

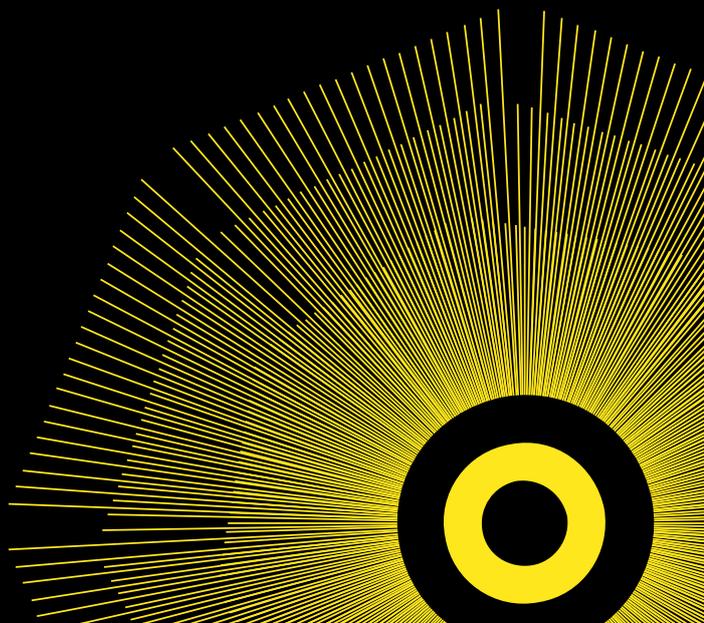
sShine 2014 final report

Safety = Design - Driving safety and
signposting risk

Betsi Cadwaladr University Health Board

September 2015

The Health Foundation
Tel 020 7257 8000
www.health.org.uk



Part 1: Abstract

Project title: Safety = Design - Driving safety and signposting risk by adapting the philosophy of traffic icons to guide behaviour of healthcare staff and patients and their carers at the bedside.

Lead organisation: Betsi Cadwaladr University Health Board

Lead Clinician: Chris Subbe

Partner organisations: University College London Partners, Aneurin Bevan University Health Board, Helen Hamlyn Centre for Design, 1000 Lives Plus, Bangor University

Clinical & Non-clinical Partners: Safety=Design was facilitated by a large group of professionals from a broad range of organisations and backgrounds. We are indebted to their participation and constructive feedback in the different phases of project:

Helen Hamlyn Centre for Design: Hawys Tomos, Jonathan West. **Barnet & Chase Farm Hospitals:** Fiona Morcom, Tracy Goodman, Vivienne Clark, Philip Jacobs, Steven McLaren, Davidson Sookhansingh, A Cole. **Royal Gwent Hospital:** Tom Cozens, Llifon Edwards, Emma Mason, Natalie Skyrme, Rachel Jones, Sian Forward. **University College London Hospitals:** John Welch, Jane Sproat, Chris Whitman (Patient Representative), Findlay Macaskill. **Wrexham Maelor Hospital:** Rodri Dafydd Pyart, Hashim Riaz Khan, Julie Ward Jones (Project Manager), Vijaya Ramasamy, Ben Thomas. **Ysbyty Gwyedd, Bangor:** Tracy Savjin (Project Manager), Lisa Roberts, Iman Abulela, Parisa Amiri, Jodie Sabin, Ceri Owen, Ceri-Ann Evans, Gillian Roberts, Mandy Jones, Sian Hughes Jones, Christian P Subbe, Khalid Shinwari, Stuart Stevenson (Patient Representative). **Bangor University:** John Parkinson, Nia Goulden, Neil Harold, Chris Whitaker, Ives Ntambwe. **Cardiff University:** Elinor Spacie, Rhianna Church. **Public Health Wales/ 1000 Lives:** Alan Willson, Chris Hancock. **Springfield Consultancy:** Richard Edgeworth. **Others:** John Kellett.



Chris Hancock & Chris Subbe reviewing results August 2015

Abstract

Acute Kidney Injury and Sepsis are two of the most common causes of avoidable harm to patients admitted to hospital. Life saving Information that is crucial for safe management of patients at risk of these two conditions is often buried between the redundant and trivial in bulky records.

We aimed to develop a system of icons that translates complex information into simple visual prompts to signpost risk to patients, carers and clinicians at the bedside.

In workshops we brought together clinicians with patient representatives and designers from the Helen Hamlyn Centre for Design at the Royal College of Art. In consecutive Plan-Do-Study-Act cycles we developed and tested a suite of four interrelating interventions on six hospital sites in two clinical networks in London and Wales to improve safety of patients at risk in general wards.

- **Patient diaries** explained significance and risk of renal dysfunction and offered patients the opportunities to become active partners of their care. In the participating patients 84% were able to record their fluid intake and 87% the quality of urine output. Patients with measurable frailty using the Clinical Frailty Scale found the tool more difficult to use ($p < 0.01$).
- The **KidneySafe Bracelet** is being given to patients who are identified at risk by clinicians or automated alert systems generated by pathology computers. Attachment of the bracelet led statistically significant improvements in the documentation of urine output ($p < 0.032$).
- The **WeeWheel** allows nurses to get instantaneous information about the minimum safe volume for urine of individual patients. The dial up of the patient's weight shows recommended and 'at-risk' output per hour and per 6-, 12-, and 24 hours.
- The **SepsisPanel** is a set of icons for Systemic Inflammatory Response Syndrome and infection, which is located in the patient's bed space. Abnormal sepsis markers get turned and change from blue to red.

The metrics for measuring impact of Safety=Design had to be changed during the course of the project. In the absence of already abnormal renal function current algorithms for risk assessment for Acute Kidney Injury proved to be too complex for broad clinical use. Cost of interventions varied between £0.06 and £3.54 for single use items and between £5.88 and £42.10 per bed space for re-usable items.

Safety=Design has been a complex project given the broad geographic spread of partners and multiple interventions for several key safety risks. The multi-professional team has overcome these challenges with enthusiasm and an eagerness for joint learning that allowed us to test consecutive iterations of design interventions in a tight time frame in a variety of clinical settings.

We achieved proof of concept that patients can contribute to their own hospital records and thus support their own safety. We showed that visual prompts can significantly enhance clinicians' intuitive understanding of interventions required in the context of Acute Kidney Injury and result in measurably different behaviour for monitoring of patients at risk.

Visual information is likely to improve safety of patients at risk with little or no extra workload for staff at minimal cost.

Part 2: Quality impact: outcomes

2.1 Baseline for standard of care in Sepsis and Acute Kidney Injury (AKI)

The participating hospitals collected baseline data on compliance with existing local care bundles for care of sepsis (Fig 1a) and Acute Kidney Injury (Fig 1b) in samples of 5 files per ward and week. The data confirmed poor compliance throughout the project with patients at risk receiving only 30-40% of desirable interventions.

Fig 1a: Sepsis Compliance per week as percentage of patients with sepsis – pooled data.

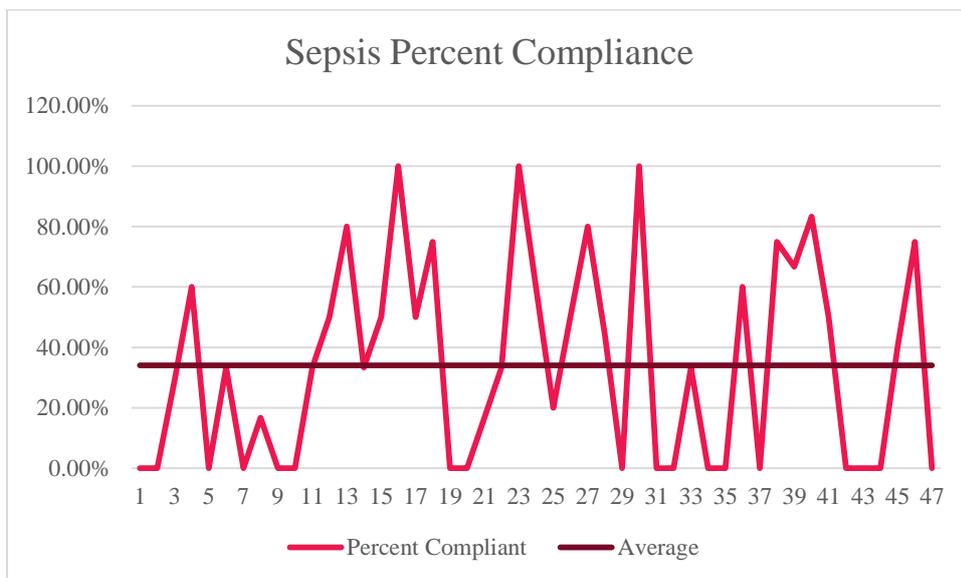
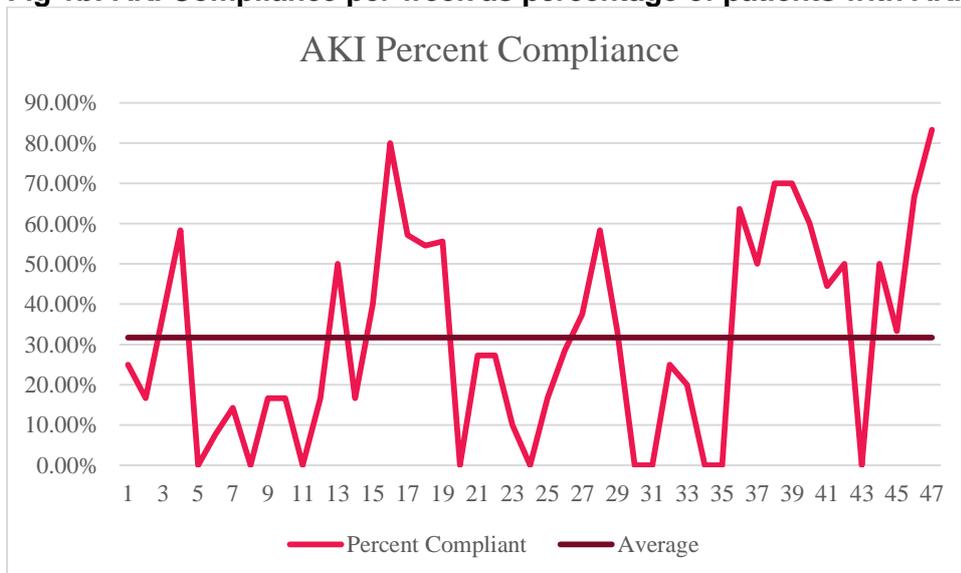


Fig 1b: AKI Compliance per week as percentage of patients with AKI – pooled data.



2.2 Project development

A workshop was held in London in September 2014 to define key priorities for clinicians. These were charted in a value-map. First ideas were developed sequentially using the concept of the 'Double Diamond'¹ method with four distinct phases:

- In the 'discover' phase, insights were gathered
- During the 'define' phase potential problems were outlined
- The 'develop' stage of the project saw distinct concepts developed, prototyped, tested and iterated
- The 'delivery' stage resulted in a set of prototypes that could be used by the hospitals to gather experience and data about their effectiveness.

The methodology resulted in a suite of interventions with a strong emphasis on management of Acute Kidney Injury.

Progress was managed through weekly conference calls between clinicians and design team and local workshops.

Fig 2: Workshop at the Royal College of Art with Design team and Clinicians



¹ <http://www.designcouncil.org.uk/news-opinion/design-process-what-double-diamond>

2.3 Patient diaries

were the most patient focused intervention. Patients become part of the care team by documenting fluid input and urine output.

Fig 3: Sample pages Patient Diary

The image shows two sample pages from a patient diary. The left page is titled 'DRINKS' and is orange. It has a header with 'Date' and a checkbox 'Tick if you are receiving any medication through a drip'. Below this is a table with columns for 'Time', 'Type of drink', and 'How much did you drink?'. The 'How much did you drink?' column has four options: 1/4, 1/2, 3/4, and Full. There are five rows of data, each with a time slot (AM or PM) and a checkmark. The entries are: 1. 10:30 AM Milk (1/4), 2. 11:30 AM Water (1/4), 3. 12:30 PM Water (1/4), 4. 1:30 PM Juice (1/4), and 5. (blank). The right page is titled 'URINE OUTPUT' and is blue. It has a header with 'Date' and a checkbox 'Tick if you are taking any medications that make you wee'. Below this is a table with columns for 'Time', 'AM', and 'PM'. The 'Time' column has four entries: 9:20, 9:30, 6:30, and 7:55. Below the table are seven rows of checkboxes for 'Pain or stinging?', 'Unusual smell?', and 'Colour'. The 'Colour' section has seven options: No 1, Pale 2, Straw, Transparent 3, Yellow, Dark 4, Amber 5 / Honey, Brown 6 / Syrup, and Red / Pink 7. Each option has a corresponding colored teardrop icon. The 'Yellow' and 'Dark 4' options have checkmarks.

68 patients at the Ysbyty Gwynedd tested two iterative versions: 47% the patients on a general medical ward were able and willing to contribute to their care by completing surprisingly detailed diaries.

During a 24-hour period with diary V2 the mean number of urine samples logged in the diaries was 5 (range 0-8). 100% documented the time and 94% the colour of urine. The mean number of drinks recorded was 7 (0-12). The type of drink was documented for 96% the volume in 95% and the time of consumption in 90% of entries.

Patients filled structured feedback questionnaires (Fig 4). They were delighted with the information and rated the diary at an average of 8/10. Younger patients and those who were not frail² found it significantly easier to take part, thus providing face validity to the assessment tools.

² Frailty was measured using the Clinical Frailty Scale. Online resource accessed 21 September 2015. http://geriatricresearch.medicine.dal.ca/clinical_frailty_scale.htm

PRESENTATION	Yes (%)	INSTRUCTIONS	Yes (%)	INFORMATION	Yes (%)	PURPOSE	
Easy to read	90.6	Too complicated	25.0	Noticed the information	68.8	Keep track of fluids to stay hydrated	6
Style suitable	81.3	Right level	71.8	Read the information	50.0	For your own health	2
Enough space	78.1	Too easy	3.1	Understood the information	56.3	More aware of how kidneys are working	7
Easy to navigate	81.3	Read the instructions	81.3	Considered it useful	40.6	Research	2
Simple enough for others	84.4	Examples helpful	84.4	Would like to know more	31.3	Don't know	3
		Easy to remember	68.8				
Simple	4	Did not need help	81.3	Very Informative	3	Further comments:	
Neat	3			Not interested	9	Stay informed about your own health	
Good colour scheme	3	Forgot, filled in retrospectively	4	Already knew	6	Useful to learn about these things	
Pretty	3	Complete it immediately to remember	5			Highlights a very important issue	
Nice layout	4	Keep diary within eyesight to remember	4			Noticed peeing differently in hospital	
Good diagrams	3	Needed help from nurse	4	USEFULNESS	Yes	Such a hassle, don't have the time	
Needs more colours	3	Needed help from family member	2	Diary was useful	56.3	Did not like filling it in at all	
Further comments:		Would like a reminder somehow	3	More conscious of urine colour	34.4		
- too bland, more colours would help it stand out		Further comments:		Drank more as a result	28.1		
- more information should be diagrams, so its less wordy		- make it more colourful, brighter, bigger to jog memory more					
- writing darker so its easier to read		- eg poster or sticker on jugs to remind you					

Fig 4: Structured Patient Feedback

2.4 The WeeWheel

is a circular tool to quantify whether urine output of a patient is enough to maintain renal function. It matches patient's weight with the minimum amount of acceptable urine output per hour, 6, 12 and 24 hours.

The WeeWheel facilitates reliable recognition of dangerously low urine volumes. The smaller Version 2 was particularly enthusiastically embraced. A junior nurse from the Royal Gwent Hospital, Newport, refused to return the WeeWheel and work without it!

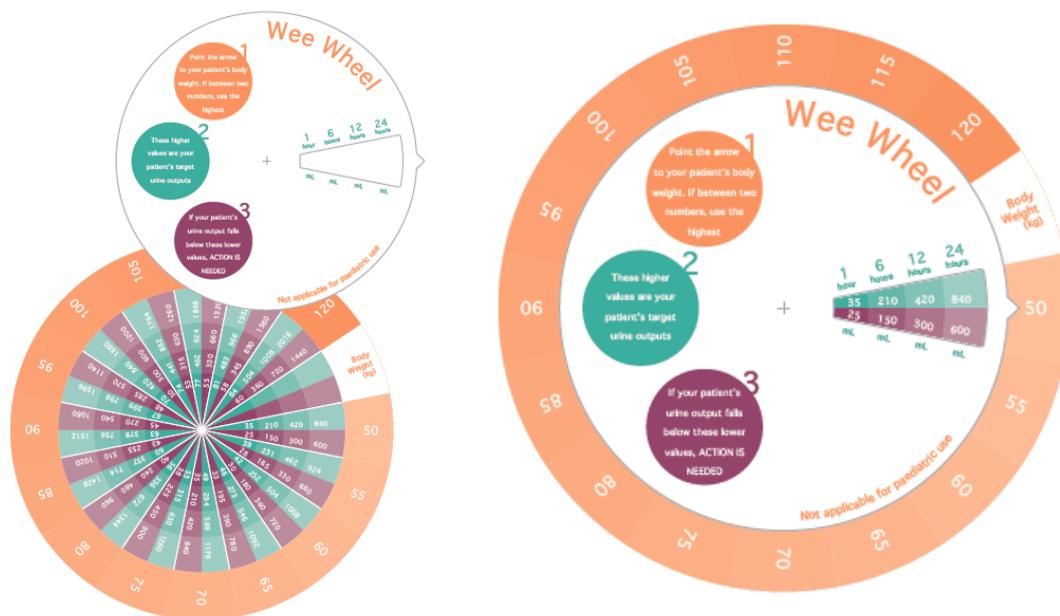


Fig 5: WeeWheel-V2: Parts and assembled WeeWheel

2.5 The KidneySafe Bracelets

Is a bracelet that depicts droplets in a number of colours from clear to brown to red corresponding to urine colours. Patient and staff are instructed that clearer urine is good and that darker colours require review.

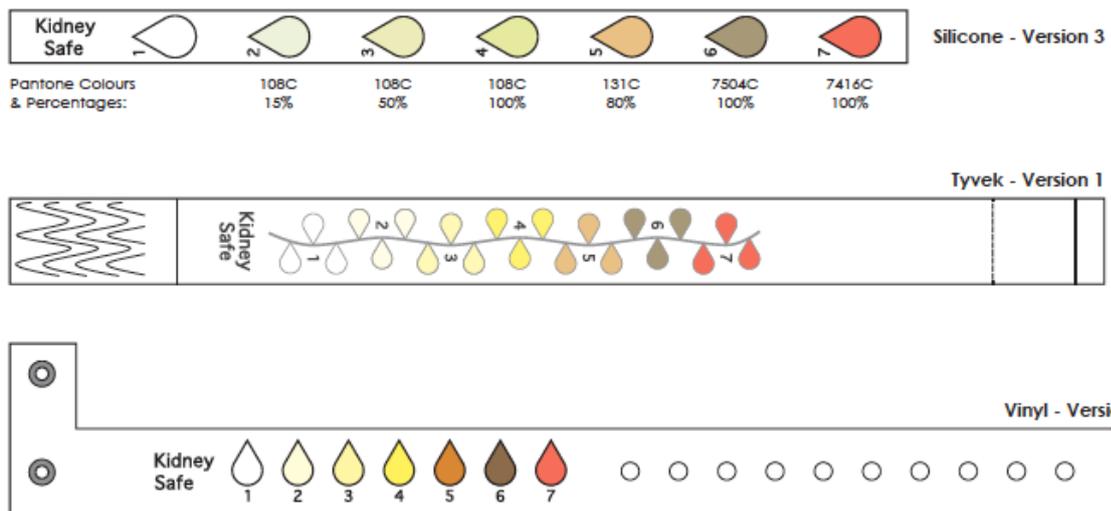


Fig 6: KidneySafe Bracelet in three different materials

Re-design of AKI Care

The Welsh Clinical Portal links a number of online pathology, radiology and documentation systems in the Welsh Hospitals. The recent addition of an AKI-alert for increases in Creatinine offered the opportunity for the redesign of pathways: Patients with an AKI-alert were given a KidneySafe Bracelet an alert label was placed in clinical records.

Documentation of urine output in a convenience sample of 19 patients wearing KidneySafe Bracelets improved: Comparing the 24-hour periods before and after the application of the KidneySafe Bracelet showed that percentage of patients with Significant or Complete documentation of urine output more than doubled from 26% to 68% ($p < 0.032$, Fisher's Exact Test). Median recorded urine output increased from 250 to 733 ml/24 hours.

2.6 The SepsisPanel

Is a panel of icons relating to the diagnosis of sepsis. Normal values have blue icons, abnormal findings are red. The Panel is used jointly by nurses and doctors. If a defined number of icons has been turned from blue to red sepsis is diagnosed.

The SepsisPanel was enthusiastically welcomed during a user workshop. Nurses of variable seniority liked the graphics, suggested improvements and volunteered ideas for a subsequent pilot. The final magnetic prototype that can be mounted behind the head end of a bed became only available in the second week of September 2015.



ANY 1 + **ANY 2** = **SEPSIS 6**

INFECTION **SIRS**

The Sepsis 6 should be started as a matter of URGENCY if there is a diagnosis of SIRS in the presence of an infection, or suspected infection.

EVERYONE

CONFIRMED INFECTION ?
If you know that the patient has an infection, flip the card to show the red side.

SUSPECTED INFECTION ?
If you suspect that the patient has an infection, flip the card to show the red side.

DOCTORS

C 32 mmHg
If the patient's PaCO₂ falls below 32 mmHg or 4.2 kPa, flip the card to show the red side.

12 x 10⁹/L
If the patient's white blood cell count exceeds 12 x 10⁹/L or 12000/mm³, flip the card to show the red side.

4 x 10⁹/L
If the patient's white blood cell count falls below 4 x 10⁹/L or 4000/mm³, flip the card to show the red side.

When a patient shows any of the symptoms represented on the cards, flip the card onto the red side to indicate this has occurred.

If any two of the blue areas* (DOCTORS or NURSES/HCAs) cards are flipped onto red, this means that SIRS has been diagnosed.

NURSES / HCAs

20 breaths per minute
If the patient's respiratory rate exceeds 20 breaths per minute, flip the card to show the red side.

90 bpm
If the patient's heart rate exceeds 90 beats per minute, flip the card to show the red side.

38.3 °C
If the patient's temperature exceeds 38.3 degrees Celsius, flip the card to show the red side.

36.0 °C
If the patient's temperature falls lower than 36 degrees Celsius, flip the card to show the red side.

Fig 7: SepsisPanel at bed side with Health Care Assistant indicating a rising temperature by turning the blue magnet to reveal the red side. Flyer with explanation for staff.

2.7 Staff feedback

In an online survey the participating clinicians rated the usefulness of the interventions on a scale from 1 to 5 (Table 1). The WeeWheel was the intervention with the best feedback. Taking part in the project was considered useful learning for the local leads (1.8), ward teams (2.0) and their patients (2.4)

Table 1: Feedback from participating clinicians about the interventions.

Grading 1: Strongly agree, 2: Agree. 3: Neither agree nor disagree, 4: Disagree, 5: Strongly disagree

Intervention	... improves patient safety.	... reduces nurses workload.	... should become routine practice after the end of the project.
WeeWheel	1.8	2.5	1.8
KidneySafe Bracelet	2.8	3.2	3.0
Patient Diary	2.7	2.7	2.7
SepsisPanel	3.0	3.3	3.2

2.8 Outcome measures

The primary pre-defined outcome measure for Safety=Design was an improvement in compliance with local care-bundles for management of sepsis and AKI. While a significant number of data points were collected for the control phase (see above) we did not achieve an increase in the reliability in the intervention phase. This was in part due to the variable transparency of clinical documentation and in a larger part due to a change in the format of the interventions. Ideas were developed and tested sequentially and concepts that had not been anticipated were felt to bring potentially more benefit for patients than the initially planned icons. The SepsisPanel was the only icon-based intervention and only became available in the last month. During testing we did not see any unintended consequences.

Quality of data from a number of sites was additionally compromised by changes in the local teams in three of the hospitals and major organisational changes in two of the organisations.

2.9 In summary:

While we had to alter our initial measurement plan we have achieved a proof of concept for a suite of tools to support patients with AKI and the clinicians looking after them by field-testing in multiple settings that

[1] Visual prompts for key risks are acceptable to staff and patients,

[2] Patients on general hospital wards are able to actively participate in their own documentation and care and can thus become safety-partners of nurses and doctors.

Part 3: Cost impact

We did not include cost measures in the original application. The set-up of Safety=Design as a service improvement project and the sampling method and sample size of patients exposed to the interventions limits extrapolation and generalisation. We are however able to share some general considerations:

- The **cost of Acute Kidney Injury (AKI)** to the NHS (excluding AKI in the community) is highly significant with £434 million - £620 million per year. Some 20-30% of cases are thought to be partially or fully preventable leading to potential cost savings of up to £ 100 million per year.
- Unit **costs for our proto-types** ran between £0.06 (simplest version of the KidneySafe bracelet) and £3.54 (for the patient diary V2) for single-use items. The WeeWheel V2 would cost £5.88 per member of nursing team and the Magnetic SepsisPanel would cost £42.10 per bed space. Bulk purchases would likely bring down the per-item price.
- **Costs for staff training** needs were not formally evaluated but anecdotal evidence would suggest acceptable costings: The SepsisPanel was introduced during a 5-minute session with nursing staff on a busy Friday evening and was used competently in the following 72 hours of observation. The Bracelets were used during existing interactions with clinicians by an AKI prevention team with about 5 minutes interaction per patient. Given that the interaction is determined by discussion of the diagnostic entity AKI it is not clear whether extra working time is incurred or whether the time could be reasonably expected as part of usual clinical care.
- **Cost for training of patients:** training in the usage of the patient diaries took 5-10 minutes per patient – The salary of a band 5 nurse starts at £ 21,478, the hourly rate would be thus £10.98. Pro:rata training per patients would therefore costs £0.55 - £1.10.
- **Cost of a bed-day** depends on nature of the hospital ward and care intensity but on a general ward or intermediate care ward cost will be usually between £ 300 and £ 400.

Based on these costs it would thus be reasonable to assume that the shortening of the duration of hospital stay by a single day in 5% of patients exposed to the intervention would still be very likely to result in savings ('light green dollars').

Part 4: Learning from your project

4.1 Successes

Safety=Design achieved greater insight into the behaviour of patients, doctors and nurses towards patients with AKI and sepsis within a group of diverse healthcare professionals involved in the project on no less than six sites in two different health systems in the UK. We developed and tested four interventions in several iterations each with significant changes between iterations.

We established potential 'world-firsts' for hospitalized patients:

- Patient delivered safety interventions with the bedside diary.
- Innovative wearable safety information with the bracelet.

While data on the wider impact on patient safety is still required we are proud to have achieved proof of concept within a limited time frame and resources. We believe that the contribution from clinicians from rural and urban, academic and non-academic hospitals assures the relevance of the intervention to a large proportion of NHS hospitals.

4.2 Cross-fertilisation between Clinicians and Designers

While we had initially anticipated the usage of a simple set of 'traffic signs' it soon became clear that other techniques of introducing visual information into the patient environment might offer more promise. The Helen Hamlyn Centre for Design focuses on design for a more inclusive society irrespective of age and ability and the creation of safer and better health services.

Using the unique expertise of the Helen Hamlyn Centre meant that ideas and concepts that are outside the horizon of clinicians in the NHS became available for the participating networks. The dialogue with 'not healthcare professionals' was the crucial ingredient for the project.



Fig 8: Creating value maps with clinicians at the Helen Hamlyn Centre for Design

For the designers in the team, the project benefited from an extraordinary level of access to front line clinical workers, and their input fed directly into the designs. Having a broad spectrum of ward types was also hugely beneficial in providing a variety of perspectives; having a non-clinical element to the team forced the practitioners to explain seemingly obvious things from first principles, allowing nothing to be taken for granted.

At the same time the iterative development of new tools meant that new manufacturers and distributors had to be identified. This is a process that we underestimated in the original planning process and that did impact on the overall time available for testing the interventions.

Because development was done in such close quarters with those on the front line, it was obvious that the interventions could not have taken the form of yet another protocol or form to fill in. As a consequence, this pushed the design work further than it otherwise would have gone; a completely different visual language was required, one that necessarily had to step out of the typical idiom of the ward, yet still be intuitive to staff and patients.

In order to achieve this aim, the team prototyped ideas early, and learned quickly from failure. The resulting suite of tools has been well received by those on the front line of care who play such a pivotal role in AKI and sepsis treatment.

4.3 Group cohesion

Delivery of Safety=Design on a number of geographically distant sites was always going to be a challenge, which we hoped to manage through organisational culture of the two networks UCL Partners and 1000 Lives.

The project delivered despite the change of key personnel and whole scale re-organisation in two of the partner organisations. This included the successful transition of project management responsibility half way through the project.

Engagement with staff and patient representatives meant that qualitative feedback was maintained and weekly conference calls had enough participation to harvest comments and ideas throughout the duration of the project. Staging from a single centre might have been more robust but would have led to less qualitative feedback and a loss of generalizability of the findings.

4.4 Additional learning

Clinicians felt that **PatientDiary** could not be put into the patient legal record in its current format. The ownership of patient generated documentation would require further exploration.

Patients did not object to a **SepsisPanel** openly identifying them as a sick patient for all to see; patient representatives concurred that the panel would be inline with existing interventions such as 'Nil by Mouth signs'.

At **University College London Hospital** in a Urology ward the **WeeWheel** was the most well received intervention. 'We have a number of new nurses to the team and they actively embraced using the tool and felt more confident to raise concerns to the medical teams.'

At the **Royal Gwent Hospital** one of the junior staff nurses refused to return the **WeeWheel**: 'She's since moved on to a job in haematology day unit, and taken it with her. Shortly after an email from another nurses on the haematology ward asked where she could get one!'

4.5 Health policy

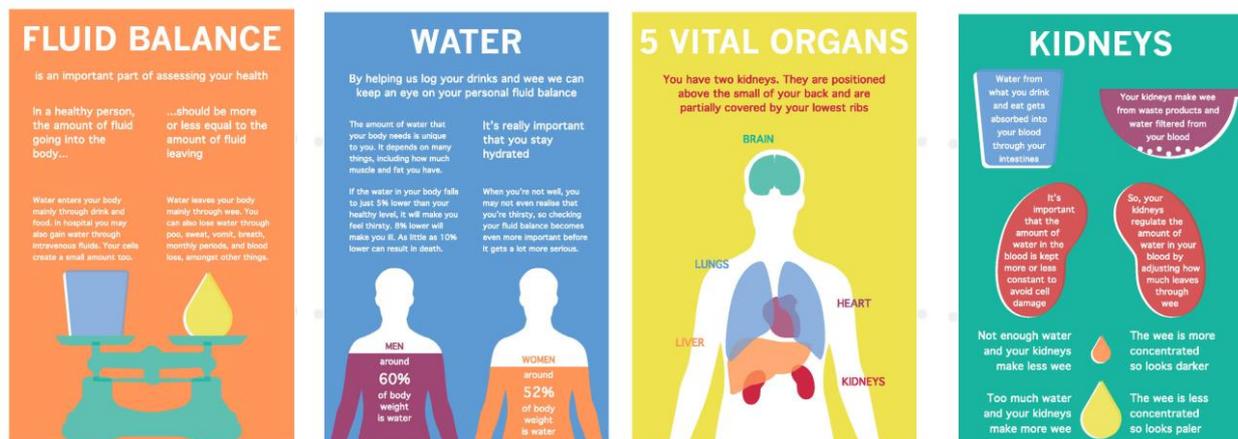
Anecdotally one of the best-filled PatientDiaries was submitted by the relative of a very frail patient. Usage of the diary in a home care environment could empower caring relatives to improve renal safety.

This concept would thus fit well within the current thinking of 'Prudent Healthcare' in NHS Wales³. 'Prudent Healthcare' is designed to delivering three objectives:

- Do no harm
- Carry out the minimum appropriate intervention.
- Promote equity between professionals and patients.

The PatientDiary and KidneySafe Bracelet are both enablers of better cooperation between healthcare professionals and patients built around the concept of getting the basics of care right. The concepts on the project may thus be worthy of embedding in 'chronic' well patient within the renal and cardiac cohort and with expert patient programs who already engage in monitoring their conditions including weights.

Fig 9: Information about AKI from patient diary



³ Bradley, P. & Willson, A. (2014) Achieving prudent healthcare in NHS Wales (revised). Cardiff: Public Health Wales

4.6 Review of metrics

The primary pre-defined outcome measure for Safety=Design was an improvement in compliance with local care-bundles for management of sepsis and AKI. We failed to demonstrate impact for this measure for a number of reasons:

1. The interventions that were tested were only available to a small number of patients and never rolled out. The routine sampling of 5 patients per ward and week was therefore not sensitive or specific enough to demonstrate change.
2. The 'DASH'⁴ or 'CRASHED' (Table 2) algorithm for screening of AKI proved to be complex for reliable clinical usage. High-risk groups were difficult to identify by clinicians, despite the availability of the tool in every patient file in two of the units. Data about risk factors collected in this cohort will however support the development of a simpler screening tool.

Table 2a: Prevalence of risk factors for Acute Kidney Injury in a sample study ward

Risk Factor	Example ward
C CKD (eGFR < 60ml/min)	38/155
R Relevant comorbidities: such as diabetes, hypertension, heart failure or liver disease	87/155
A Angiotensin Converting Enzyme Inhibitors, Angiotensin Receptor Blocker, Aldosterone Antagonists	41/155
S Sepsis, Systemic Inflammatory Response Syndrome or Shock	32/145
H Hypotension (Systolic Blood Pressure < 100mmHg)	12/145
E Elderly (Age > 75 years)	62/145
D Drugs (Other) – Non-Steroidal Anti Inflammatory Drugs, Aminoglycosides, Lithium	39/144
3 or more risk CRUSHED risk factors (at risk population)	56/158

Table 2b: Compliance with treatment & monitoring -57 at-risk patients on sample ward

Treatment interventions for Patients at Risk of Acute Kidney Injury	Intervention received
Sufficient Fluid	33/57
Toxic Drugs Held	33/57
Obstruction Excluded	17/57
Plan for check of renal function	21/57
Complete response bundle	12/57
IRise in Creatinine at Month 3 in patients with AKI score of 3 or more	30%
Rise in Creatinine at Month 3 in patients with AKI score of less than 3	0%

⁴ DASH stands for Diuretic, Age, Sepsis, Hypotension

Part 5: Plans for sustainability and spread

Facilitating spread through project set-up

Sustainability and spread were built into the existing project proposal. We brought together two of the UKs leading patient safety networks with 1000 Lives and UCL Partners. Workshops with Chris Hancock from 1000 Lives and John Welch from UCL Partners will assure a platform for dissemination of the learning from Safety=Design.

Spread in Wales: Linking Quality Improvement with Academic Expertise

At Betsi Cadwaladr University Health Board and in Aneurin Bevan University Health Board we worked closely with clinical leaders at medical and nursing level to develop the interventions. **AKI ward rounds** with KidneySafe Bracelets have been **established** on one site in BCUHB with a second site about to follow.

With the Rapid Response For Acute Illness Learning Set (RRAILS) of 1000 Lives we have examined conditions for spread in the Welsh network. We have scheduled a **learning event in the Welsh capital Cardiff on the 11th of November** to bring together lead nurses, the Welsh AKI network, patient safety specialists and clinical champions as well as the designers and manufacturers of the interventions.

We have identified additional key stake-holders in the renal community in Wales. In August we had a series of conference calls with the **Chair in Renal Medicine at Cardiff University**, Professor Aled Phillips and the AKI lead of the **Welsh Renal Network**, Dr Gareth Roberts. Professor Phillips is actively researching AKI in hospitalized patients with three peer reviewed publications in this field in the last year alone^{5,6}. The Welsh Renal Network has an existing AKI working group that is developing standards for treatment and prevention. There are thus significant synergies. In the e-mail communication and phone calls we found real interest in using the Safety=Design suite of interventions for implementation throughout the Welsh network of 16 District General and University Hospitals. The **All-Wales Laboratory Information Management System (LIMS)** that analyses data from all patients in Wales would allow real time evaluation of impact at population level once the project has been implemented to scale.

Funding

We are submitting in September 2015 for additional funding from the Health Foundation to kick-start the roll-out and facilitate evaluation. Even without dedicated funding we believe that the cheapest intervention with the low unit cost of 6p per patient could be implemented within existing budgets. More sophisticated tools will require dedicated support and resources for training and implementation would need to be accessed.

Publications

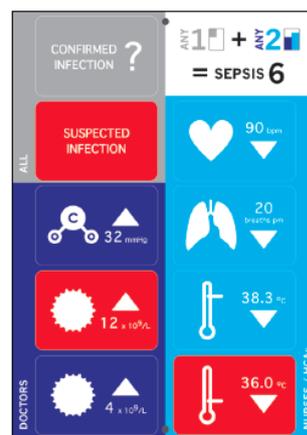
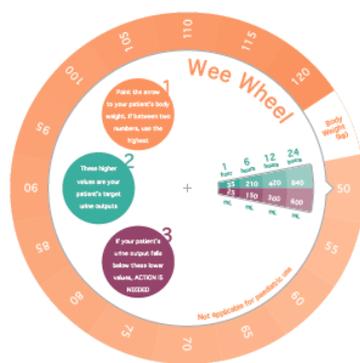
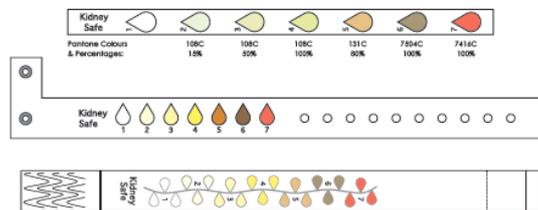
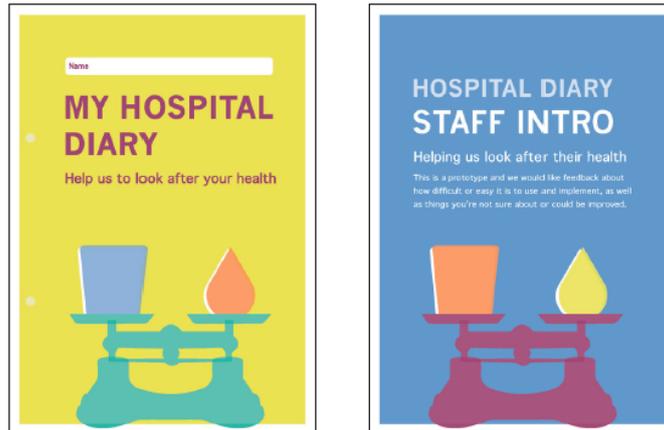
Within the Safety=Design team we have explored the channels for spread over the next 12 months. We are aiming for publication in the Design press and at least one peer reviewed Medical or Nursing Journals. Candidate publications are BMJ Quality & Safety (<http://qualitysafety.bmj.com>) which is supported by the Health Foundation or BMJ Quality Improvement Reports (<http://qir.bmj.com>). Additionally we are planning presentations at key conferences such as the International Forum for Quality & Safety in Healthcare (<http://internationalforum.bmj.com>) in Gothenborg and UK's the Patient Safety Congress (<https://www.patientsafetycongress.co.uk>). For more renal focused meetings we are in conversation with our renal partners in Wrexham and Cardiff.

⁵ Meran S, Wonnacott A, Amphlett B, Phillips A. How good are we at managing acute kidney injury in hospital? Clin Kidney J. 2014 Apr;7(2)

⁶ Wonnacott A, Meran S, Amphlett B, Talabani B, Phillips A. Epidemiology and outcomes in community-acquired versus hospital-acquired AKI. Clin J Am Soc Nephrol. 2014 Jun 6;9(6):1007-14.

Appendix 2:

Final versions of the interventions & Sample pages PatientDiary



Final versions of the interventions - Patient Hospital Diary Version 2 and Staff Supplement, Wee-Colour Bracelet - Silicone Version 3, Vinyl Version 1, Tyvek Version 1, Wee Wheel version 2, Magnetic Sepsis Icons Tool Version 3

HELLO

This is a health diary for you to fill in. It will help you keep track of two important things:

How much you drink

&

The health of your wee

The healthcare staff need to know this information to help continuously assess your health and the health of your kidneys. This should help to quickly pick up any potential complications that might develop during your stay in hospital.

I understand that the purpose of this diary is to help to look after my own health. I agree to fill it out to the best of my ability and if I am unsure or worried about anything I will tell a member of the healthcare team looking after me.

YOUR TEAM

Your healthcare team are here for you

Your ward is

Your consultant is

Your ward sister is

You may have different nurses and healthcare assistants looking after you. You can write their names here. There is also more space at the back:

Name <input type="text"/>	Date <input type="text"/>
Name <input type="text"/>	Date <input type="text"/>
Name <input type="text"/>	Date <input type="text"/>
Name <input type="text"/>	Date <input type="text"/>
Name <input type="text"/>	Date <input type="text"/>
Name <input type="text"/>	Date <input type="text"/>
Name <input type="text"/>	Date <input type="text"/>
Name <input type="text"/>	Date <input type="text"/>

2, 3

FLUID BALANCE

is an important part of assessing your health

In a healthy person, the amount of fluid going into the body...

Water enters your body mainly through drink and food. In hospital you may also gain water through intravenous fluids. Your cells create a small amount too.

...should be more or less equal to the amount of fluid leaving

Water leaves your body mainly through wee. You can also lose water through poo, sweat, vomit, breath, monthly periods, and blood loss, amongst other things.

WATER

By helping us log your drinks and wee we can keep an eye on your personal fluid balance

The amount of water that your body needs is unique to you. It depends on many things, including how much muscle and fat you have.

If the water in your body falls to just 5% lower than your healthy level, it will make you feel thirsty. 8% lower will make you ill. As little as 10% lower can result in death.

It's really important that you stay hydrated

When you're not well, you may not even realise that you're thirsty, so checking your fluid balance becomes even more important before it gets a lot more serious.

MEN

around **60%** of body weight is water

WOMEN

around **52%** of body weight is water

4, 5

5 VITAL ORGANS

You have two kidneys. They are positioned above the small of your back and are partially covered by your lowest ribs

KIDNEYS

Water from what you drink and eat gets absorbed into your blood through your intestines.

Your kidneys make wee from waste products and water filtered from your blood.

It's important that the amount of water in the blood is kept more or less constant to avoid cell damage.

So, your kidneys regulate the amount of water in your blood by adjusting how much leaves through wee.

Not enough water and your kidneys make less wee. The wee is more concentrated so looks darker.

Too much water and your kidneys make more wee. The wee is less concentrated so looks paler.

6, 7

AKI

One dangerous complication that can develop during a stay in hospital is a condition called Acute Kidney Injury or AKI.

Your kidneys have two very important jobs, they:

- Filter your blood and produce wee to remove unwanted waste products from your body.
- Keep the amount of water in your blood at the correct level by regulating how much leaves through wee.

However, sometimes your kidneys can show the strain of the illness that brought you into hospital. This can cause them to stop working properly. Therefore, it's important that we keep a close eye on the health of your kidneys and we do this by checking on the wee they're producing. There's also a blood test that can help.

Treatment for AKI includes:

- Taking the strain off the kidneys by flushing them through with plenty of water. This can be either through a drip or by drinking.
- Sometimes, a 'medication holiday' may be necessary. This is a temporary change to medication until the kidneys are better.

Further information can be found at 'NHS Choices': www.nhs.uk/conditions/acute-kidney-injury

URINE OUTPUT

To help keep track of the health of your wee and kidneys, you will need you to fill in some information EVERY TIME you wee.

If you have a catheter, your wee will collect in a bag and the nurses will be able to see it easily. You do not need to do anything else.

If you do not have a catheter, you will need to make a note of EVERY TIME you have a wee. If you cannot do this alone or need any assistance at all, please tell a nurse who will be happy to help.

8, 9

EXAMPLE

Write the time here and tick to indicate AM or PM

Time: 5:10
 AM
 PM

Tick the first box if you notice any pain or stinging when you wee. Tick the second box if you notice any unusual or bad smell. Please tell a nurse when possible.

Pain or stinging?
 Unusual smell?

Check the colour of your wee and tick the colour that most closely matches. We ask you to do this because the colour of your urine is a good indicator of your health and hydration. If you're not sure - ask a nurse to help. You can also use your colour bracelet to help check and remember the colour of your wee when you go to the toilet.

No 1 Colour:
 Pale 2 Straw
 Transparent 3 Yellow
 Dark 4 Yellow
 Amber / Honey 5
 Brown 6 / Syrup
 Red / Pink 7 Tinge

If your wee is a brown / syrup colour tell a nurse IMMEDIATELY

If you notice a red or pink tinge tell a nurse IMMEDIATELY

URINE OUTPUT

Date:

Tick if you are taking any medications that make you wee
 Please tell a nurse if you tick any of the starred options below

	1	2	3	4
Time	<input type="checkbox"/> AM <input type="checkbox"/> PM			
Pain or stinging?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Unusual smell?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
No 1 Colour	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Pale 2 Straw	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Transparent 3 Yellow	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Dark 4 Yellow	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Amber / Honey 5	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Brown 6 / Syrup	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Red / Pink 7 Tinge	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

10, 11