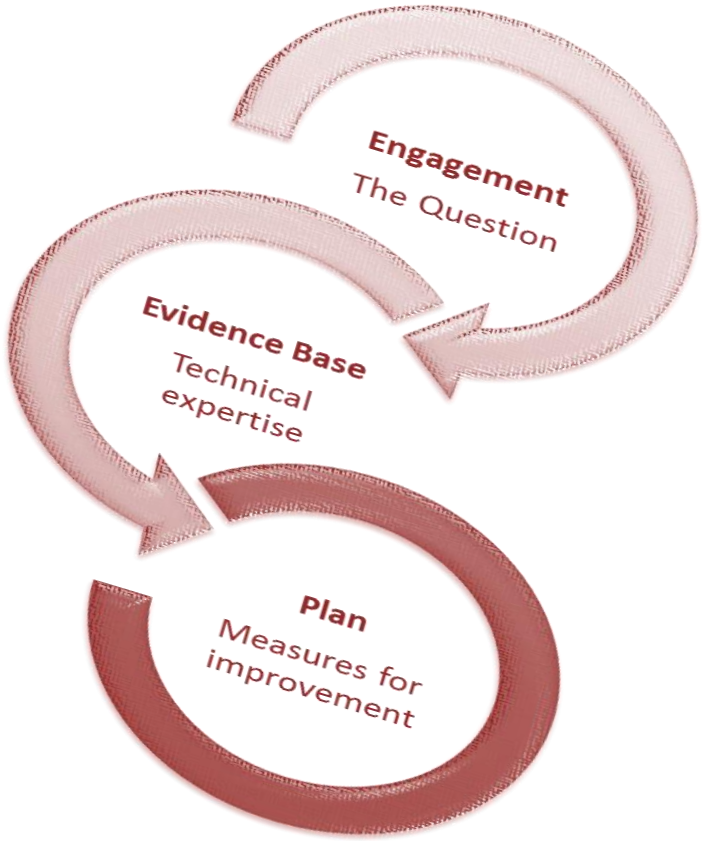
The Health Foundation - Advancing Applied Analytics Programme

Can interactive data visualisation help clinicians improve patient care?



Design Principles

How the project came about

Funding from the Health Foundation

- Advancing Applied Analytics Programme

“Aims to improve analytical capability in support of health and care services and provide lessons for the wider care system.”

Aims of the project

1. To engage with clinicians, to understand their requirements for interacting with data on quality of care, and to explore the ways in which interactive data visualisation in real 'day-to-day' practice can help them improve patient care.

2. To use the insight gained in step 1, to adapt 3 existing NEQOS products using 'off-the-shelf' data visualisation software, creating exemplar outputs for piloting in North East & North Cumbria acute trusts that subscribe to NEQOS. The products selected were:
   - *Maternity profile*
   - *Hip and knee dashboard*
   - *Mortality report/slides*

3. To share the learning from the project locally, regionally & nationally.

Method

- Three-pronged start to the project:
  - Choosing the data visualisation software;
  - Rapid literature review of the evidence base for data visualisation and dashboard design principles in clinical settings;
  - Choosing the NEQOS outputs to be adapted.

- Initial exploration of clinician requirements through interviews, focus groups and regional meetings, using a topic designed with input from a digital design company (Orange Bus);

- Development of prototype dashboards in Tableau;

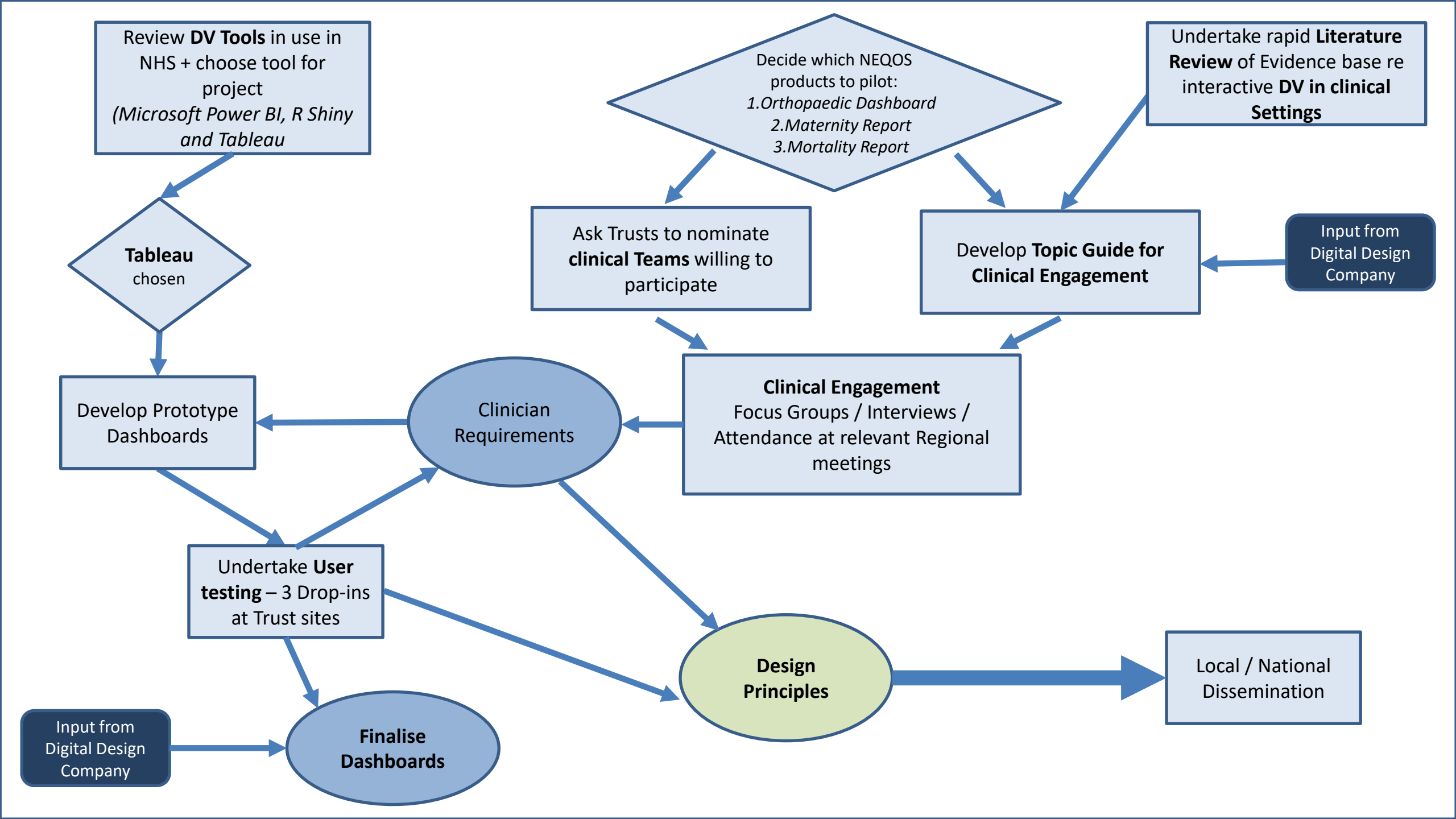
Method (2)

- Drop-in sessions at 3 trusts to enable:
  - clinicians to interact with the prototypes / provide feedback; and
  - the NEQOS team to assess the end-user experience.

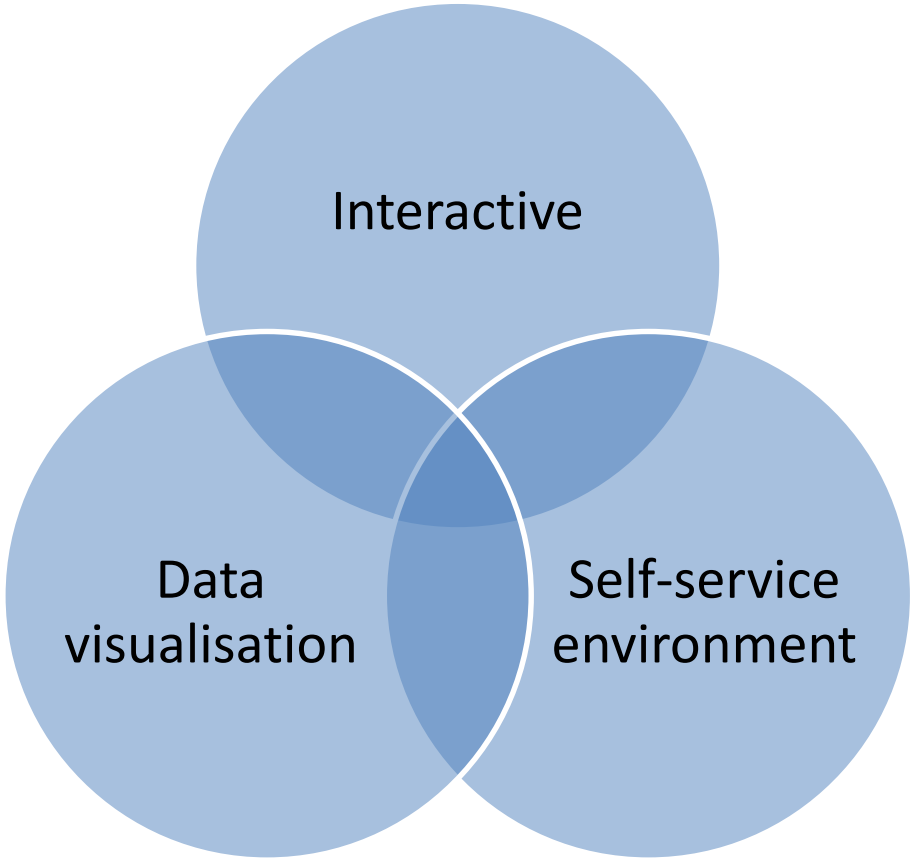
- Digital design company carried out a “light touch review” of the prototypes focusing on ease of use, navigation and content surrounding the visualisations;

- Resulting in updated clinician requirements & further refinement of the dashboards;

- Generation of generalisable design principles for using DV tools in clinical settings.


Review **DV Tools** in use in NHS + choose tool for project *(Microsoft Power BI, R Shiny and Tableau*
Decide which NEQOS products to pilot:
1.Orthopaedic Dashboard
2.Maternity Report
3.Mortality Report
Undertake rapid **Literature Review** of Evidence base re interactive **DV in clinical Settings**
Tableau chosen
Ask Trusts to nominate **clinical Teams** willing to participate
Develop **Topic Guide for Clinical Engagement**
Input from Digital Design Company
Develop Prototype Dashboards
Clinician Requirements
Clinical Engagement Focus Groups / Interviews / Attendance at relevant Regional meetings
Undertake **User testing** – 3 Drop-ins at Trust sites
Design Principles
Local / National Dissemination
Input from Digital Design Company
Finalise Dashboards

Caveats



- Limited to aggregated/group level data for quality measurement and audit purposes (not operational / record level data).
- Not a full review of generic visual design principles.
- User experience of interacting with the dashboards was obtained via two rounds of drop-ins only.

Existing Relevant Design Principles* - example

- The UK government has a set of 10 design principles which have some relevance for public service webpages (https://www.gov.uk/guidance/government-design-principles). The NHS is a public service and we have noted a degree of overlap with our design principles described later (highlighted in red).

1. Start with user needs
2. Do less
3. Design with data
4. Do the hard work to make it simple
5. Iterate. Then iterate again.
6. This is for everyone
7. Understand context
8. Build digital services, not websites
9. Be consistent, not uniform
10. Make things open: it makes things better

- There is a difference between audiences in that the webpages are intended for the general public rather than purely clinicians.

**To note: this project has not conducted a full review of visual design principles.*

Design Principles

Summary of Design Principles generated through the project

1. End-user (clinician) engagement in the design stages is essential for getting the functionality of an interactive data visualisation (DV) tool/dashboard right for them and ensuring acceptability.
2. Be clear about the main clinical question(s) for end-users and design the DV tool /dashboard accordingly.
3. Data should be as up-to-date as possible (and consider excluding data that is too old to answer the question(s)).
4. Ensure that the DV tool/ dashboard is self-explanatory to end-users to use (no significant IT skills / conventional User Manual required).
5. Be cognisant of recognised visual design principles.
6. Ensure that the DV tool/dashboard is easy to navigate.
7. Ensure that selections made within the DV tool/dashboard are retained as users navigate the dashboard / DV tool.
8. Ensure that the dashboard/ DV tool has the capability for outputs to be extracted for inclusion in users' own reports and presentations.
9. Include interpretive narrative where interpretation is required, ensuring that you avoid "busy" visuals and information overload.
10. Static and interactive dashboards both have a useful role, as static reports may still be required to be provide overviews of care quality and interactive DV tools/dashboards may be required to allow 'deep dives'.

1. End-user (clinician) engagement

End-user (clinician) engagement in the design stages is essential for getting the functionality of an interactive data visualisation (DV) tool/ dashboard right for them and ensuring acceptability.

- For a DV tool/dashboard to be used to inform quality improvement it needs to be acceptable to the end-users (clinicians). Acceptability is increased if users are involved in the design stages.

- Clinicians involvement in the design phase allows exploration of how a clinician would use a dashboard/DV tool and therefore functionally is not based on supposition from the development team.

1. End-user (clinician) engagement

- Due to their clinical commitments and competing priorities, engagement with clinicians has to be shaped and adapted to fit a clinical model.

- Use creative methods to ensure that you get sufficient clinician engagement.

  - focus groups
  - 1-2-1 interviews
  - telephone discussions
  - regional meetings

  } Round 1

  - ‘Drop-in’ events at Trusts
  - SurveyMonkey
  - Emails
  - Post-it note challenge

  } Round 2

2. Be clear about the clinical question

Be clear about the main clinical question(s) for end-users and design the DV tool / dashboard accordingly.

- Avoid the temptation to answer questions that are not being asked, just because you have a large dataset.

- The clinical question can often be focussed with a number of follow-up questions if necessary.

- This can cause data overload, potentially leading to the key information being missed. A dashboard/visualisation should “filter the noise” so that the “signal” is easier to find in all the information.

2. Be clear about the clinical question

Use the right level of data to answer the question - requirements for overviews of care quality compared to 'deep dives' are likely to be different.

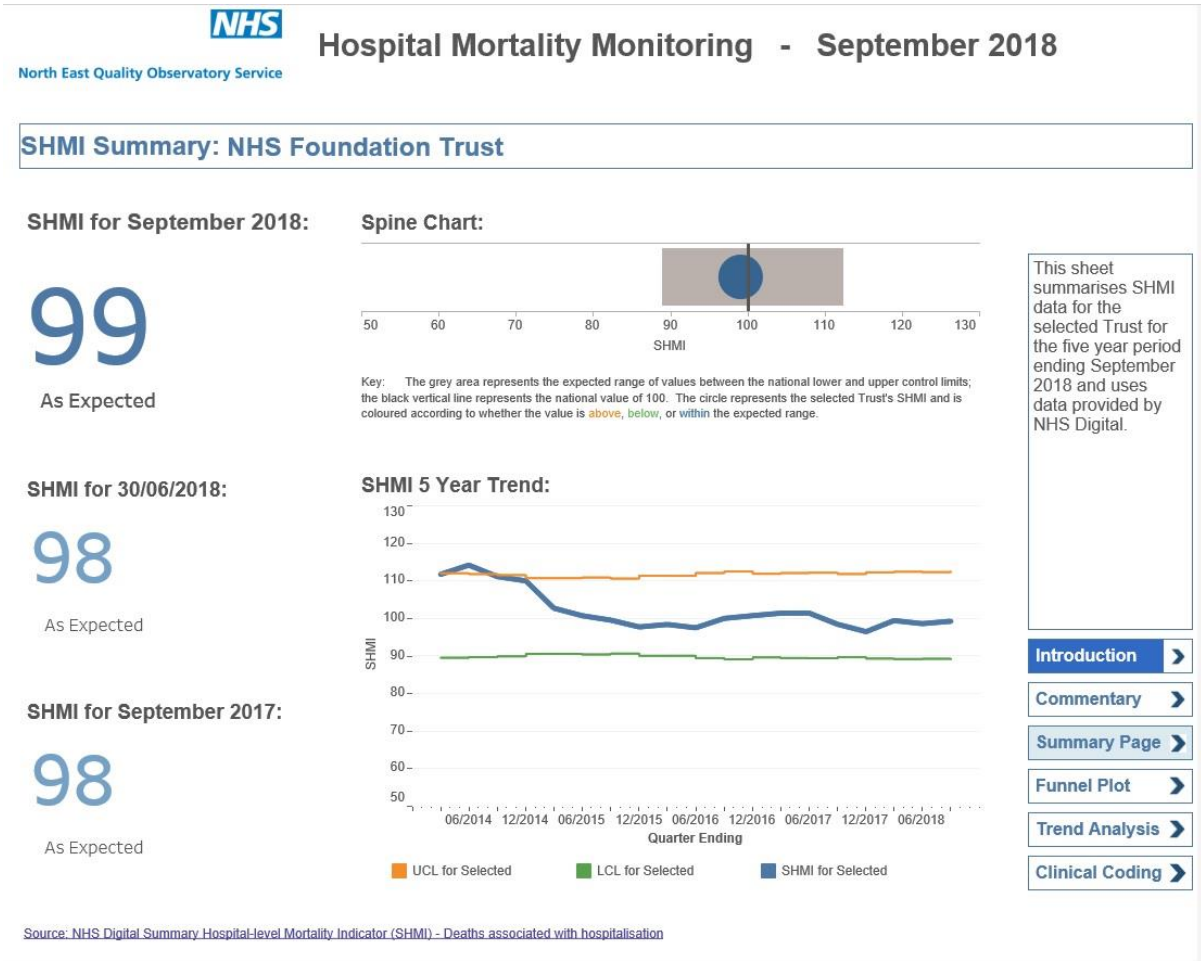
- When end-users would like to have an overview of their clinical unit they are asking a different set of questions than when exploring the data to find out in-depth information about different aspects of quality.

- Therefore a dashboard / DV tool should ideally be designed to allow for various levels of detail depending on the questions being asked. For example:

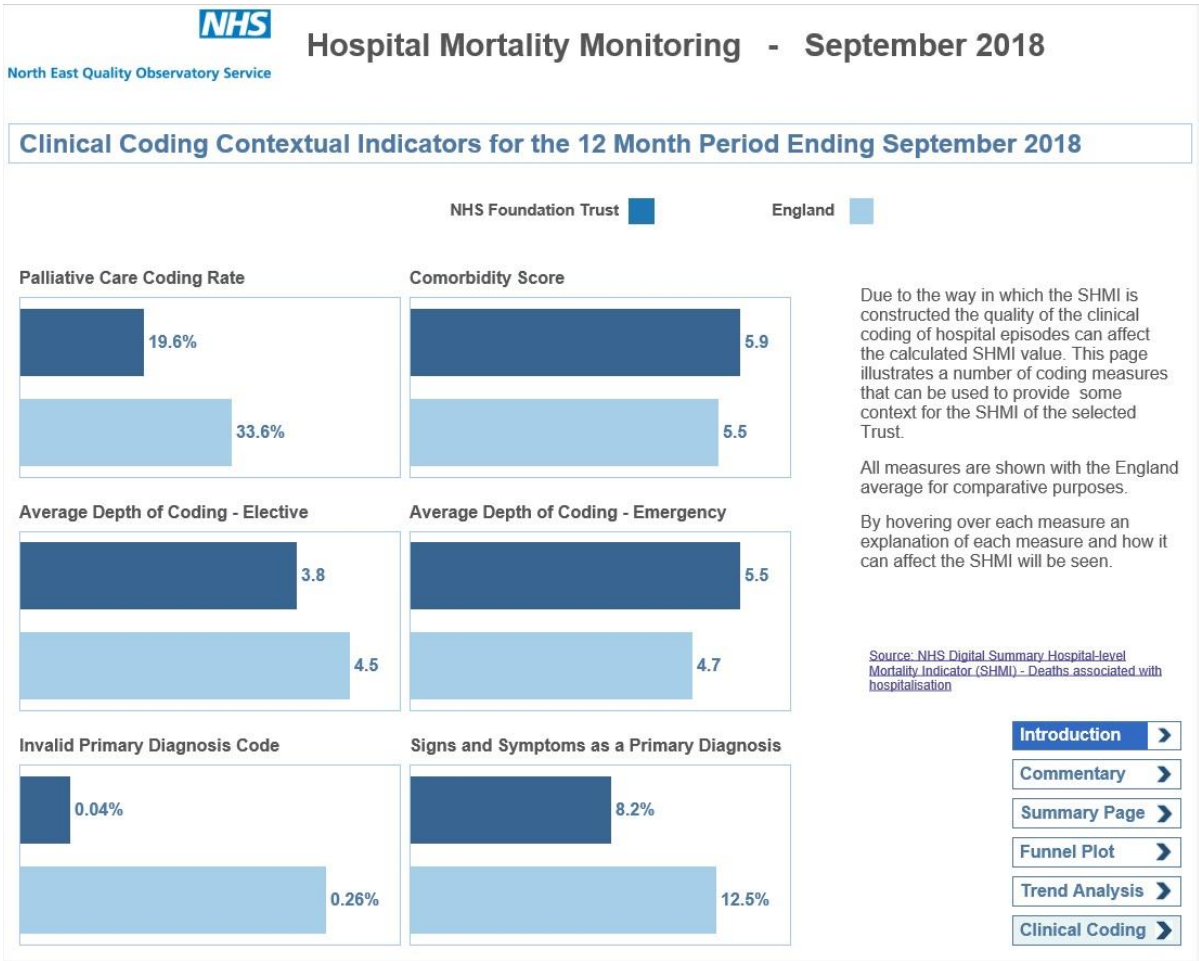
  - Overview of data: Number of hip replacements per Trust per year
  - Deep dive of data: Number of hip replacements by fixation method and by surgeon per year

2. Be clear about the clinical question - example

North East Quality Observatory Service



Mortality Overview



Mortality Deep-Dive

3. Timely data

Data should be as up-to-date as possible (and consider excluding data that is too old to answer the question(s)).

- Data may lose some of its power and become irrelevant if it is “old”.

- Decisions on quality of care should be made based on the most recent data available that is considered useful.

- Consider excluding metrics based on underlying data that clinicians consider to be too old to provide useful insights.

3. Timely data

"I don't use data if it is more than 2 years old"

Clinical Drop-in Participant
(Maternity)

MBRRACE-UK Perinatal Mortality Surveillance report for births in 2017

MBRRACE-UK is pleased to announce the publication on the 10th October 2019 of the MBRRACE-UK Perinatal Mortality Surveillance Report for Births in 2017.

- Full Report
- Summary Report
- Four page overview
- Infographic
- Downloadable tables in excel

4. Ease of use

Ensure that the dashboard / DV tool is self-explanatory to end-users to use (no significant IT skills / conventional User Manual required).

- End-users have limited amount of time to learn how to use a new tool. Therefore in order to maximise usage, the tools and their navigation need to be self-explanatory and should not require a qualification in IT/Computing to be able to interact with the data with little lead-time.

- There should be no need for a conventional User Manual to be able to interact with the data.

- Incorporated tool tips and explanatory text, whilst taking account of the need to balance layout and utility of the information.

4. Ease of use

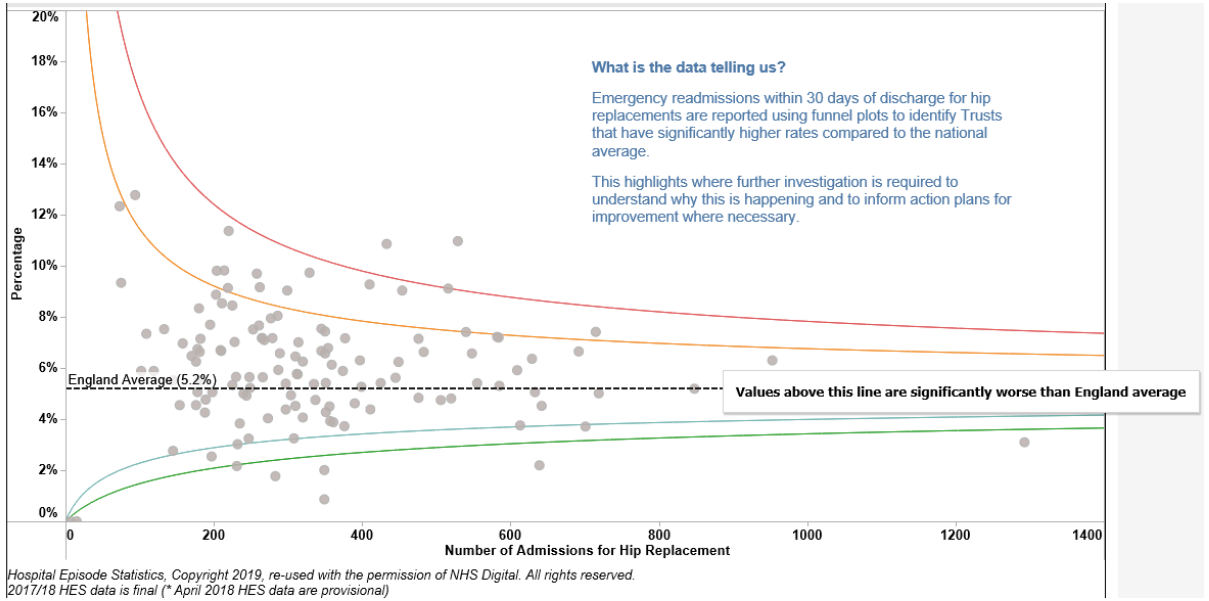
Incorporating details of “how to” into the dashboard

“How to” – Tool and function

- Clinicians require the dashboards to be self-explanatory with hovering to explain how something works - there should not be a need for a user manual.

“How to” – Data content

- There is a requirement for some explanation of what the content is demonstrating.



5. Cognisant of visual design principles*

Be cognisant of recognised visual design principles

- Layout / formatting are important - There needs to be a good balance between visual complexity and information utility.
- The information needs to be sufficient to be helpful and provide answers without the visualisation being too complex to provide easy-to-view answers to a question.
- When choosing colour for a dashboard be careful about using colour that may have a meaning that you didn't intend (e.g. Red, Amber, Green).
- Font size needs to be easily legible.

**To note that this project has not conducted a full review of visual design principles*

5. Cognisant of visual design principles

Be cognisant of recognised visual design principles

- It is important that there is consistency across a single dashboard. The screens and components need visual consistency and formatting – they should look like they are related or part of a collection.

- It may be important that there is consistency between dashboards. When dashboards are being presented as part of a package or as multiple products from the same institution it may be advisable to have consistency across the set.

- Once a functionality is set-up on one viz the users expected all further vizes to have the same functionality and feel.

5. Cognisant of visual design principles - example

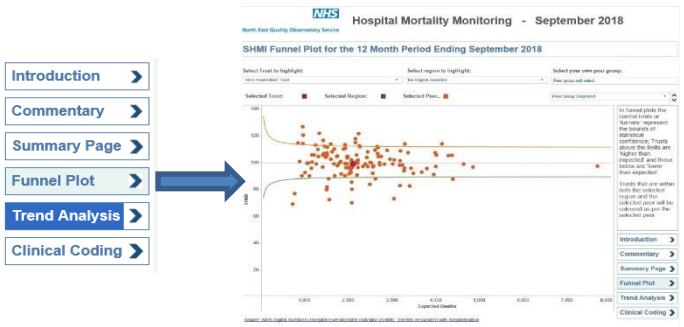
North East Quality Observatory Service

Visualisation

Developers of a dashboard/DV tool should be cognisant of PARC principles (Proximity, Alignment, Repetition and Contrast) and Gestalt principles, for example:

- It is human nature to look for patterns whether they exist or not;
- It will be assumed that if something looks similar it will function similarly.

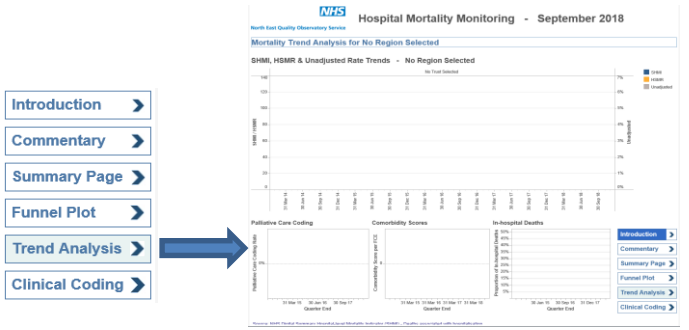
1.



The buttons for graphs 1 and 2 had similar layouts and positioning.

- The button on graph 1 produces the expected funnel plot.
- The button on graph 2 produces blank charts unless additional choices have been made on other vizes.

2.



Therefore the layout must be clear and understandable; anything in close proximity, aligned or with similar features will be assumed to be related.

6. Navigation

Ensure that the DV tool / dashboard is easy to navigate

- Navigation through a DV tool/ dashboard needs to be clear.
- The order or flow of metrics should make sense to clinicians.
- Don’t assume that users will navigate the tool the way that you intend.
- It should be clear to users where a link will take them.
  - This will reduce the guess work needed and speed up their navigation around the visualisations allowing users to focus on the data and not on finding their way around.
- Ensure navigation elements are consistent (same place, look the same, clear labelling) otherwise users will find it confusing.
  - It will be easy for users to “get lost” when the look and feel is inconsistent throughout the DV tool / dashboard. For example, menus need to be placed in the same place on each page, if possible.

7. Retention of users' selections

Ensure that selections made within the DV tool / dashboard are retained as users navigate the dashboard / DV tool.

- It is important that the selections make in one section of the dashboard are retained across all sections of the dashboard, this ensures that the visualisations are correctly interpreted.

Query saving

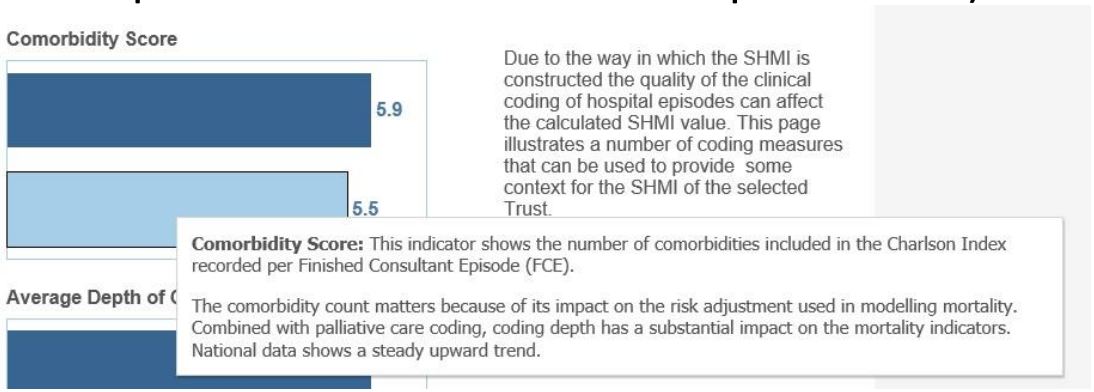
- Having set-up their own queries of the data, users need functionality that allows them to share them or re-run them at regular intervals.
- Being able to save the queries ensures that there is no variation in the question being asked at the next time-point and this should assist in validating the results and highlight any issues (e.g. being an outlier).
- To maximise the productivity of an interactive dashboard it should be possible for a user to save their queries to re-run again at a future date.

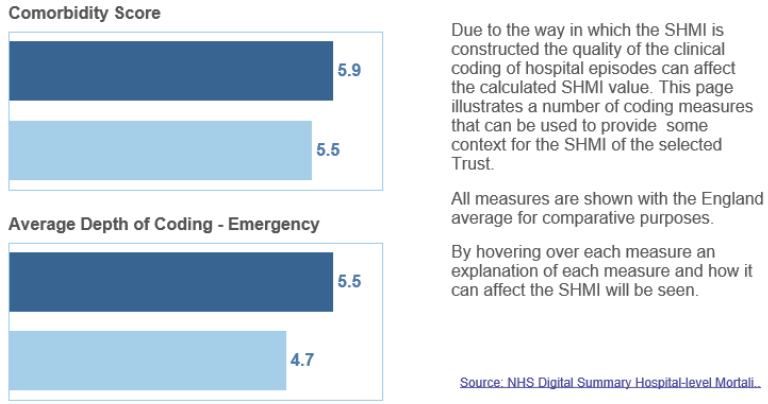
8. Extraction for presentations / reports

North East Quality Observatory Service

Ensure that the dashboard /DV tool has the capability for outputs to be extracted for inclusion in users' own reports and presentations.

- It should be possible to save the charts from a particular viz and download them.
- The charts should be saved in a format that allows them to be shared, either by email or by inserting them into a different document/ presentation.
- The layout of the charts should be conducive to extraction from the visualisation tool (i.e. interpretive text does not overlap the chart).





9. Explanation & Interpretation

Include interpretive narrative where interpretation is required, ensuring that you avoid "busy" visuals and information overload.

- Clinicians requested interpretive narrative where the definition of a metric (e.g. the OPCS codes have been used to define a procedure) or the meaning of the data (e.g. what is the funnel plot telling us?) is not obvious.
- Determining the "appropriate" level of detail to include is challenging, and requires engagement with clinician to assess their requirements.
- However too much explanatory text on a viz is unhelpful and should not obscure the contents of the charts.
- Explanatory text needs to be available to the end-users but should not impact on the users experience of interacting with the visuals (including the download of the information for slides etc). This may mean providing metadata on external webpages or URLs directing users to the original data sources.

10. Static and interactive products both have a useful role

Static and interactive dashboards both have a useful role, as static reports may still be required to provide overviews of care quality and interactive DV tools/ dashboards may be required to allow 'deep dives'.

- Don't assume that if you have produced an interactive product this means that the static product is no longer required. Both types of reports (static and interactive) have distinct roles which are both beneficial to clinicians.
    - This is related, at least in part, to outdated / restrictive technology that inhibits the use of online tools in the NHS.
    - Some clinicians reluctant to use online tools due to concerns with IT system reliability and possibility of technical difficulties, preferring to rely on static outputs that have been shared with them, for example via email.
    - Static reports have limited content in that the questions cannot be changed while interactive reports allow the user to ask their own questions.

10. Static and interactive products both have a useful role

"Static reports are good when you are time challenged whereas dynamic reports are good when you have time to spend."

Clinical Drop-in Participant

Distillation – alternative option

A Digital Design Company (Orange Bus) was asked to review our design principles and as a result we now have an alternative option of 7 more refined principles, a distillation of the original 10.

1. Clinicians are involved every step of the way

End-user (clinician) engagement in the design stages is essential for getting the functionality of an interactive data visualisation (DV) tool/dashboard right for them and ensuring acceptability.

2. Lead with the right clinical question

Be clear about the main clinical question(s) for end-users and design the DV tool /dashboard accordingly.

3. Make data timely and relevant

Data should be as up-to-date as possible (and consider excluding data that is too old to answer the question(s)).

Distillation – alternative option

4. There's no learning curve for users

Ensure that the DV tool/ dashboard is self-explanatory to end-users to use (no significant IT skills / conventional User Manual required). Ensure that the DV tool/dashboard is easy to navigate.

5. There's no need to reinvent the wheel

Be cognisant of recognised visual design principles. Include interpretive narrative where interpretation is required, ensuring that you avoid "busy" visuals and information overload.

6. Data is flexible and shareable

Ensure that the dashboard/ DV tool has the capability for outputs to be extracted for inclusion in users' own reports and presentations.

7. The right tool for the job

Static and interactive dashboards both have a useful role, as static reports may still be required to be provide overviews of care quality and interactive DV tools/dashboards may be required to allow 'deep dives'.

Summary - Design Principles (Original)

1. End-user (clinician) engagement in the design stages is essential for getting the functionality of an interactive data visualisation (DV) tool/dashboard right for them and ensuring acceptability.
2. Be clear about the main clinical question(s) for end-users and design the DV tool /dashboard accordingly.
3. Data should be as up-to-date as possible (and consider excluding data that is too old to answer the question(s)).
4. Ensure that the DV tool/ dashboard is self-explanatory to end-users to use (no significant IT skills / conventional User Manual required).
5. Be cognisant of recognised visual design principles.
6. Ensure that the DV tool/dashboard is easy to navigate.
7. Ensure that selections made within the DV tool/dashboard are retained as users navigate the dashboard / DV tool. *
8. Ensure that the DV tool/dashboard has the capability for outputs to be extracted for inclusion in users' own reports and presentations.
9. Include interpretive narrative where interpretation is required, ensuring that you avoid "busy" visuals and information overload.**
10. Static and interactive dashboards both have a useful role, as static reports may still be required to be provide overviews of care quality and interactive DV tools/dashboards may be required to allow 'deep dives'.

**Omitted from distilled principles by Orange Bus (as they felt it was more of a detailed guideline) but we will retain.*

***Included under their principle (5) by Orange Bus but highlighted text fits better under their principle (7) in our view.*

Summary - Design Principles (Post-Orange Bus)

1. **Clinicians are involved every step of the way**
2. **Lead with the right clinical question**
3. **Make data timely and relevant**
4. **There's no learning curve for users**
5. **There's no need to reinvent the wheel**
6. **Data is flexible and shareable** *(including retention of selections as you navigate the dashboard)*.
7. **The right tool for the job** *(including interpretive narrative where interpretation is required).*