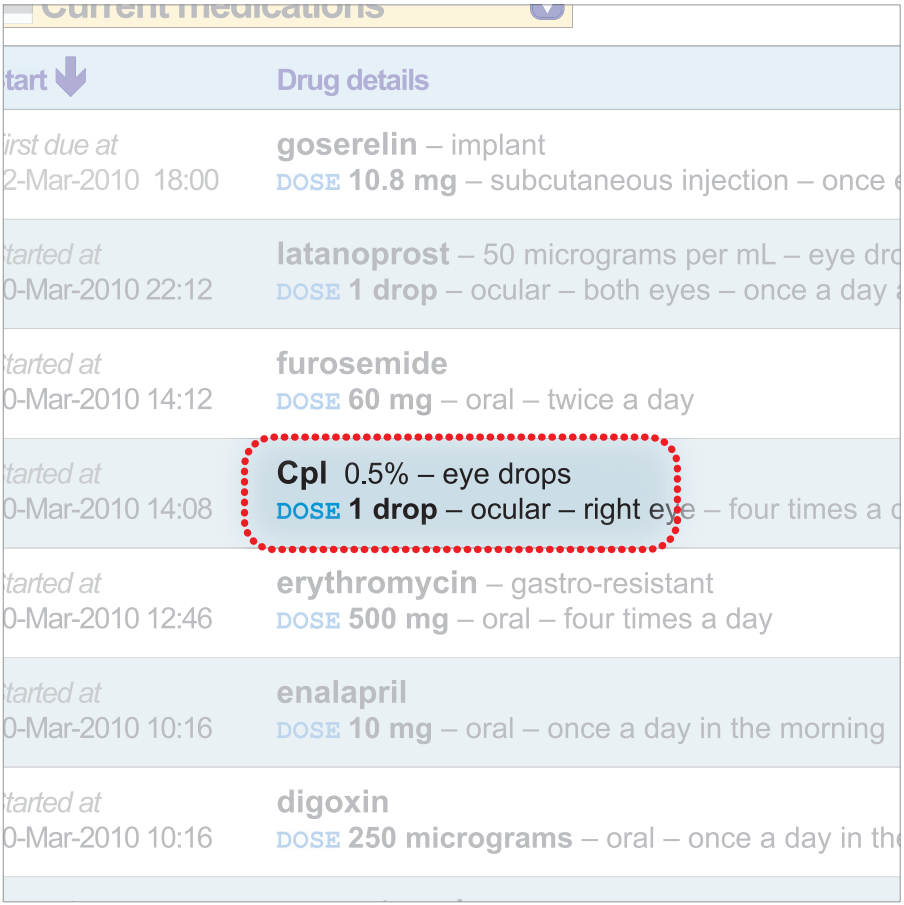
1.1 Confusion arising from non-standard drug names

Issue

Confusion can be caused by IT systems adopting locally-approved drug names, abbreviations and acronyms for drugs with similar names.

This is because the local versions may not be universally familiar and therefore might be misinterpreted by an increasingly mobile workforce. In the worst case, an approved shortening or abbreviation in one locale may directly conflict with a similar shortening from a different locale.

In the example shown, 'Cpl' may equally well be read as 'chloramphenicol' or 'cyclopentolate', both of which are available as eye drops with a 0.5% concentration of active ingredient. These drugs are not interchangeable.



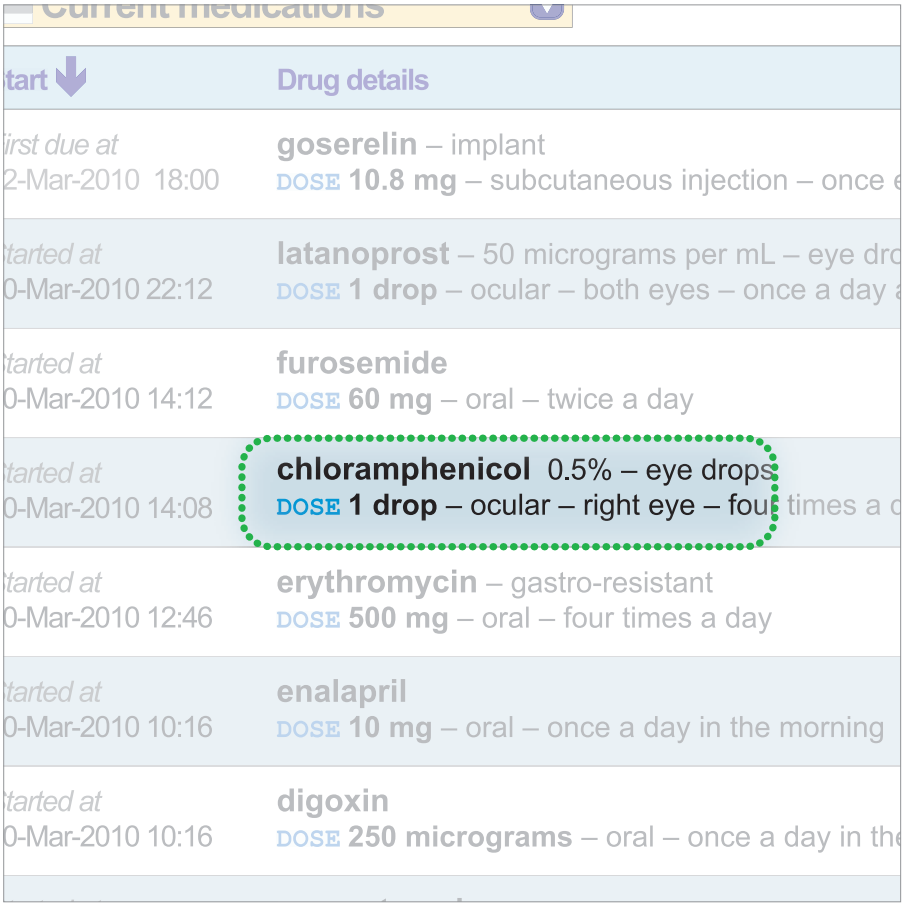
Recommendation

Only use drug names (and where necessary any shortened forms) provided by your national standard drug dictionary.

Avoid the risk of misinterpretation by using drug names provided by national health standards organisations.

For example, in England use the generic and brand names provided by the NHS dm+d.

Please note that this recommendation (and those which follow that also cover shortened forms) does not preclude the use of shortened forms for rapid data entry (e.g. while prescribing), as long as these are expanded in full before being authorised. Therefore, it would be acceptable for a prescriber to type 'cpl' as a shortcut to find and select the appropriate drug in a search results list.



1.2 Confusion caused by abbreviating salts

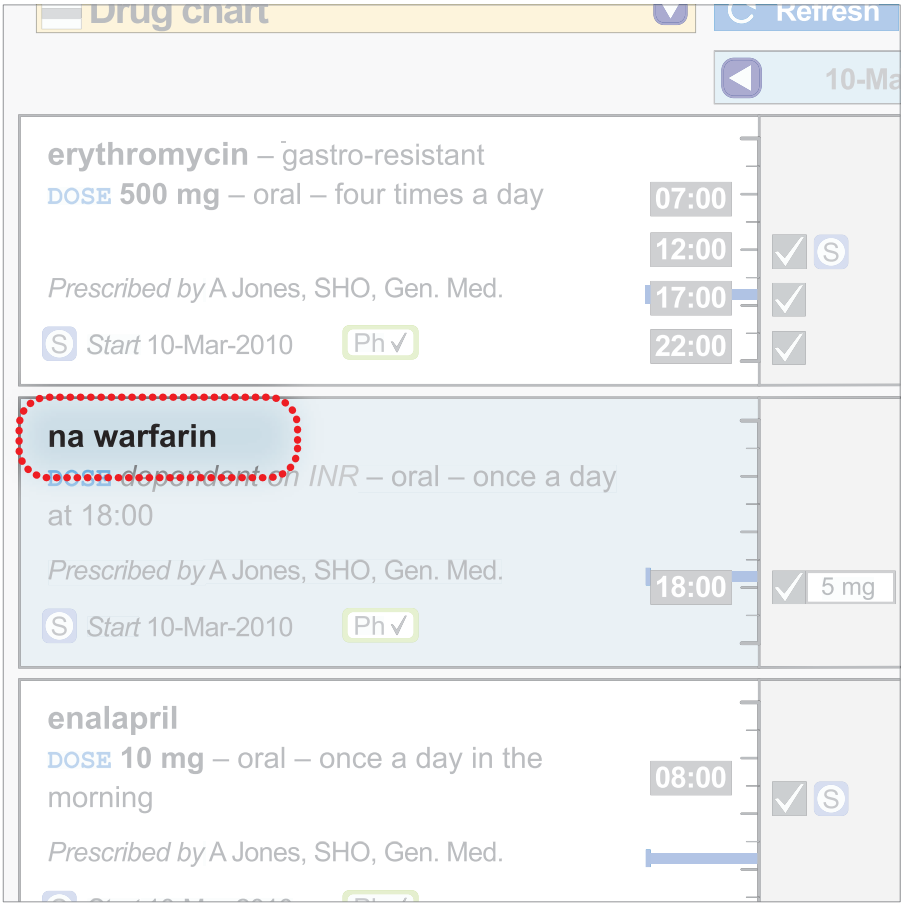
Issue

Sometimes, perhaps in an effort to conserve screen space or to follow a tradition from paper-based practice, drugs containing salts are displayed using the abbreviated forms of their chemical elements.

However, it is increasingly likely that these abbreviations may be confusing to some members of the care team. In the example shown, 'na warfarin' could be misread as 'No warfarin', possibly leading to important treatment being withheld.

Other abbreviated forms, either used alone or in combination with full words, can also be misleading, for example:

- HCl
- Br
- K
- butylBr



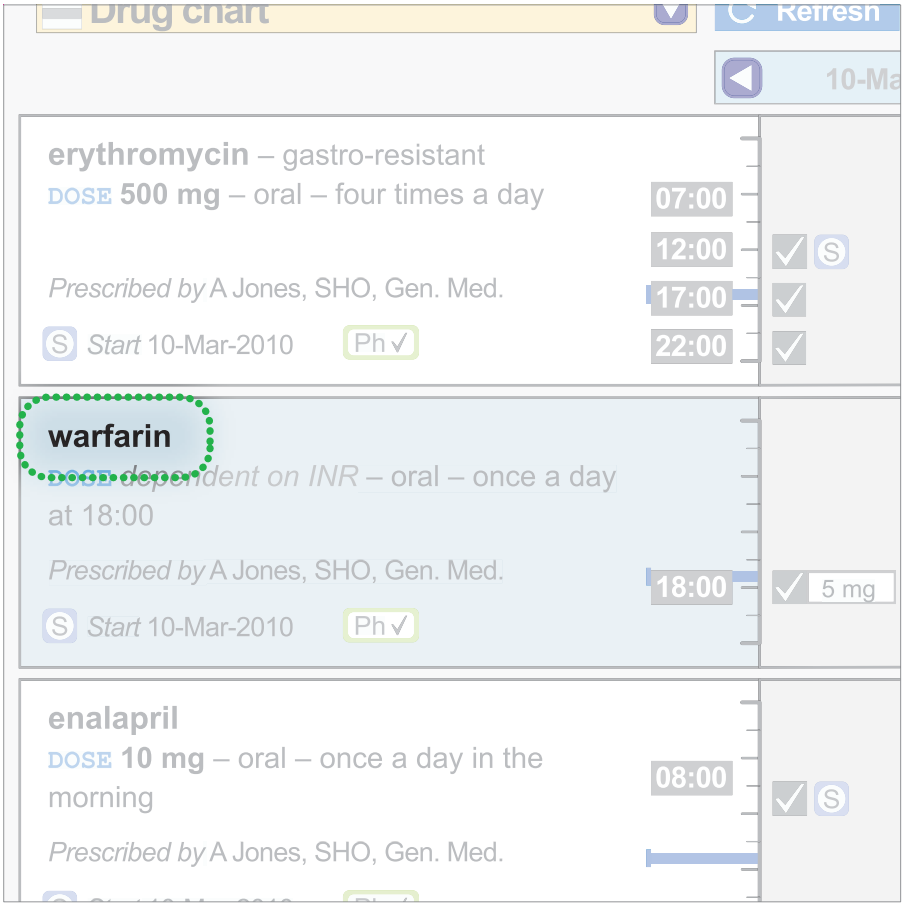
Recommendation

Only use shortened forms when provided by your national standard drug dictionary.

Display drug names, including salts, in full.

Only use shortened forms (i.e. abbreviations or acronyms) where necessary when these are provided as part of your national standard drug dictionary.

In England, at the time of writing, the NPSA and NHS CFH have not approved any shortened forms for on-screen use. Shortened forms are provided within the NHS dm+d for use on labels, but these should never be used on-screen.



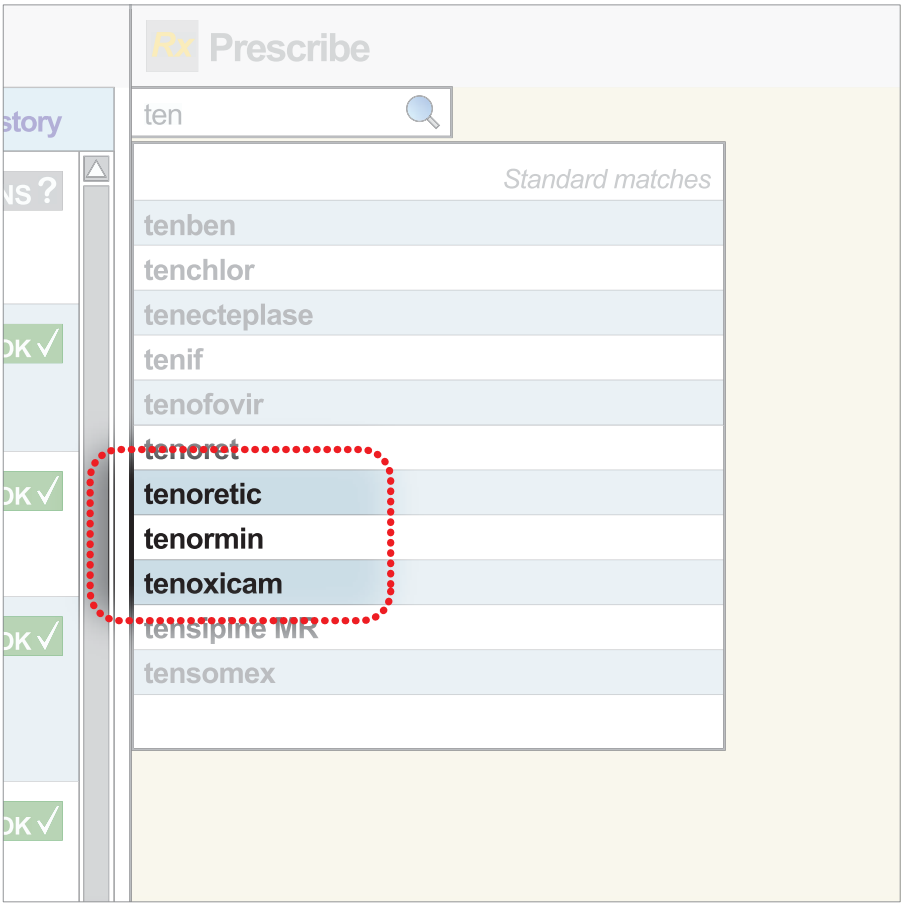
1.3 Confusion between generic and trade names, and between active ingredients of branded drugs

Issue

International standards organisations attempt to ensure that the names of different drugs (both generic and trade name) are sufficiently distinct from each other. However, given the huge, ever-increasing volume of drugs available, this is a challenging task.

In the example shown, all the generic and brand names starting with 'ten' are listed alphabetically. For a clinician searching for an unfamiliar or infrequently-used drug, this list is problematic as it contains a large number of similar-looking and sounding names.

A list like this increases the possibility of mis-selection, potentially leading to the wrong drug being administered to the patient.



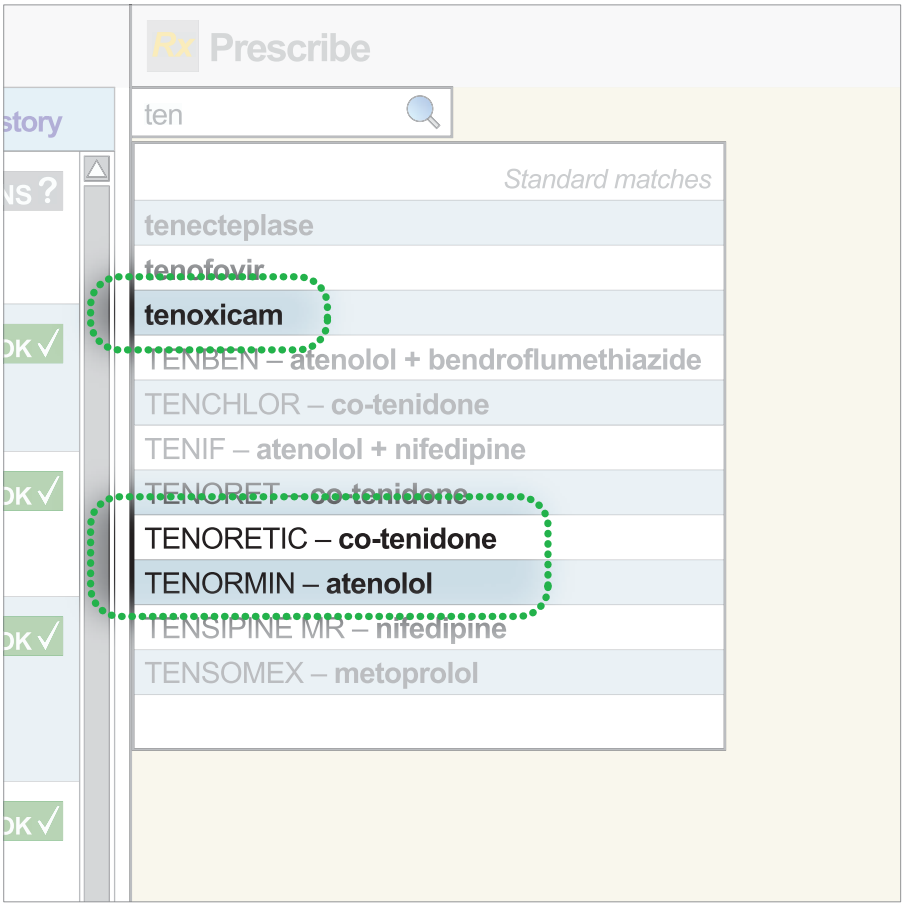
Recommendation

Display generic names adjacent to trade names, and display each using different font styles.

Firstly, display the appropriate generic name(s) with the trade name. This reduces potential confusion between similar-looking and sounding generic and trade names, and helps clinicians by showing which generic drugs are contained within which branded products.

Secondly, use lower-case and bold type-face (also if possible a slightly larger font size) for generic names, and upper-case for trade names. This further clarifies the distinction between generic and trade names.

Also, when displaying drug search results, list generic drugs first and branded products after. In the example shown, this separates 'tenoxicam' from similarly-named branded products, further reducing the risk of mis-selection.



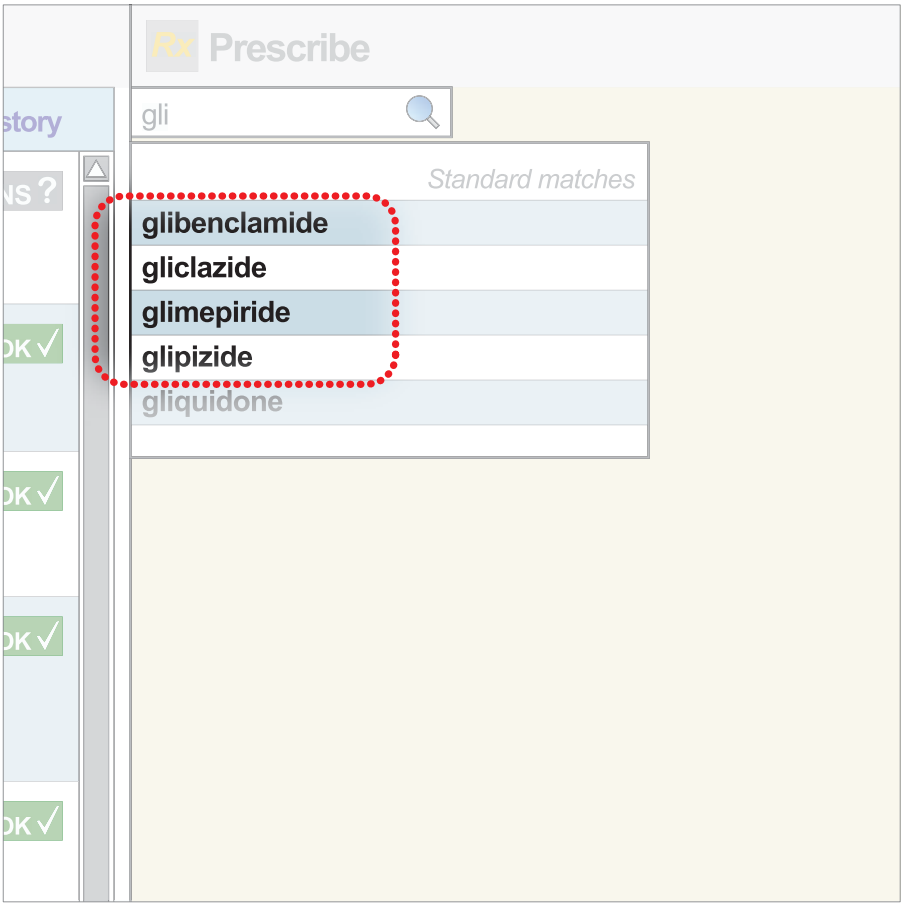
1.4 Confusion between ‘look-alike, sound-alike’ drug names

Issue

When prescribing, confusion and error can occur during selection of drugs which look or sound alike. This concern has been raised by the World Health Organization, which publishes a list of ‘look-alike, sound-alike’ drugs.

Recent research commissioned by NHS CFH found a 0.33% error rate when selecting a drug product from lists containing ‘look-alike, sound-alike’ names. As there are over 500 million prescriptions written in the UK each year, this would equate to a large number of incorrect scripts per annum.

It is therefore important to find ways to ensure that selection of drug names and other attributes is as error-free as possible.

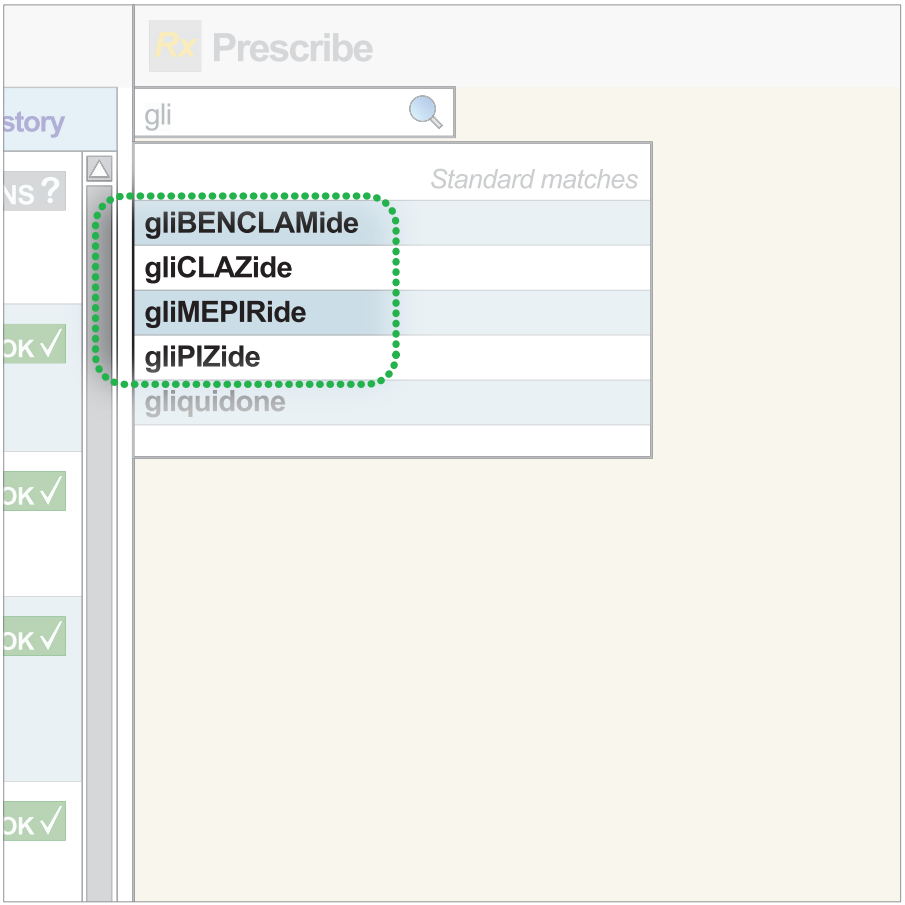


Recommendation

Use TallMan lettering for drug names known to cause confusion.

The World Health Organization recommends using 'TallMan' lettering to highlight the different letters where there is evidence of confusion between 'look-alike, sound-alike' drug names.

Recent research commissioned by NHS CFH has provided evidence that using TallMan lettering reduces (but does not eliminate) the incidence of mis-selection errors between 'look-alike, sound-alike' drug names. The report describes rules that specify which part of a drug name to capitalise (see 'Further reading').



Design recommendations

2

Text and symbols

For many years, medicine has had a strong tradition of using Latin words, Latin abbreviations and graphic symbols in place of full English words. This usage has continued due to a combination of hand-written medical communication on paper and increasing time pressures on practitioners. However, in today's healthcare systems with internationally-mobile workforces, there is increasing potential for misunderstanding when using even the most long-standing of these conventions. This is also true for abbreviated forms of English words and the use of symbols in place of words or numbers.

Actual errors resulting from these misunderstandings are well-documented in patient safety literature.

Electronic prescribing systems can help avoid these errors by following some simple design recommendations when displaying prescription details and drug product descriptions. User research has reinforced the view that the disadvantage of taking up extra screen space with full words is outweighed by the benefit of clear communication.

It should be noted that these recommendations apply only to the display, not the entry, of clinical data. Abbreviations and acronyms may be very helpful in accelerating the entry of clinical data into an electronic system, as long as they are expanded in full before being finally stored in a patient's record.

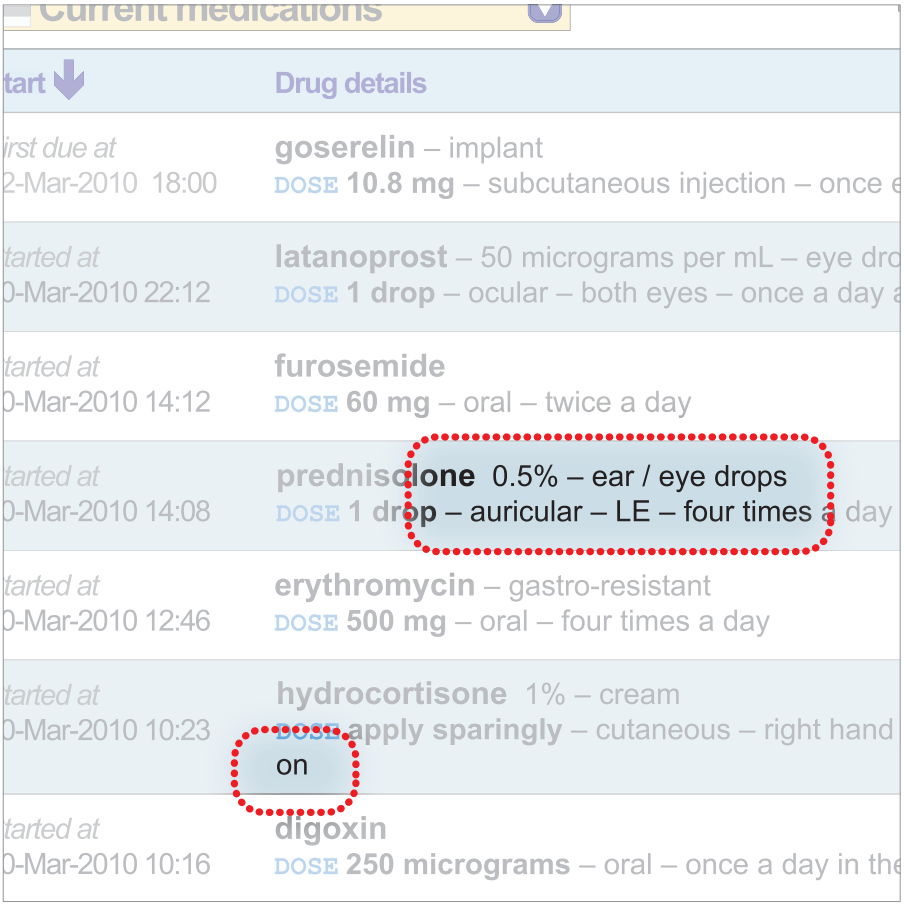
2.1 Confusion caused by use of abbreviations

Issue

The possibility of misinterpretation of abbreviations or acronyms increases where there are a number of possible interpretations of the shortened form, perhaps depending on the context in which it is used.

In the first example shown, an actual error could occur if 'LE' was mistaken for 'left eye' rather than 'left ear'. This is made less likely by the adjacent display of the route of administration ('auricular' rather than 'ocular'), but is still possible.

In the second example, the Latin acronym 'on' has been used instead of 'every night'. Someone unfamiliar with this might misinterpret it, assume it was an error, or overlook it – potentially leading to the incorrect administration of the drug.



Recommendation

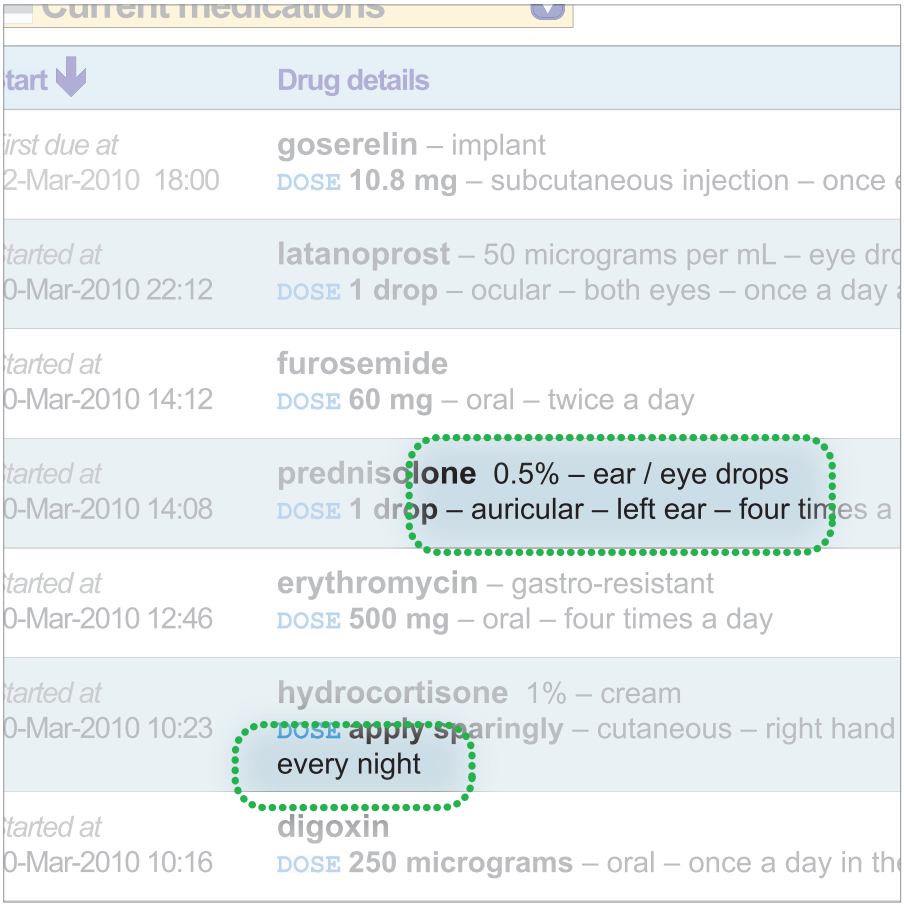
Avoid abbreviating routes, sites, frequencies, forms or any other text element (except for standard units of measure).

Where there are no nationally-agreed shortened forms, display the following in full:

- Route of administration (e.g. 'auricular');
- Administration site (e.g. 'left ear');
- Frequency description (e.g. 'every night');
- Drug form (e.g. 'ear / eye drops');
- All other text elements making up a prescription.

The exceptions to this are units of measure (see pages 30 and 31).

In England, at the time of writing, there are no nationally-approved shortened forms of this kind for on-screen use.



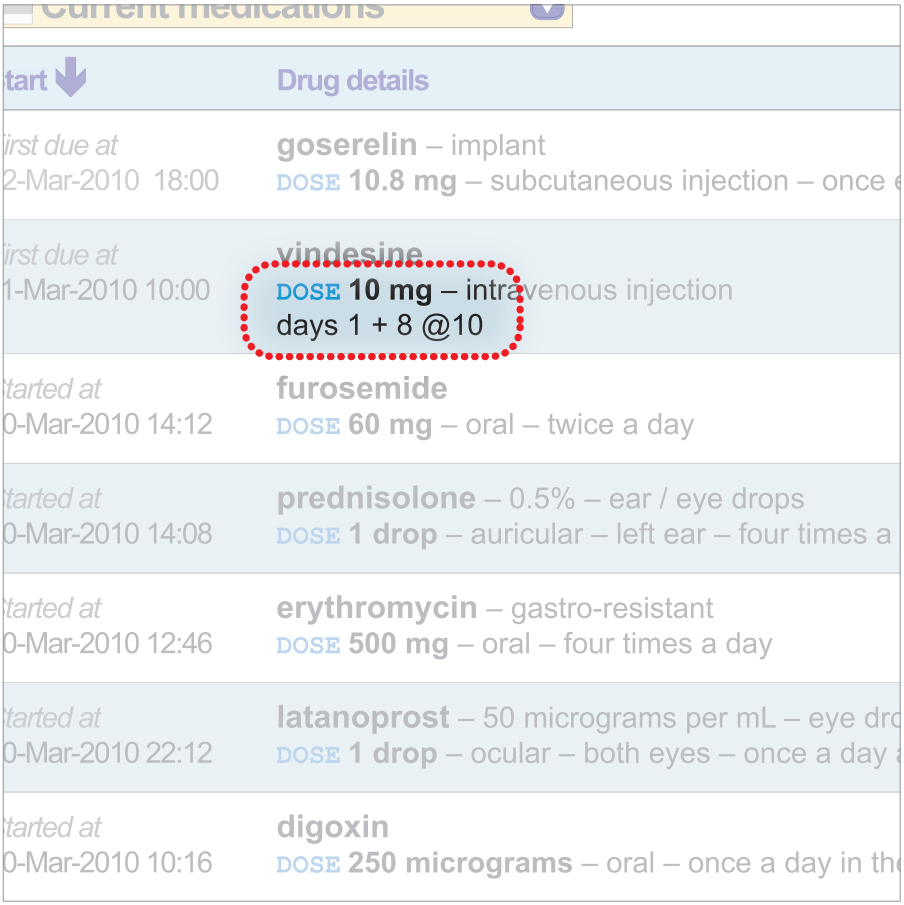
2.1 Misreading symbols as numbers

Issue

Symbols can easily be misread as numbers:

- The symbol '+' may be misread as the number 4, or completely misinterpreted;
- The symbol '@' is often used in place of 'at' and may be misread as the number 2;
- The symbol '&' may be misread as the number 2 or the number 8.

Compressed layout (as shown), possibly including symbols, increases the likelihood of misinterpretation. Here, the prescription could be mis-read as 'days 1 4 8', or the '+' could even be misread as a dash, making the prescription appear to state 'days 1 - 8' and, if not corrected, lead to a significant overdose.



Recommendation

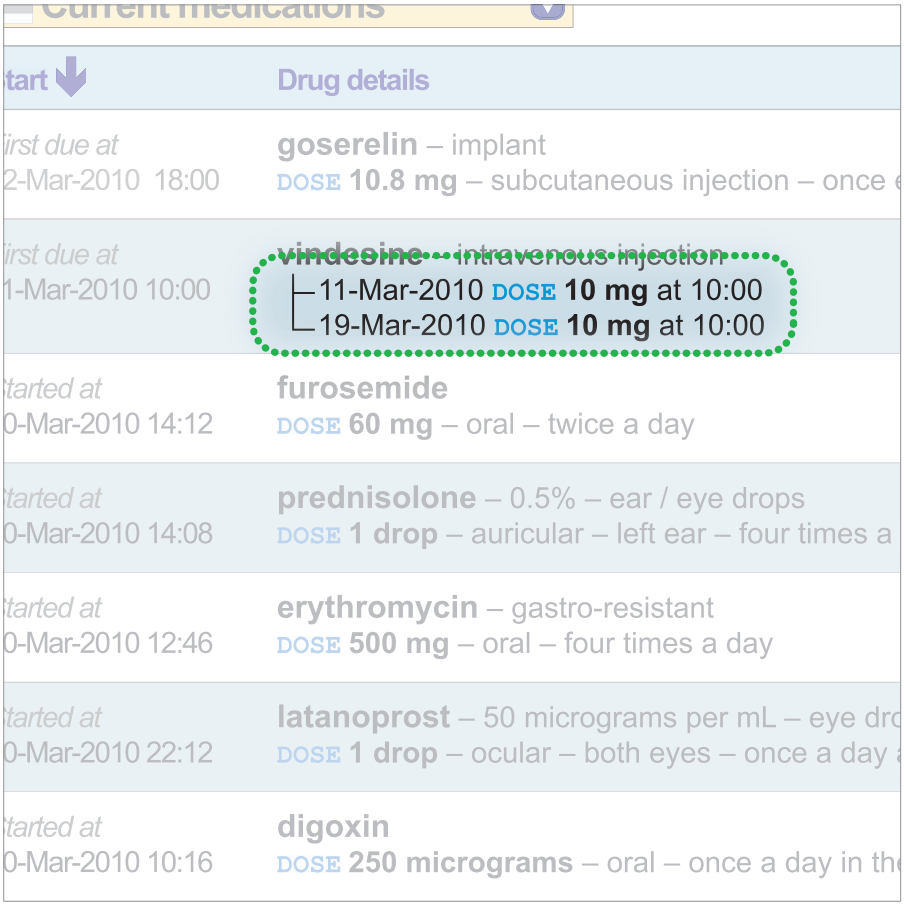
Display prescription details in full and use full English words in place of symbols.

Avoid any chance of misinterpretation by:

- displaying the prescription details in full;
- using full English words instead of symbols.

In this example, it is now much harder to misinterpret the administration schedule.

This more than compensates for the negative effect of adding extra characters to the display.



2.1 Confusion caused by use of symbols in place of words

Issue

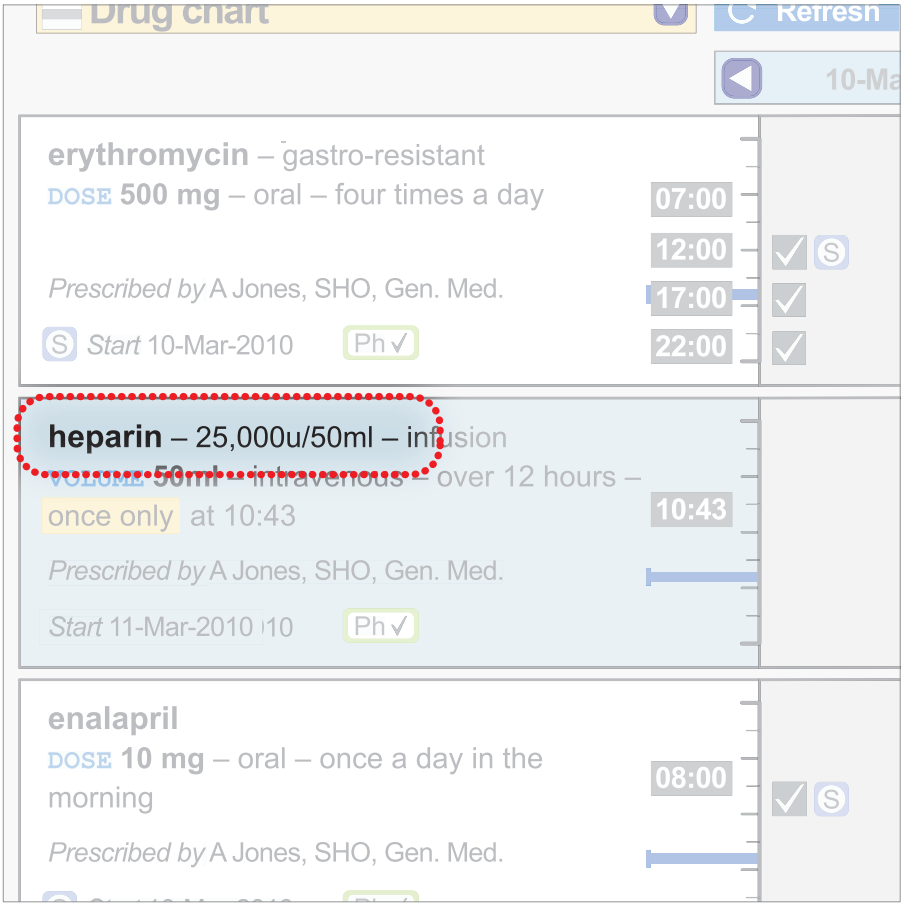
Confusion can be caused by using symbols in inappropriate ways.

For example, '/' is often used to separate measures within an expression of strength, concentration or rate, but can be mistaken as '1'.

In the example shown, there is a strong possibility that the strength will be misinterpreted as 25,000 units in 150 mL.

This type of error will be most problematic when, as in this case, the medications in question may be made up to the prescribed parameters on the ward.

Other symbols which can be either misread or misinterpreted include '<', '>', '@' and '&'.



Recommendation

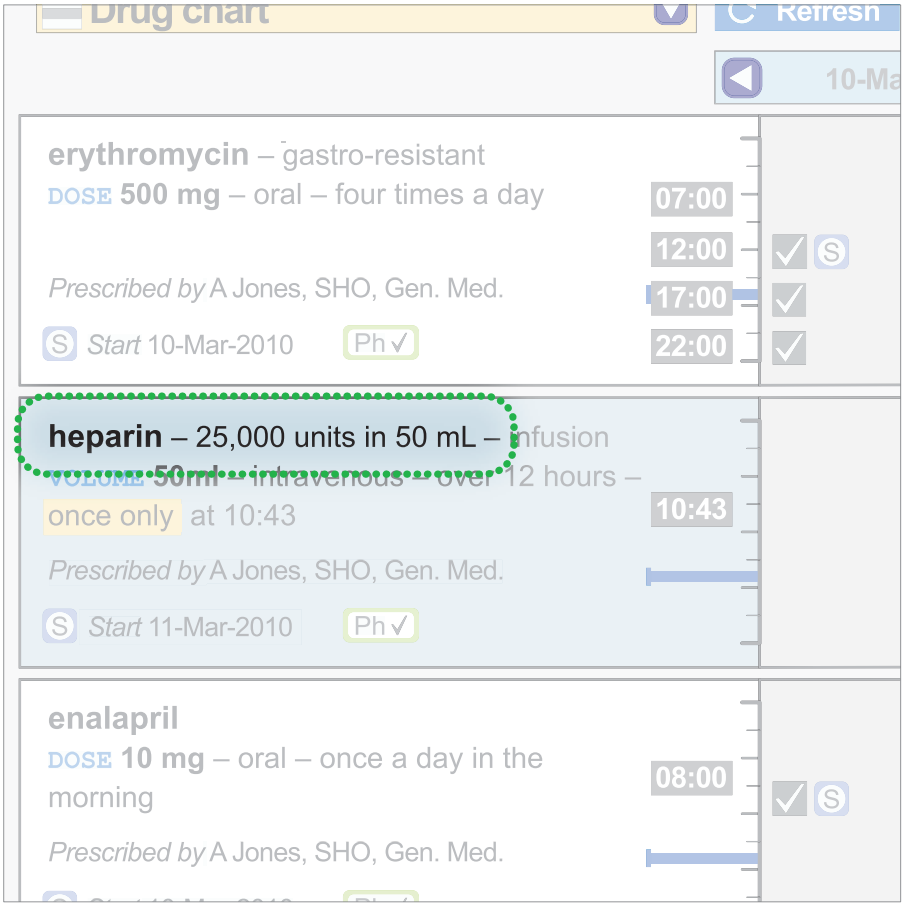
Use full English words in place of symbols.

In the example shown, the symbol '/' has been replaced by the word 'in'.

Another example using the same symbol would be a concentration of '200mg/ml'. Using the recommendations in this booklet, this should be displayed as: '200 mg in 1 mL'.

There are a very small number of exceptions to this rule:

- Do not replace '%' with 'per cent';
- Do not alter a decimal point;
- Use a comma to separate thousands (see pages 40 and 41).



Design recommendations

3

Numbers and units of measure

Prescription details and drug product descriptions contain predictably-structured combinations of words and numbers. Sometimes the juxtaposition of words and numbers can cause legibility problems, both on paper and on screen. Also, some units of measure are known to be prone to misunderstanding, and should not be used.

Actual errors resulting from these misunderstandings and legibility problems are well-documented in patient safety literature. Electronic prescribing systems can help avoid these errors by following some simple rules for formatting prescription details and drug product descriptions, and by using only standard approved units of measure.

3.1 Misinterpretation caused by different numerical elements having similar formats and units of measure

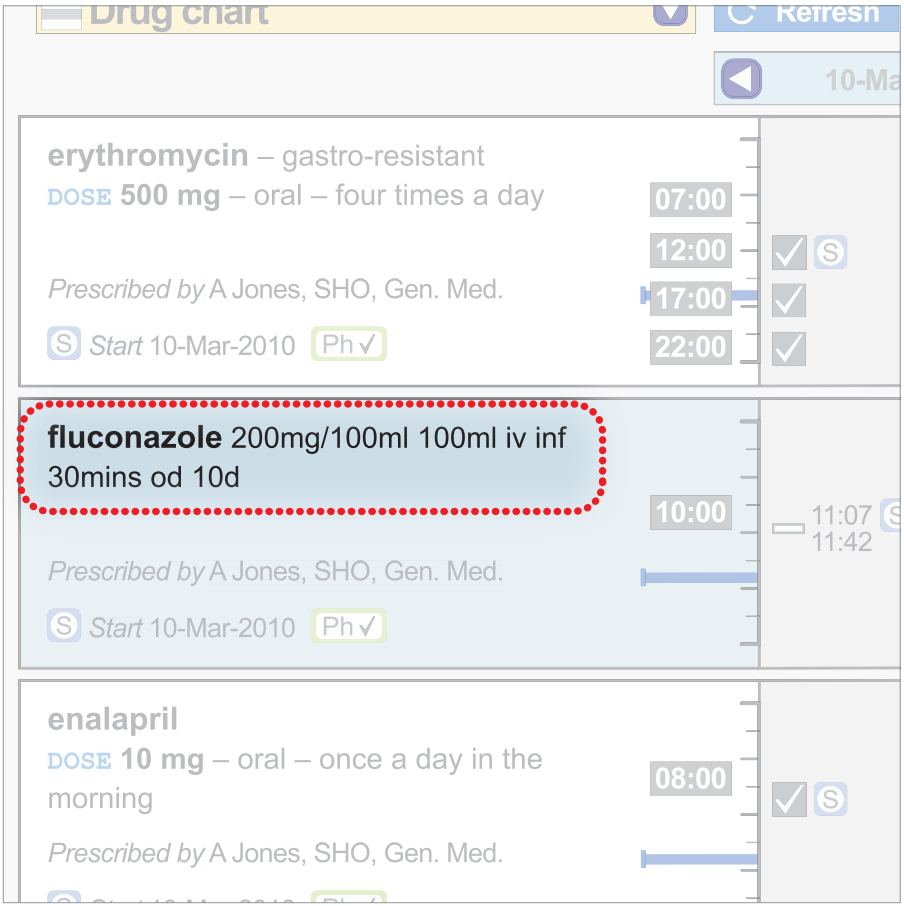
Issue

Confusion can be caused by different elements of the prescription, especially those containing numbers, having similar formats and units of measure.

The most common problem is mistaking the strength (i.e. concentration) of the medicinal product for the dose specified by the prescriber.

IT systems can increase the likelihood of this problem arising by:

- displaying elements in an unfamiliar or inconsistent sequence;
- using inappropriate units of measure and symbols (see following pages);
- not differentiating similar elements.



Recommendation

Use a consistent display order and show the name and dose in bold typeface.

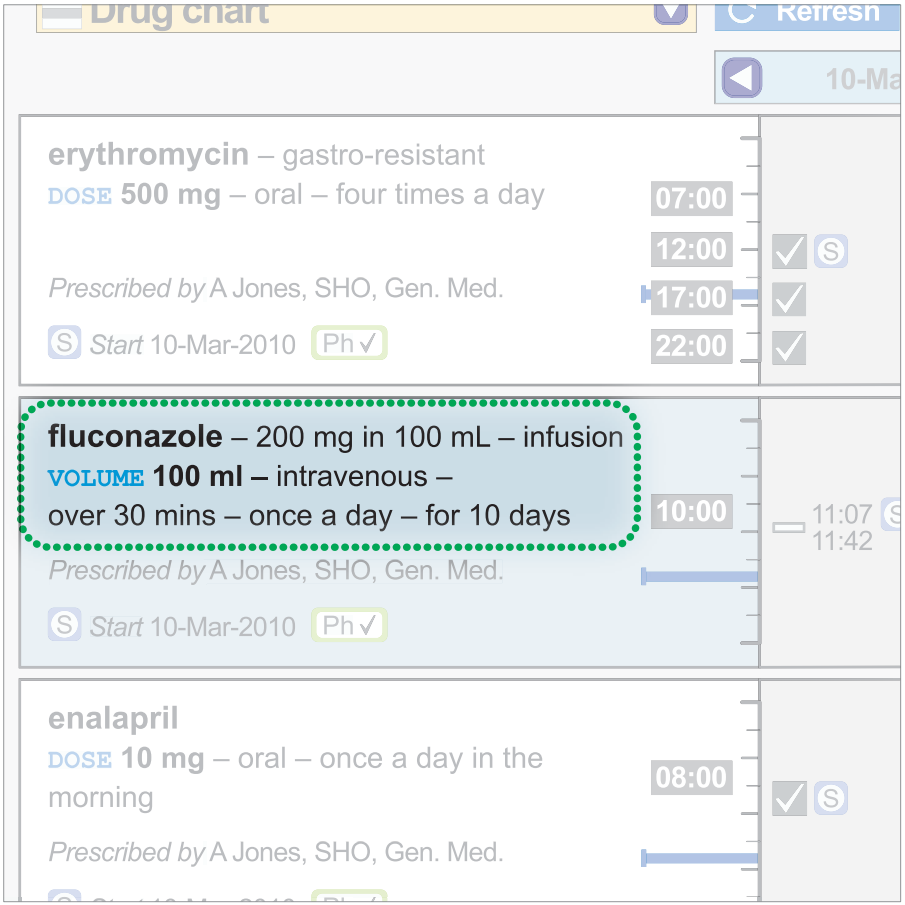
Follow the order set out below and display the relevant description from left to right as wrapped text or as specified by CUI guidance.

1. Generic name
2. Brand name
3. Strength
4. Form
5. Dose (or equivalent, e.g. rate or volume)
6. Route
7. Dose duration
8. Site
9. Frequency
10. Course duration

Increase the prominence of the dose (or its nearest equivalent, e.g. volume) by:

- preceding it by a label;
- using bold typeface.

Overall, the possibility of confusion is reduced and the readability of the dose, a key element, is increased.



3.2 Misreading or misinterpreting units of measure

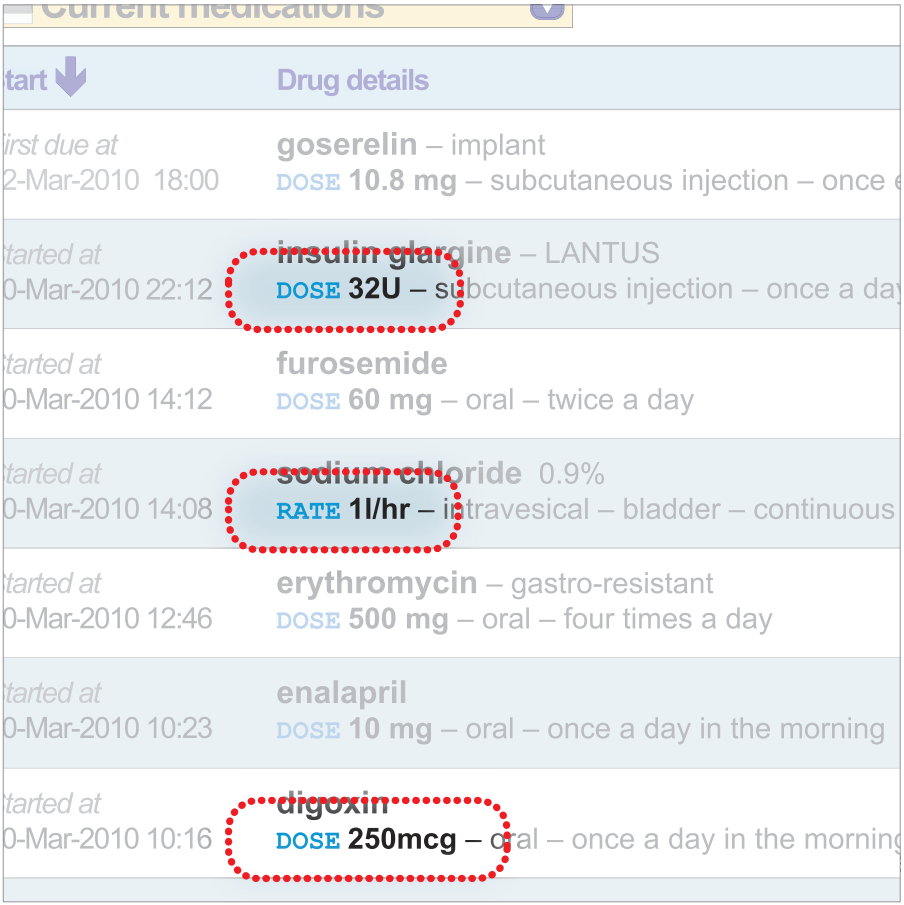
Issue

Units of measure are vital components of a prescription. If misinterpreted, the results can be fatal. IT systems can help reduce the possibility of misinterpretation by displaying only standard approved units of measure, whether written in full or abbreviated, and using these consistently at all times.

Units of measure associated with error include:

- 'U' for 'unit' being misread as the number '0';
- 'l' for 'litre' being misread as the number '1';
- 'mcg' for 'micrograms' being misread as 'mg' for 'milligrams'.

Errors are more likely when proper spacing is not used between numbers and units of measure (see pages 34 and 35).



Recommendation

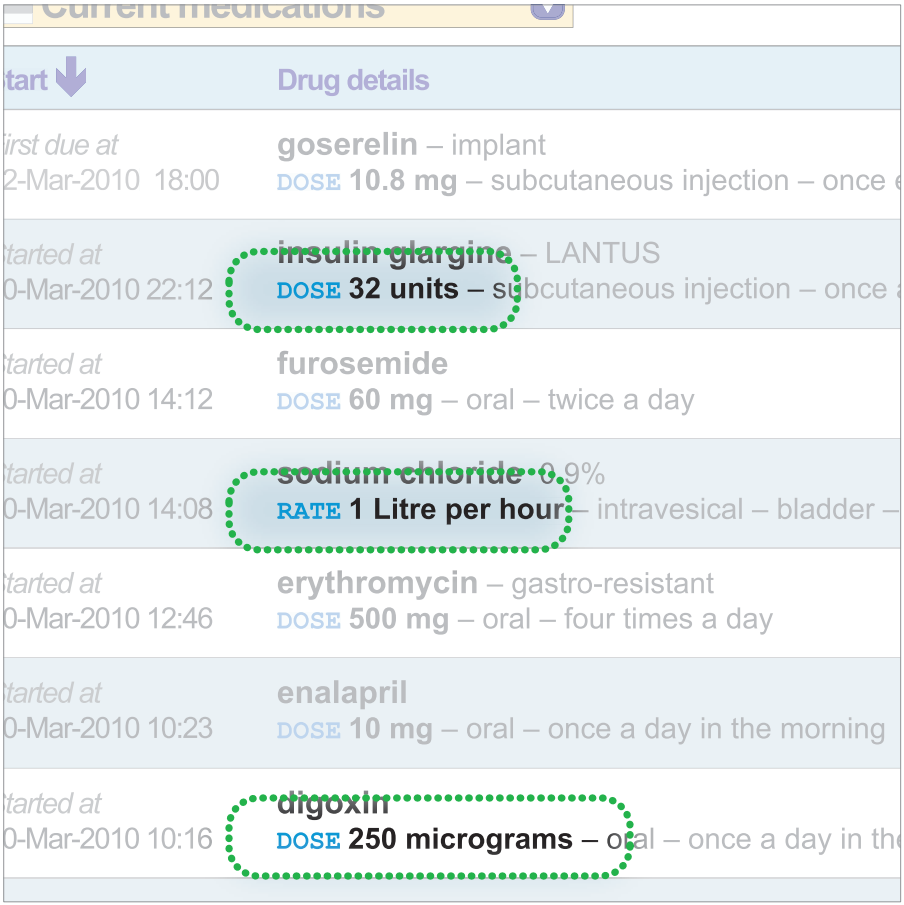
Use (and use consistently) only standard approved units of measure, and format these for maximum legibility.

Use standard approved units of measure for display (with upper and lower case formatted exactly as shown). Some commonly-used examples include:

- 'units' for 'units' (i.e. do not abbreviate);
- 'mL' for "millilitres' (NB capitalised 'l');
- 'micrograms' for 'micrograms' (i.e. do not abbreviate).

(See full list in Appendix 1)

It is also very important to be consistent, for example, do not be tempted to write units of measure in full where adequate display space is available, e.g. by replacing 'mg' with 'milligrams' in some situations. A lack of consistency in one situation may increase the probability of confusion elsewhere.



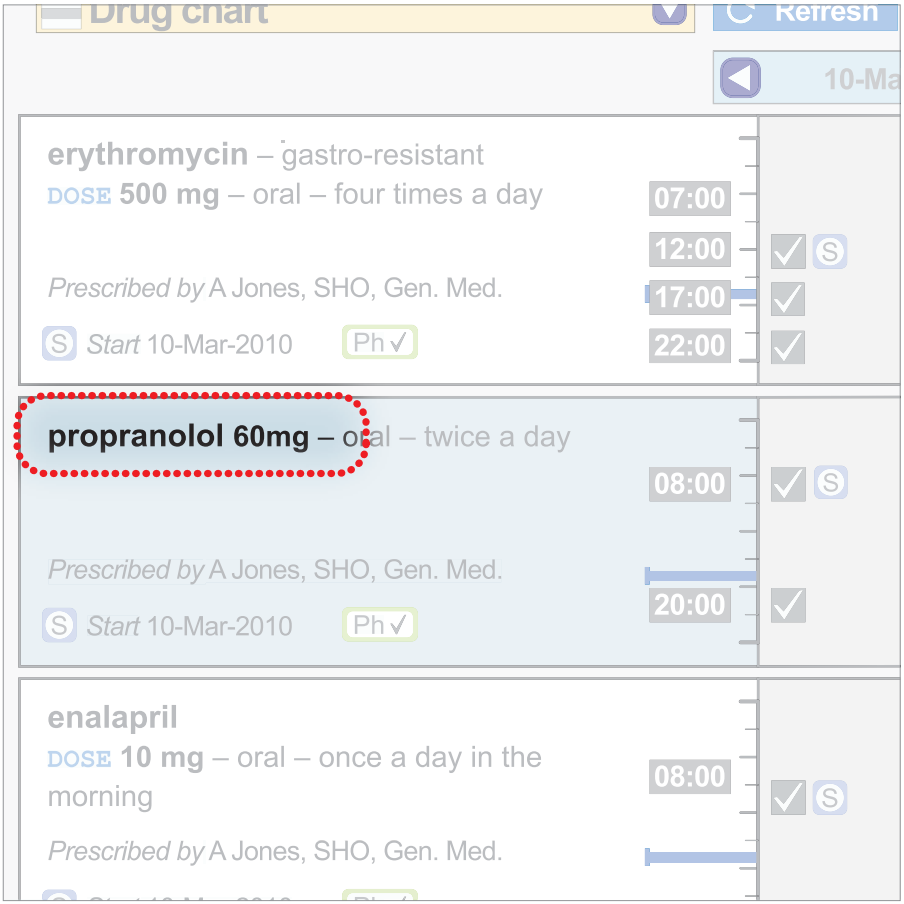
3.3 Misreading of numbers due to close proximity of preceding words

Issue

Confusion is possible when the last letters of a word, typically the name of a drug, appear to flow into the numbers which follow.

In this example, a prescription for 'propranolol 60 mg' could be misread as 'propranolol 160 mg'.

This is a particular problem when the misread dosage is credible (as in this case, where propranolol 160 mg tablets are in regular use).

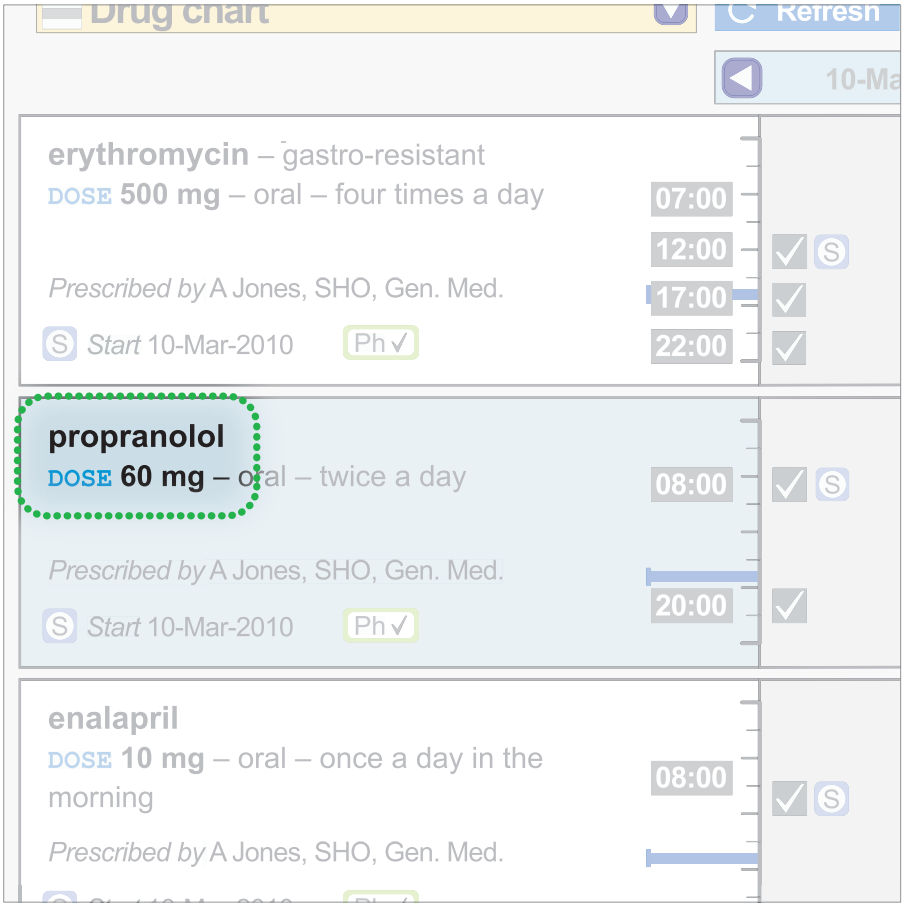


Recommendation

Use spacing, labels and separators to ensure that preceding words cannot appear to flow into numbers.

Ensure that there is unambiguous spacing between the different elements making up a prescription, so that there is no possibility of letters appearing to flow into the numbers which follow them. This can be achieved in a number of ways:

- If no separator is to be used, ensure there are two non-breaking spaces between the word and the following numbers;
- Separate the word from the following numbers using symbol separators (for best practice, use an 'en' dash, see page 47) or labels (e.g. 'Dose', as in this example);
- In addition to the above points, use new lines where appropriate to separate words and numbers.



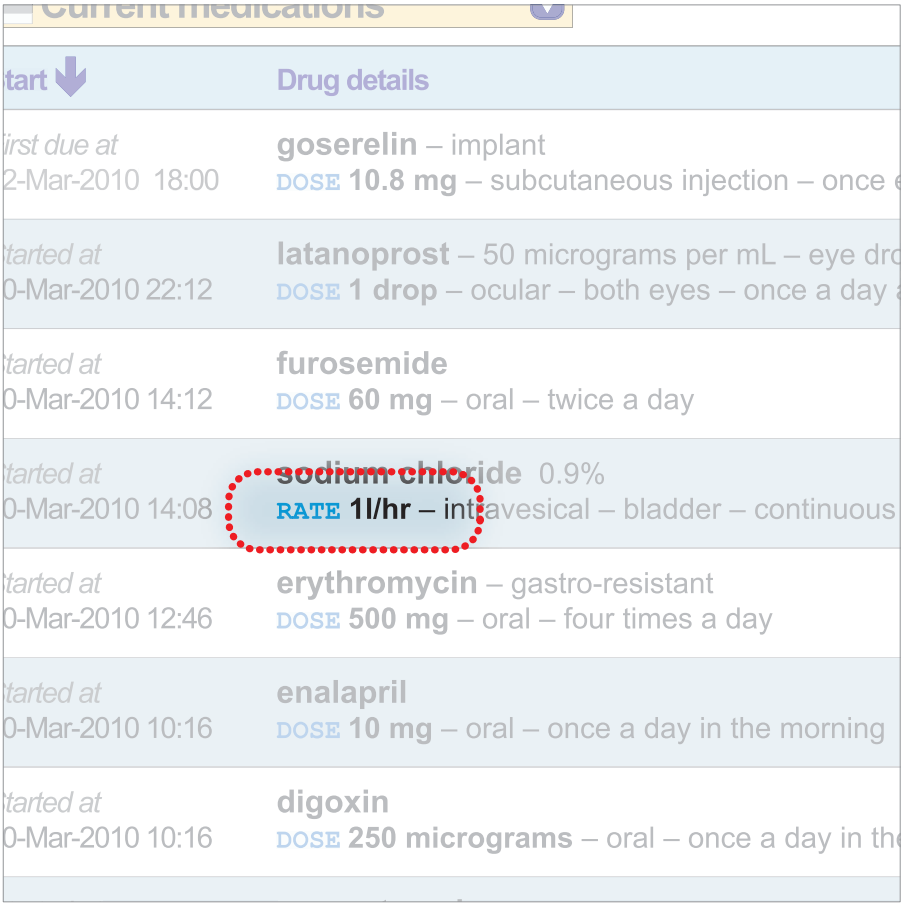
3.4 Misreading of numbers due to close proximity of trailing units of measure

Issue

Confusion is possible when numbers appear to flow into the units of measure which follow them. This situation can be exacerbated by insufficient spacing and incorrect display of units of measure.

In this case, a lower-case 'l' has been used to signify 'Litre', and no spacing has been used between the numbers, units of measure and symbols. The use of '/' rather than the full English word 'per' is also unacceptable.

The result is easy to misread as '11 Litres per hour'. While in this case the actual administration of 11 litres per hour would be very unlikely, the example shown would still be confusing and potentially lead to a reduction of confidence in the IT system.

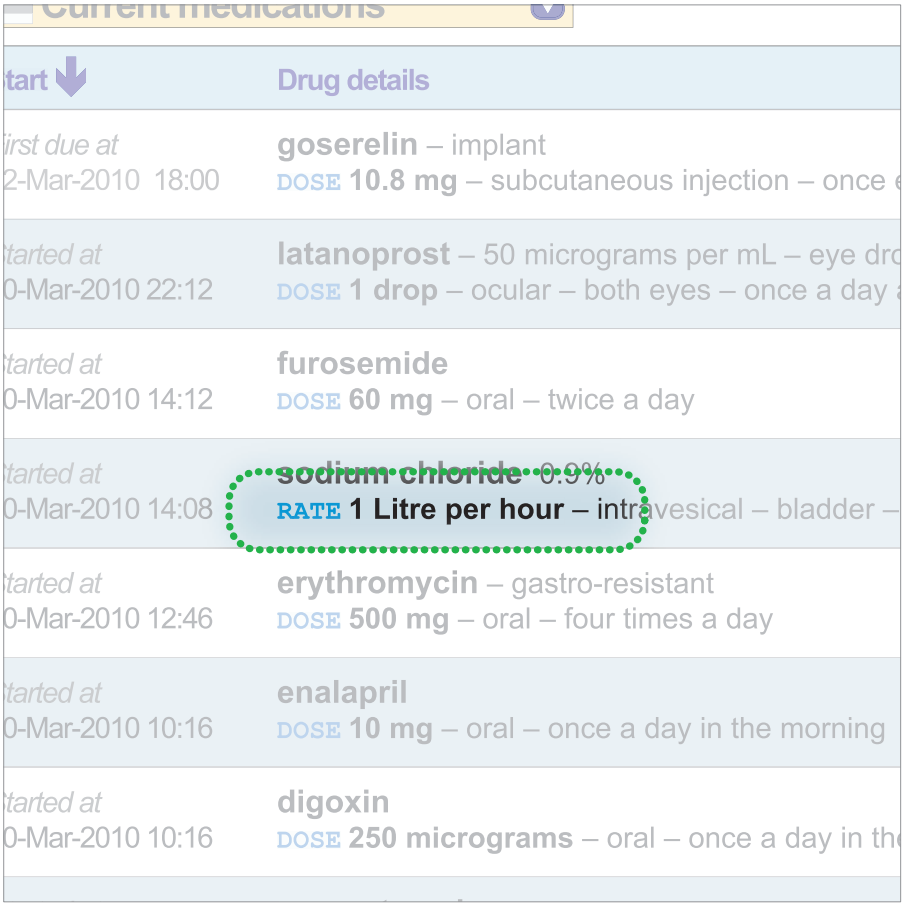


Recommendation

Leave a space between numbers and units of measure.

Ensure that spacing is adequate by always leaving one blank, non-breaking space between a number and its unit of measure.

In addition, use full English words instead of symbols (as described elsewhere in this booklet), and always use the standard abbreviation (if allowed; see Appendix 1) for units of measure.



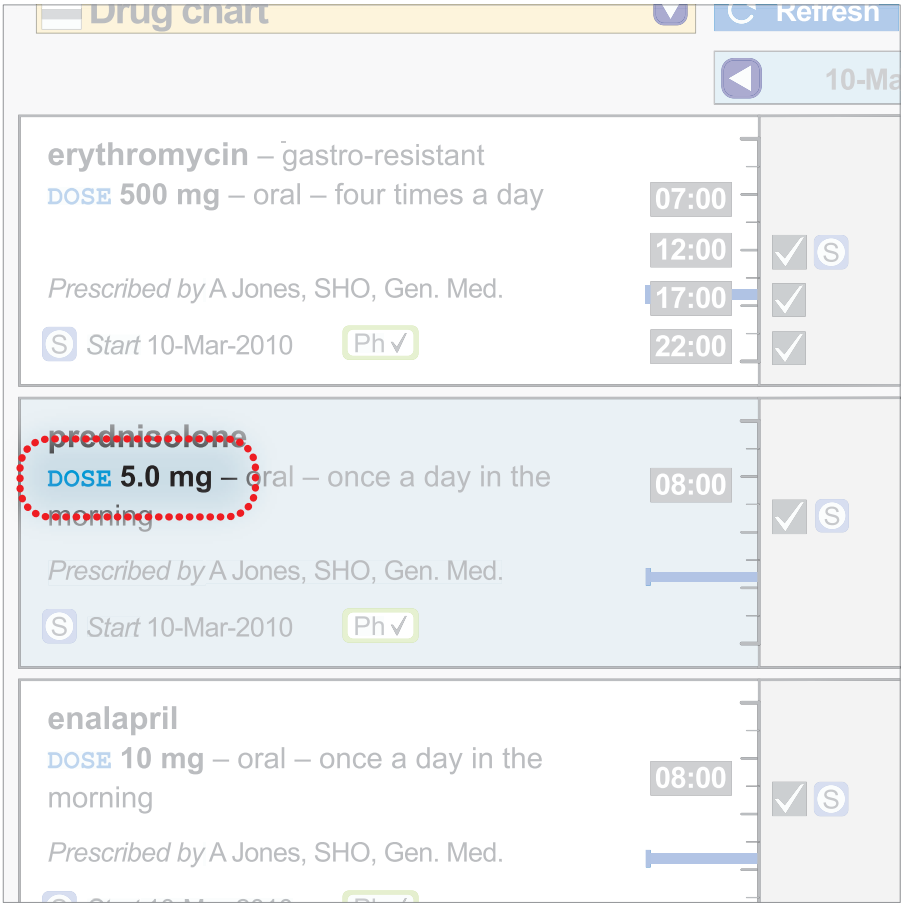
3.5 Misreading of numbers due to trailing zeros

Issue

If numbers have a trailing zero (a decimal point followed by a zero) it is easy to miss the decimal point and administer a ten-fold overdose.

In this case, the displayed dose of '5.0 mg' could be misread as '50 mg'.

This is a particular problem in situations (such as the example shown) where the misread dosage is within the typical range for the drug in question, making it very likely that, if the dose was misread, then the overdose would actually be administered to the patient.

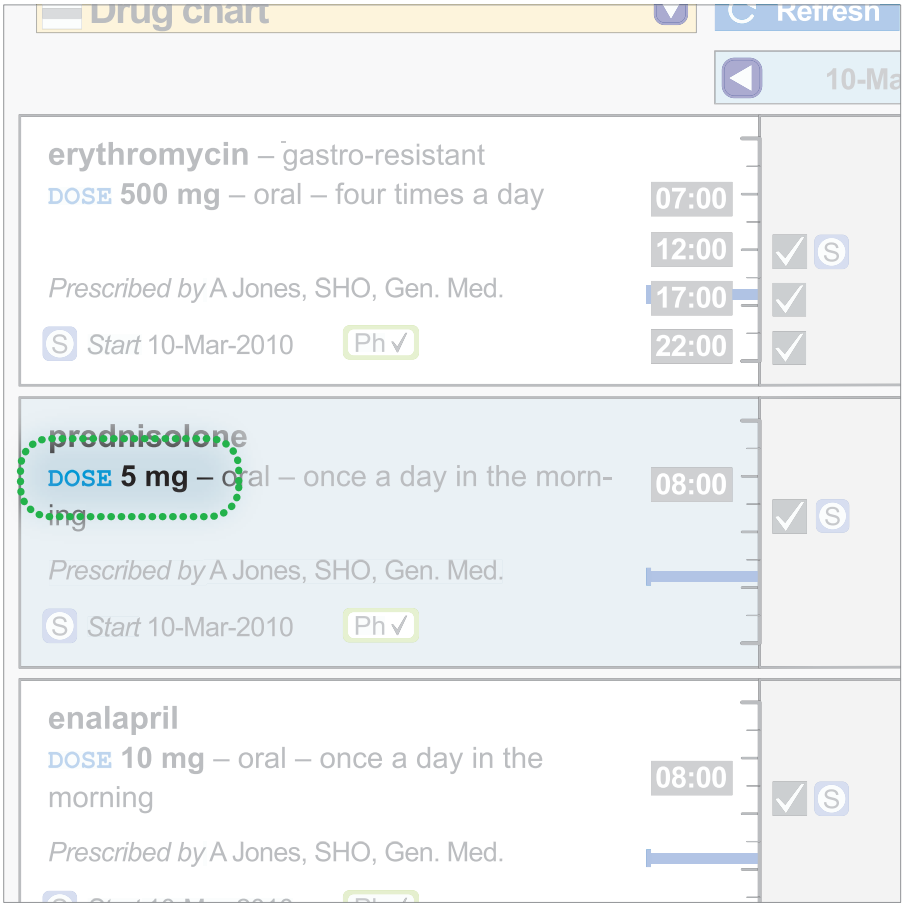


Recommendation

Do not use trailing zeros.

When displaying whole numbers, avoid the use of trailing zeros.

This means that the IT system must be flexible enough to change display formats according to the actual value of the numbers shown, so that whole numbers are shown as integers (i.e. to zero decimal points), but fractions are shown to an appropriate number of decimal points (depending on the context).

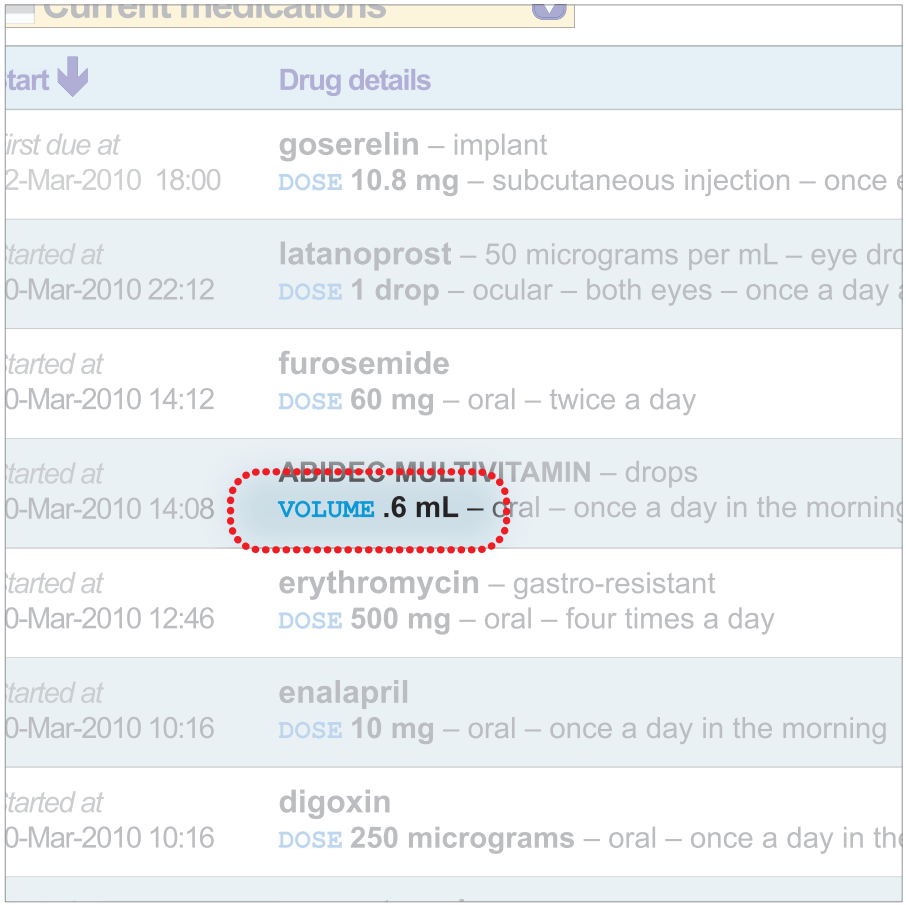


3.6 Misreading of numbers due to the absence of leading zeros

Issue

Omitting leading zeros introduces a high possibility of misreading errors, because the decimal point preceding the number(s) may not be noticed.

In this case, a ten-fold overdose would result.



Recommendation

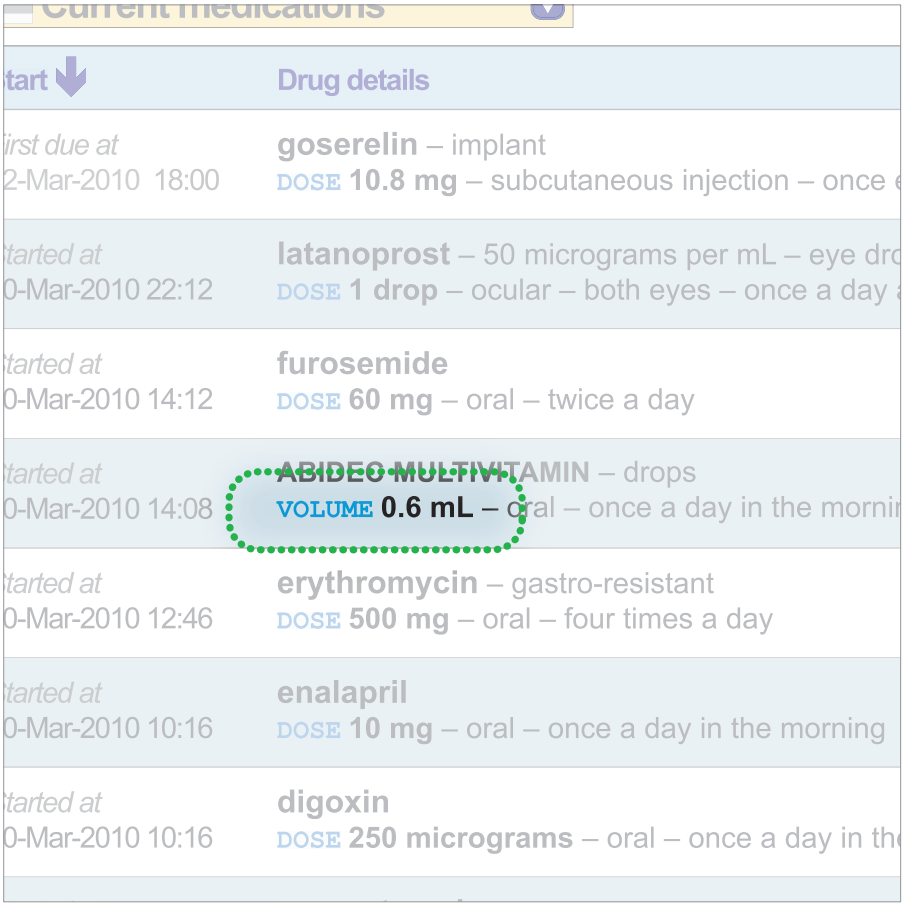
Use leading zeros when a decimal point is required (but first try to avoid decimals by using alternative units of measure).

Firstly, wherever possible, avoid decimals by using alternative units of measure when displaying numerical information, for example:

- Use ‘500 mg’ in place of ‘0.5 g’;
- Use ‘500 micrograms’ in place of ‘0.5 mg’.

However, this is sometimes not advisable, for example when the smaller unit of measure is not commonly used. In this case, ‘600 microlitres’ would not be an acceptable alternative to ‘0.6 mL’.

Secondly, where a decimal point is required, always use a leading zero.



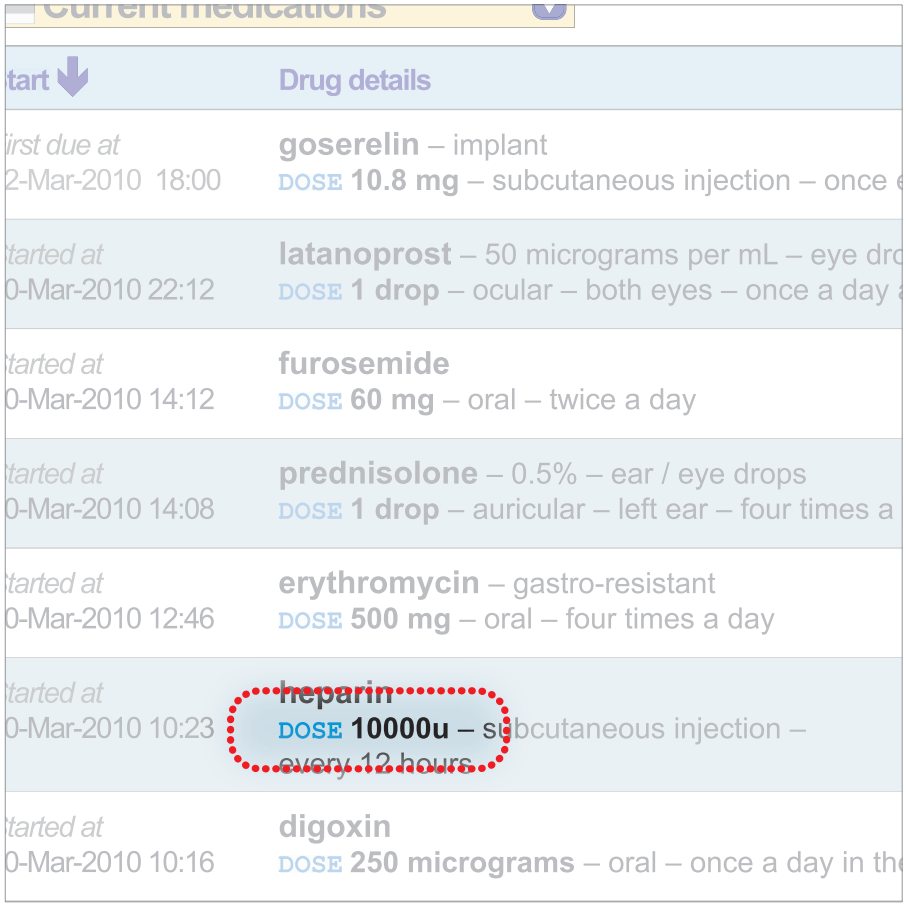
3.7 Misreading very large numbers

Issue

Commas are not always used appropriately (or at all) when displaying very large numbers. Omission of commas can lead to long strings of zeros being displayed, which are hard to interpret correctly.

This is a particular issue with drugs that are described by molecular quantity (i.e. where the unit of measure is 'unit') rather than by mass (e.g. 'g' or 'mg'). Unfortunately, some drugs measured in this way are both frequently used and associated with high rates of error.

In isolation, the dose shown could be misread as '1000' rather than '10,000'. When read in conjunction with an inappropriately displayed unit of measure (as in this case), it could also be misread as '100000'.



Recommendation

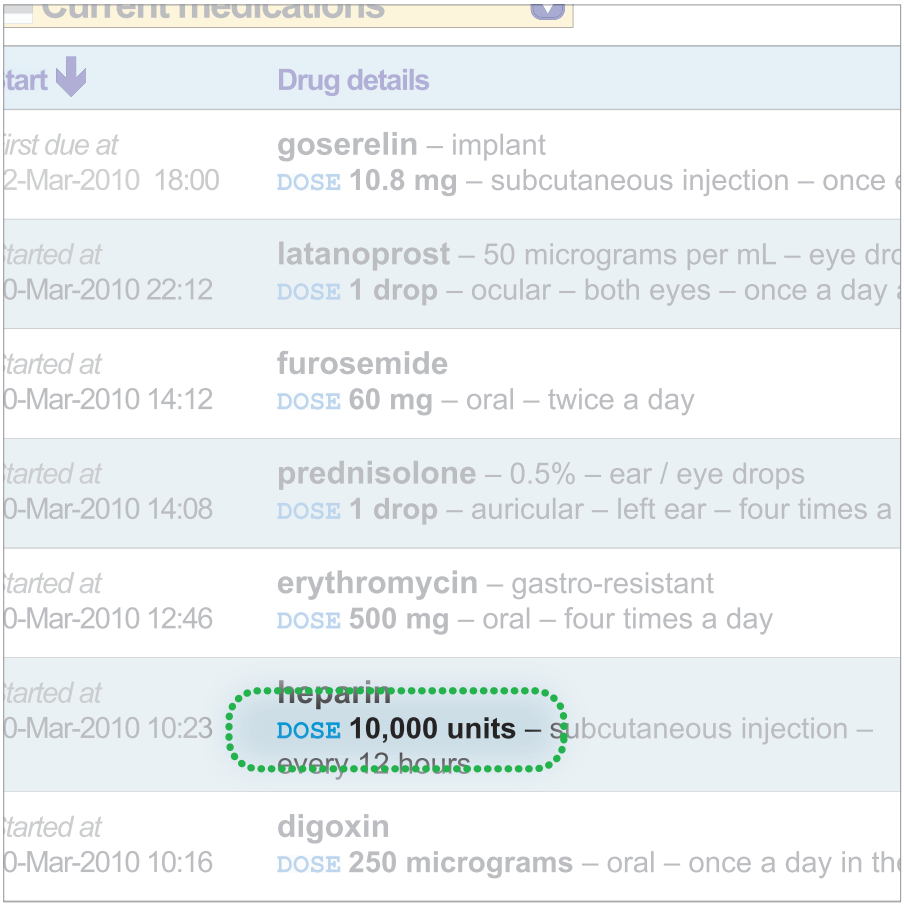
Use commas to separate groups of three digits in numbers of 1,000 and above.

For numbers which have four or more whole number digits, use a comma to separate groups of thousands.
For example:

- 100
- 999
- 1,000
- 9,999
- 10,000
- 99,999
- 100,000

This recommendation, which is in line with most Anglo-Saxon manuals of writing style, aids visual interpretation of large numbers by breaking them up into groups of thousands, thereby avoiding ten-fold (or even 100-fold) misreading errors.

Please note that a comma may be used to represent a decimal point in some locales.

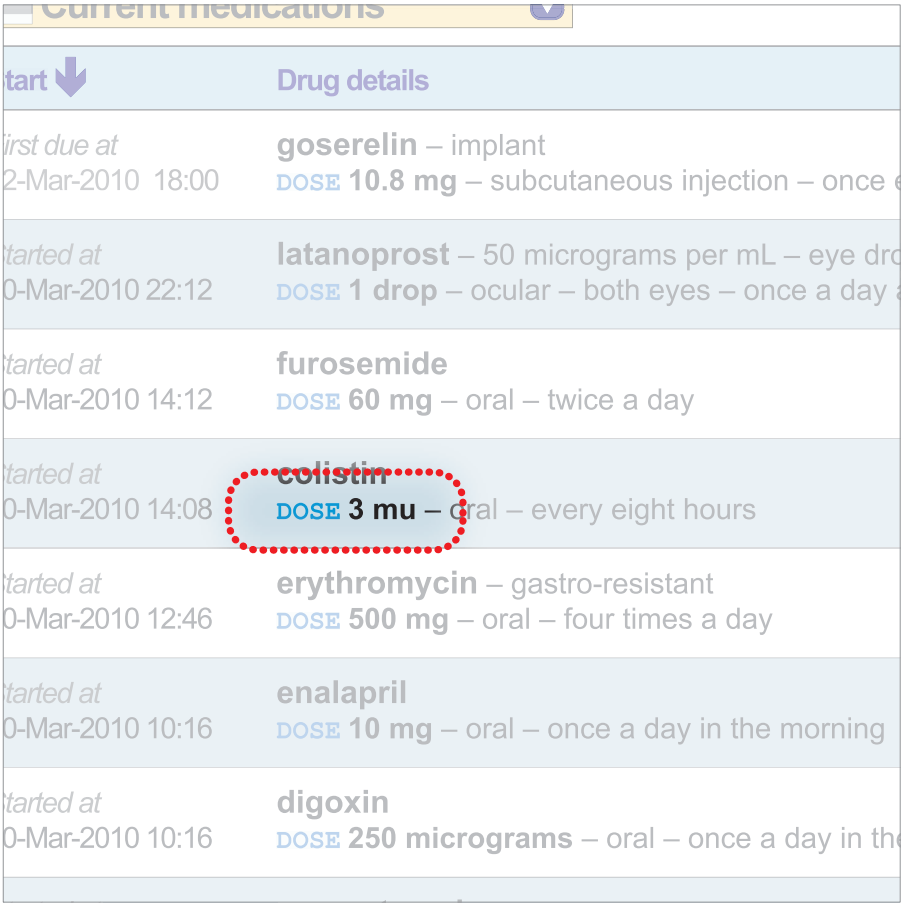


3.8 Confusion over the meaning of ‘m’ or ‘mega’

Issue

The word ‘mega’ can often cause confusion, as it can be mistaken for ‘thousand’ (because of the association with the prefix ‘milli’), either when written in full or when abbreviated to ‘m’ or ‘M’. ‘Mega’ can also cause problems when used in conjunction with ‘units’ (i.e. molecular quantities), as there is a high possibility of misreading the abbreviation ‘mu’ as ‘mg’.

In the example shown, either of these misinterpretations is possible. Neither is likely to lead to an actual error, because of the strengths available, and units of measure used on the packaging of corresponding drug products. However, misinterpretations of this kind lower confidence in IT systems and are easily avoided.

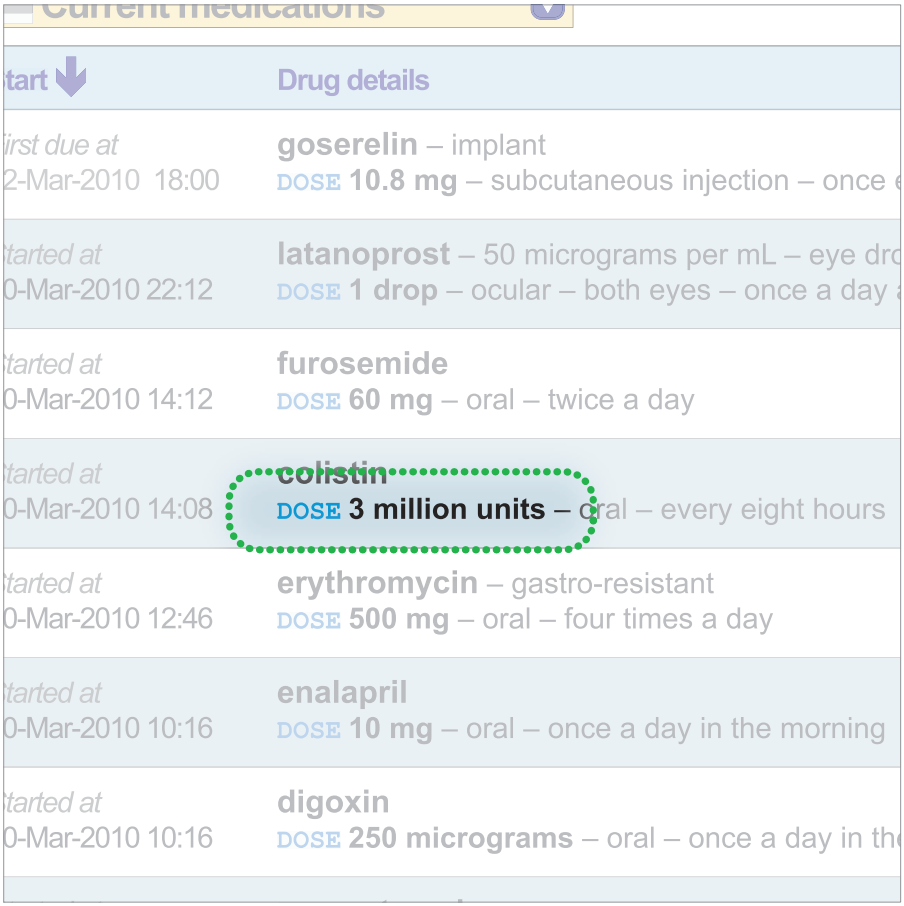


Recommendation

Use ‘million’ instead of ‘mega’.

Do not use ‘mega’ or ‘m’ to abbreviate ‘million’.

Always use the word ‘million’, written in full.



Design recommendations

4

General information display

In addition to the potential pitfalls described on the previous pages for component parts, misinterpretation and legibility problems can also arise when those parts are assembled together on-screen to describe a prescription or a drug product. These problems arise from the way that the component parts are placed in relation to each other, and the way that they are organised in relation to the whole screen.

Also, serious problems can emerge when prescription details or drug product descriptions are truncated in any way, as even experienced practitioners may be tempted to read the information that is visible and infer the contents of the rest.

Actual errors resulting from these problems are well-documented in patient safety literature and have been backed up by user research. Electronic prescribing systems can help avoid these errors by following some simple formatting rules, and by using modern software platforms which can successfully manage text wrapping and completely avoid truncation or partial display of prescription details and drug product descriptions.

4.1 Confusion caused by lack of differentiation between adjacent elements of a prescription

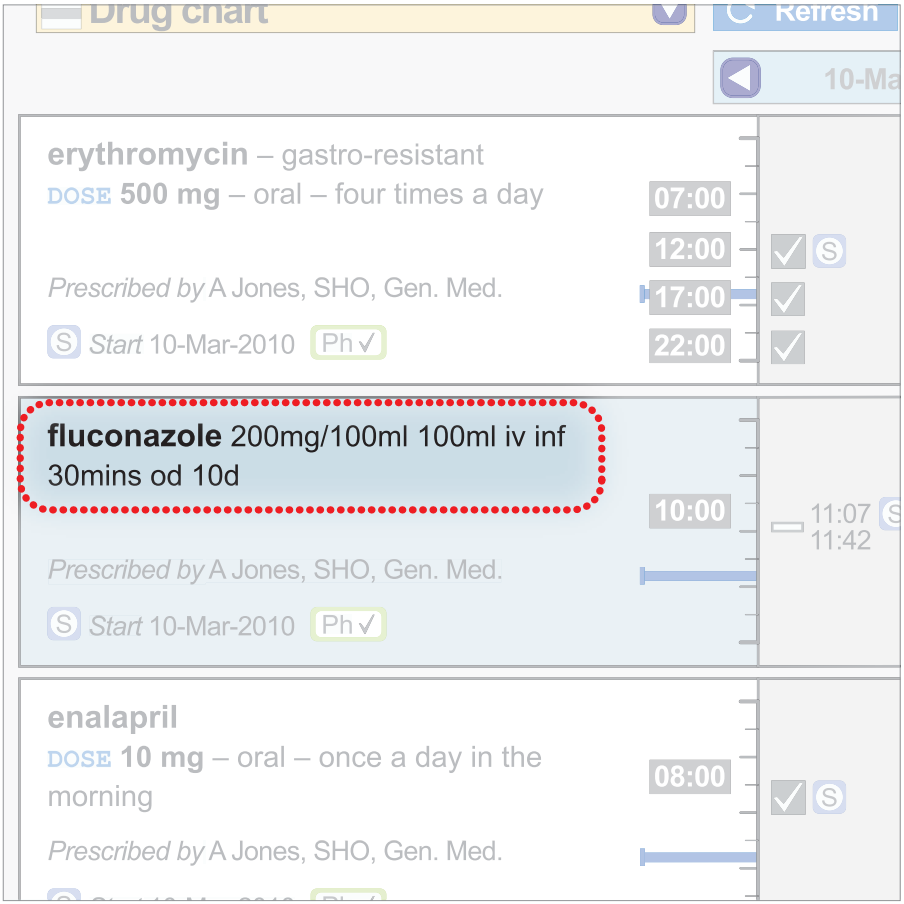
Issue

Confusion can be caused when adjacent elements of the prescription look similar.

In the case shown, the juxtapositions of '/100ml' with '100ml' and 'od' with '10d' might be confusing.

It is worth noting that a study carried out in 2003 in the UK found that approximately 50 per cent of doses of intravenous medications are given with some form of error in either preparation or administration.

Given this high rate of error in these complex, often high-risk medications, it is important to take any steps possible to minimise the risk of misreading information displayed on-screen.



Recommendation

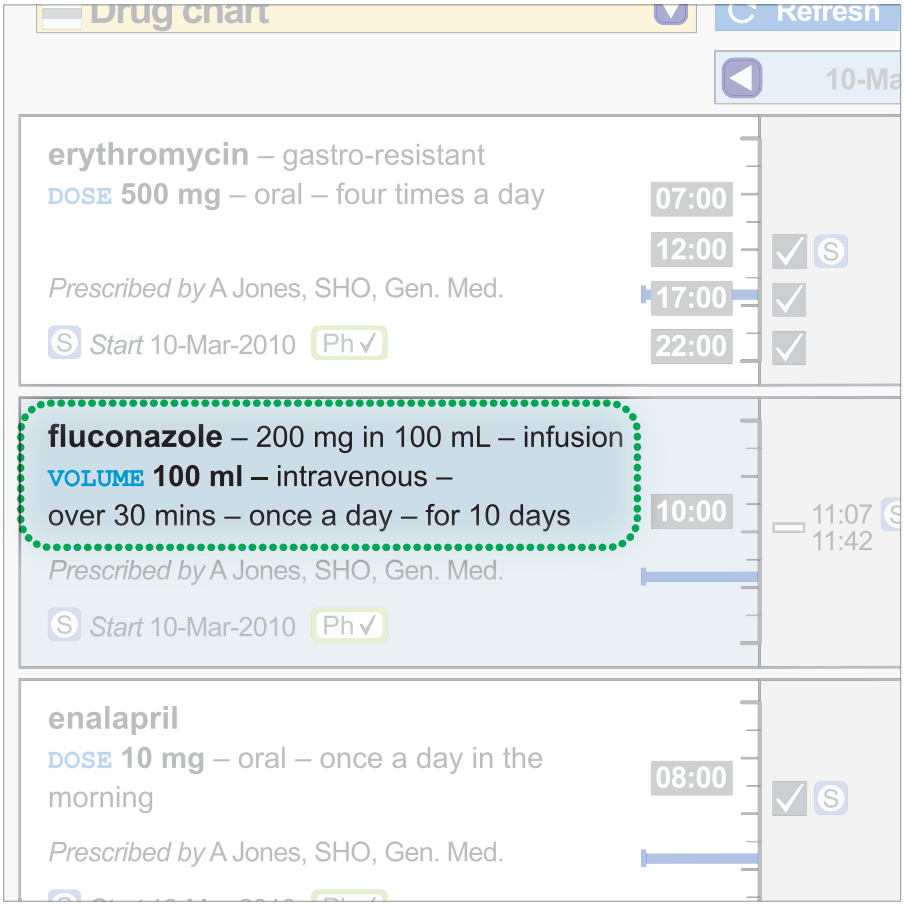
Use separators between adjacent elements of the prescription.

Firstly, use separators to help distinguish adjacent elements of a prescription, unless the elements are placed in adjacent cells of a grid or table.

The choice of character to use as a separator is also important. Guidance (CUI) recommends using a dash with a single non-breaking space on either side. An 'en' dash (see **en.wikipedia.org/wiki/dash**) is probably the best choice.

Do not use characters other than dashes as separators.

Secondly, follow CUI guidance on the placement of leading and trailing separators when wrapping text, and on the relationship between labels and separators.

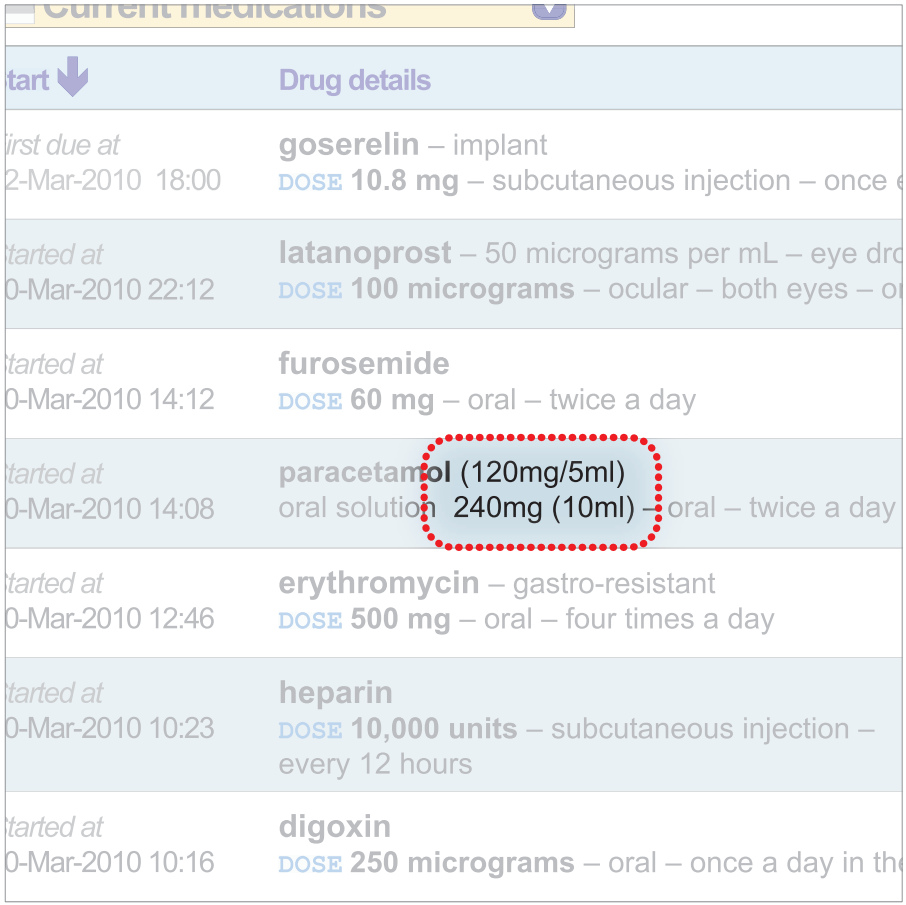


4.2 Confusion caused by visual dissociation between related elements of the prescription

Issue

Confusion can be caused by the way that information is displayed when it becomes too long to fit onto a single line. If not handled in a well-controlled manner, this 'text wrapping' can result in unclear juxtapositions of similar elements of the prescription, thereby increasing the possibility of confusion between them.

In this case, the strength of the drug product specified (which should be displayed as '120 mg in 5 mL') is shown directly adjacent to the dose in a way which makes confusion between the two perfectly possible. This could result in a lower dose being administered to the patient, potentially resulting in incomplete relief from pain.



Recommendation

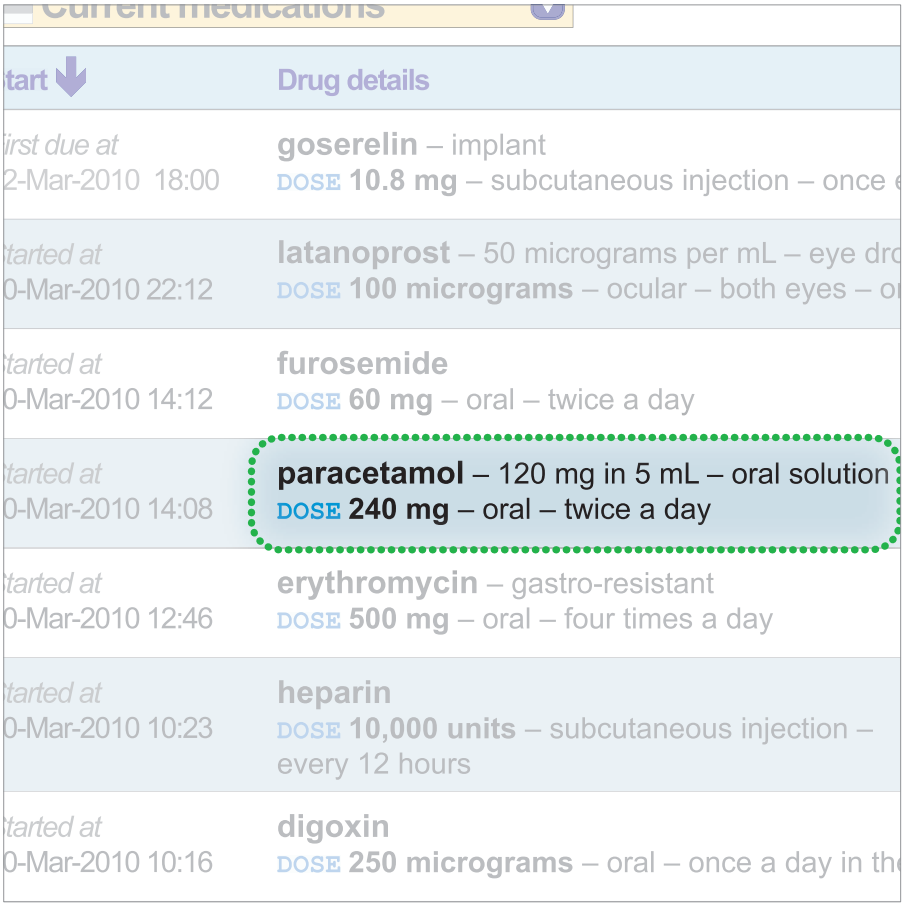
Follow CUI guidance on how to wrap prescriptions so that related data and labels are properly positioned.

Firstly, where possible, design screens so that the likelihood of wrapping is reduced to a minimum. However, wrapping may be required in some circumstances and must be planned for.

Secondly, where wrapping is required, follow CUI guidance to ensure that:

- data, labels and separators remain correctly associated;
- words are not broken by inappropriate hyphenation.

When used in conjunction with other recommendations in this guide, this will reduce the possibility of error due to unexpected visual associations.

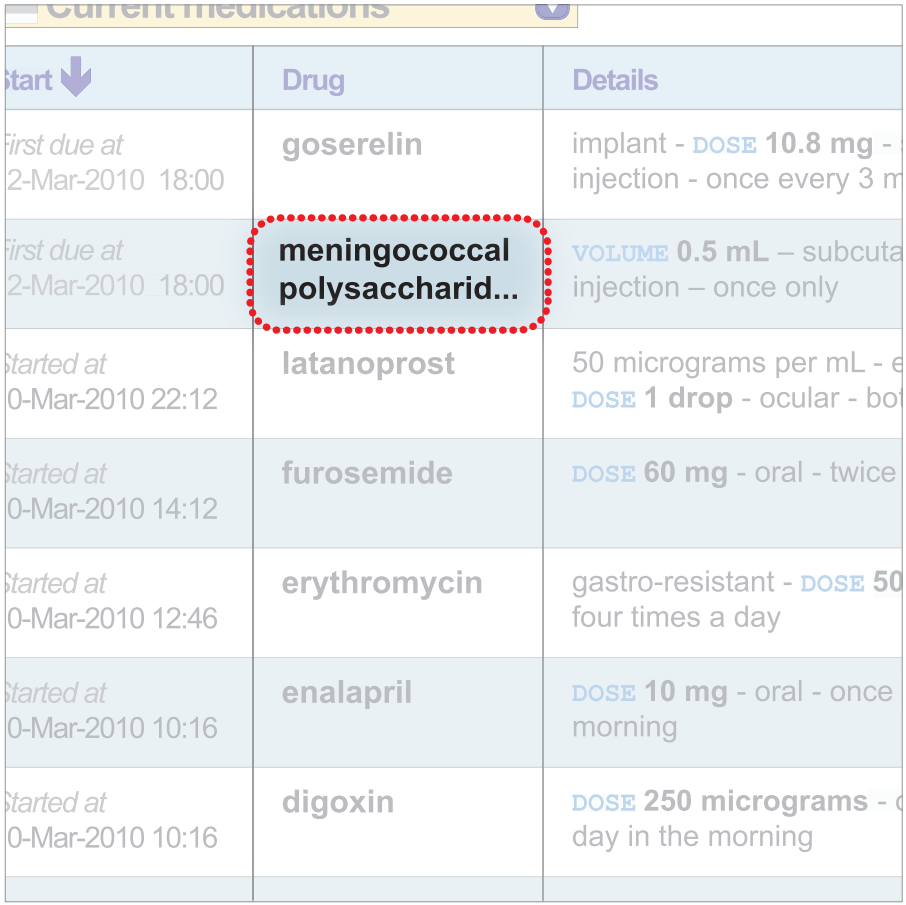


4.3 Misinterpretation caused by part of the prescription not being visible

Issue

Confusion can be caused by any part of the prescription not being fully visible, for example when information within a particular section of the screen is too large to be accommodated within the space available, and is truncated as a result.

This may tempt users to assume that they know what is hidden, when in fact the hidden information may not be as expected. In this case, it might be reasonable to assume that the hidden information is 'A and C vaccine', as this is the name of a commonly-used vaccine, when in fact it is 'A, C, W135 and Y vaccine'. This is a specific instance of a more general problem, where an incorrect assumption would lead to the administration of the wrong drug or dose.

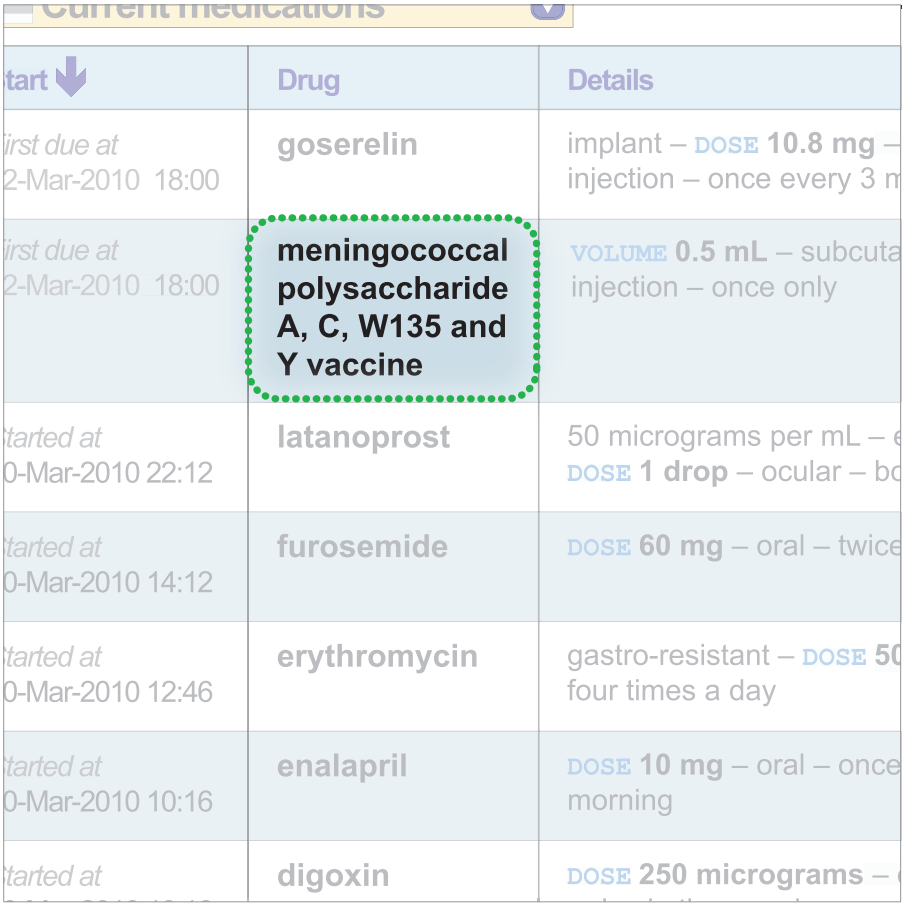


Recommendation

Never truncate any part of the prescription within a cell.

Do not truncate information which is too large to be accommodated within the standard size of the element of the screen in which it belongs.

Instead, follow CUI guidance on wrapping, even if this means that fewer prescriptions overall are displayed. This can be easily achieved by using modern standard display technologies which allow screen elements to expand dynamically to contain whatever information is provided.



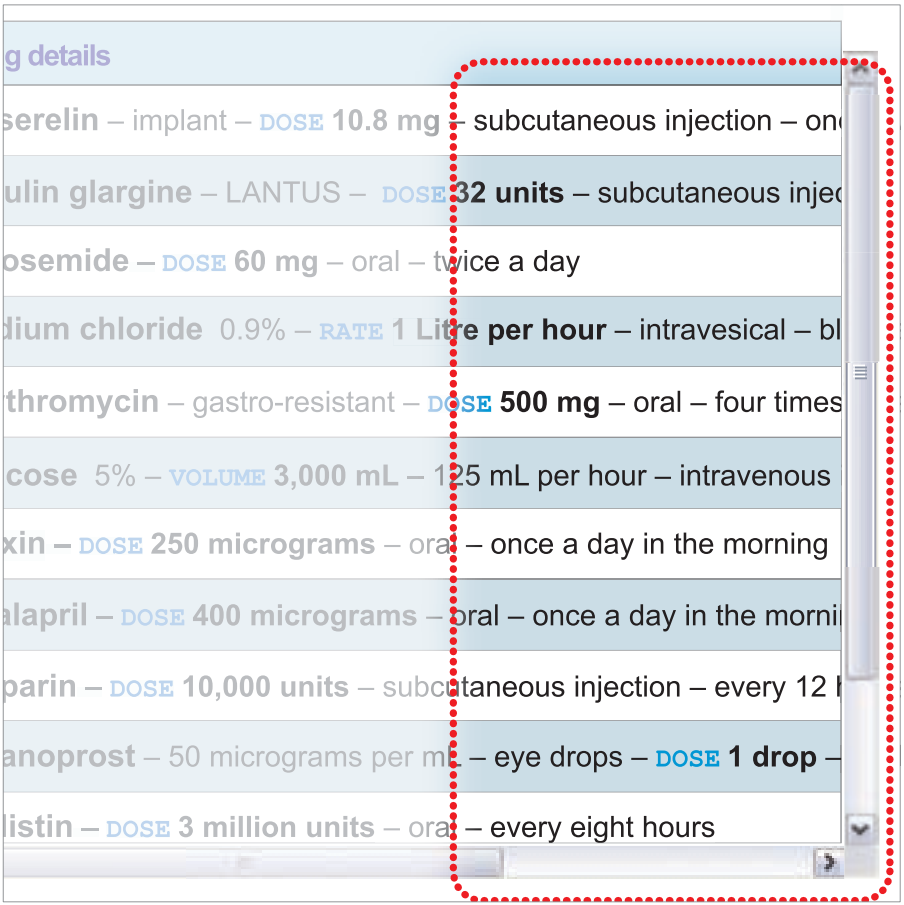
4.4 Misinterpretation caused by part of the prescription not being visible

Issue

Confusion can be caused by any part of the prescription not being fully visible. In general terms, this may tempt users to assume that they know what is hidden, when in fact the hidden information may not be as expected.

This is a particular problem when the method of making the information visible is to scroll horizontally. Horizontal scrolling is no longer acceptable in terms of general web usability, and is even less acceptable within safety-critical healthcare IT software.

Years of usability testing have shown that users do not notice visual cues associated with horizontal scrolling, and overlook information as a result. It can never be guaranteed that the hidden information will not be critically important.



Recommendation

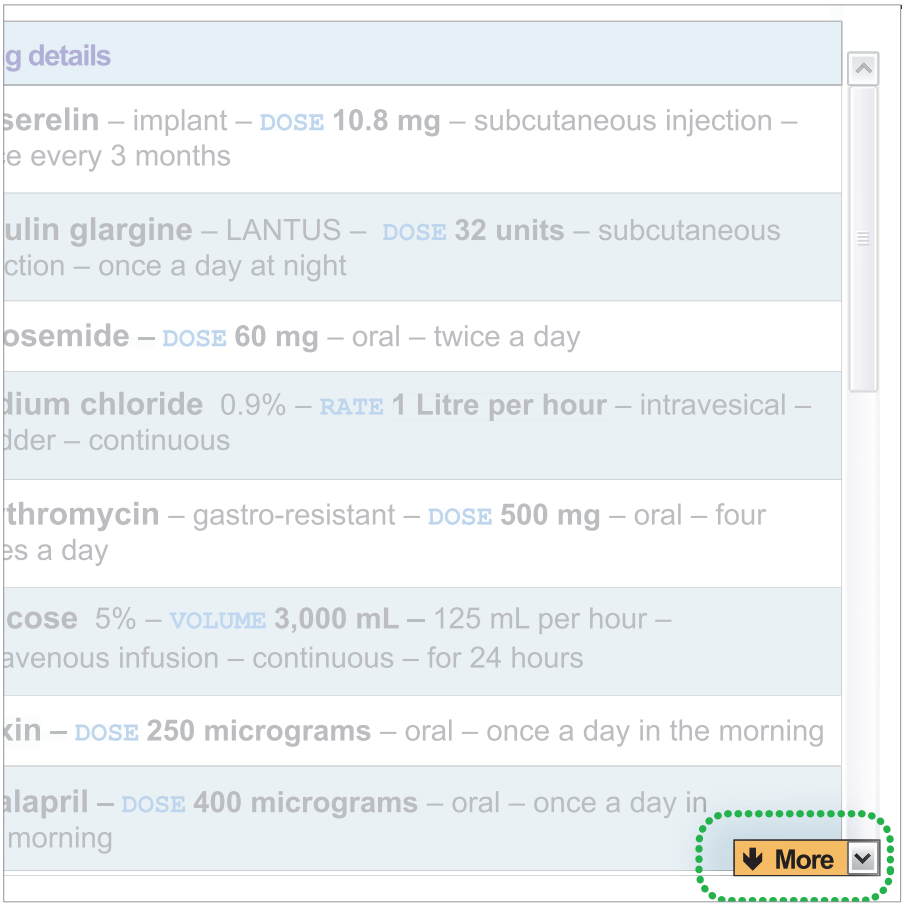
Never allow any part of the prescription to scroll horizontally off-screen, and use a look-ahead scroll notification.

Do not use horizontal scrolling.

Firstly, follow CUI guidance on wrapping, as described on page 51, even if this means that fewer prescriptions overall are displayed.

Secondly, follow CUI guidance by introducing a 'look-ahead scroll notification', as shown here, and ensure that the notification does not overlay or truncate other information. This notification alters the standard scroll-bar control and reminds the user that more information is viewable 'below the fold', i.e. scrolled off-screen.

These recommendations will improve safety by ensuring that all required information is immediately visible, and reminding users to scroll down long lists.



Further reading

Further reading

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Taxis K, Barber N. Ethnographic study of incidence and severity of intravenous drug errors. *BMJ*. 2003; 326: 684-687

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Vincent C, Neale G, Woloshynowych M. Adverse events in British hospitals: preliminary retrospective record review. *BMJ*. 2001; 322: 517-519

Wilson RM et al. An analysis of the causes of adverse events from the quality Australian health care study. *Med J Aust.* 1999; 170: 411-415

World Health Organization (WHO) Collaborating Centre for Patient Safety Solutions. Information available at: **www.ccforpatientsafety.org/Patient-Safety-Solutions**

Appendices

Appendix 1 – Units of measure and how to display them on-screen

For on-screen display, always use the form defined below and, if the form is abbreviated, use the abbreviation consistently; do not use the full description in some cases and the abbreviation in others. Also, unless noted otherwise below, do not use the plural form of abbreviations.

The use of upper case and lower case in the following abbreviations is deliberate and must be followed.

Unit of measure	On-screen display	Notes
centimetre	**cm**	
gigabecquerel	**GBq**	
gram	**g**	
hour	**hr**	Plural form allowed where appropriate, i.e. 'hrs'
international units	**int unit**	
kilobequerel	**kBq**	
kilogram	**kg**	
litre	**Litre**	Do not abbreviate 'Litre' when used in isolation
metre	**m**	
megabequerel	**MBq**	
mega units	**NOT TO BE USED**	Unless the drug cannot be described in any other way, or if alternative would directly contradict product packaging.
milligram	**mg**	
microgram	**microgram**	Do not abbreviate
microlitre	**microlitre**	Do not abbreviate
micromol	**micromol**	Do not abbreviate
minute	**min**	Plural form allowed where appropriate, i.e. 'mins'
millilitre	**mL**	Abbreviate 'Litre' when used in a word
millimetre	**mm**	
millimolar	**millimolar**	Do not abbreviate
millimole per litre	**millimole per L**	Abbreviate 'Litre' when used in a phrase
millimole	**mmol**	
mole per litre	**mole per L**	Abbreviate 'Litre' when used in a phrase
nanogram	**nanogram**	Do not abbreviate
square centimetre	**sq cm**	
unit	**unit**	Do not abbreviate. Plural form allowed where appropriate, i.e. 'units'

Appendix 2 – User involvement

The proper involvement of end-users is an indispensable part of designing and implementing any HIT software.

While it is not the purpose of this booklet to give complete guidance on how properly to involve end-users in software design, it may be helpful to provide some points for consideration – particularly in relation to the way in which the recommendations in this booklet were designed and assessed.

ISO 9241 Part 11 defines usability as the 'extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use.'

Without properly involving end-users (the 'specified users'), and specifying their goals and the contexts in which they work, it is very hard (if not impossible) to produce usable software. This is particularly true in HIT, where processes and information needs are very complex, and the 'context of use' (i.e. healthcare settings) can be extremely pressured and challenging for both healthcare professionals and patients.

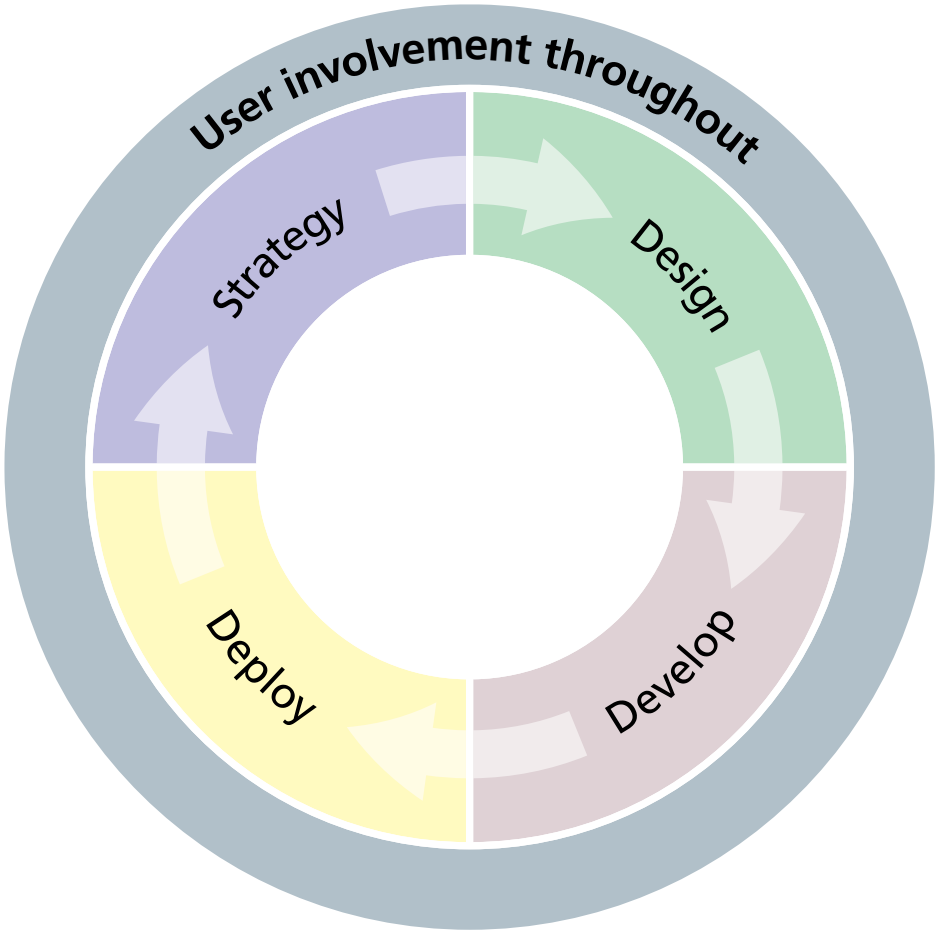
It is also worth noting that, within HIT, there are few successful usability precedents and patterns for software developers to base their products on. This is in contrast to other industries (e.g. finance, telecommunications, web shopping and services) where years of high investment in IT and a strong commercial focus have combined to produce a sophisticated awareness of the rewards of good usability.

In an attempt to redress this deficit, NHS CFH and the NPSA, through initiatives such as the ePrescribing and CUI programmes, and the NPSA's alerts, directives, tools and guidance, have worked to provide precedents and patterns which are usable and safe for the healthcare sector – some of which are included here.

The involvement of end-users has played an important role in the development of this booklet, particularly within the CUI programme. In more general terms, for user involvement to be beneficial, the software development lifecycle must have certain key characteristics:

- The overall lifecycle must comply with ISO 13407 (currently under development as ISO 9241 - 210); this still allows flexibility in the detail of the process.
- The lifecycle must be rapid and iterative so that it is possible to respond quickly to user input and requests for change.
- Iterations must be planned so that intelligence from users' involvement in previous releases can be fed into ongoing and future development.
- End-users must be involved throughout so that all aspects of the lifecycle can be focused on defining and achieving an acceptable level of usability.
- End-users must be involved in appropriate and productive ways, for example, so that they engage with realistic prototypes rather than technical specifications, and retain their own perspective rather than learning to be software developers.
- User involvement must include, but not be restricted to, professionally-conducted usability testing, with the results reported using the ANSI CIF (Common Industry Framework) structure to ensure completeness.
- A safety management process, involving end-users as well as subject-matter experts, must be part of the lifecycle so that usability issues can be mitigated and not become a risk to patient safety.
- Usability and user-centred design professionals must be centrally involved in the process.

Like infection control in hospitals, successful software development organisations have realised that usability is everyone's responsibility, not just the preserve of a small number of specialists. By bearing this in mind, and re-working the development lifecycle in line with the recommendations above, usability in HIT software can be significantly improved.


User involvement throughout
Strategy
Design
Develop
Deploy

Appendix 3 – Stakeholder review panel

A stakeholder review panel was formed to ensure this booklet addresses a wide and representative range of issues, across care settings and international boundaries.

Name	Role	Affiliation
Andrea Gill	Clinical Pharmacy Services Manager	Alder Hey Children's NHS Foundation Trust, UK
Ann Slee	Clinical Lead, ePrescribing programme	NHS Connecting for Health, UK
Chris Curtis	Head of Pharmaceutical Services	Burton Hospitals NHS Foundation Trust, UK
David Bates	Director, Center for Patient Safety Research and Practice	Brigham and Women's Hospital, US
David Cousins	Head of Safe Medication Practice and Medical Specialties	National Patient Safety Agency, UK
David Gerrett	Senior Pharmacist, Safe Medication Practice and Medical Specialties	National Patient Safety Agency, UK
Hillary Judd	Head of Knowledge Base Services	First DataBank (Europe), UK
Jamie Coleman	Consultant, Clinical Pharmacology and Senior Lecturer	University Hospital Birmingham, UK
Jonathan Meadows	General Manager and Clinical Safety Officer	Egton Medical Information Systems Ltd (EMIS), UK
Kit Lewis	User Experience Lead, ePrescribing programme	NHS Connecting for Health, UK
Lesley Brown	Principal Pharmacist	Burton Hospitals NHS Foundation Trust, UK
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