

Shared Purpose

Final Report

Project: The development of an evidence-based, early warning/predictive workforce planning toolkit (I Plan) to provide reliability in staffing provision and improve quality in clinical care

Organisation: Imperial College Healthcare NHS Trust

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Final report for Shared Purpose	
Project title	The development of an evidence-based, early warning/predictive workforce planning toolkit (I Plan) to provide reliability in staffing provision and improve quality in clinical care
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Abstract

Please provide a brief overview of your project

We believe that inadequate clinical team planning and anticipation of workforce problems and requirements can put patient care at risk, with the potential for increased mortality, morbidity and infection. Yet clinical teams have not had access to integrated multidisciplinary data for team planning; instead, separate workforce data has traditionally been presented to individual professional groups in dense data tables using descriptive analysis in retrospective reports that are unrelated to clinical or process outcomes. Separate clinical data, often for clinical governance review, has been discussed separately. Professional groups have attempted to use these separate data sources to plan rosters independently, with little multidisciplinary communication.

Our aim was to develop a tool that presents multidisciplinary, integrated information in a clear, visual format, highlighting key trends and risk areas that can be used by the multidisciplinary clinical team to jointly plan ahead. Our project identified relevant, timely and integrated measures of workload, staffing numbers and clinical outcomes which have informed the development of our prototype tool. This information is enabling our multidisciplinary teams to plan how to address and escalate anticipated shortfalls in staffing – for example, due to seasonality, weekend staffing, and varying patient numbers – and to implement improvements or alert senior colleagues to potential risks.

By facilitating appropriate, prospective targeted workforce planning, the tool enables us to address fluctuating acute care needs and challenges. With the tool, our units are developing improved planning and emergency preparedness, to ensure a better quality of care and an improved patient experience.

What was the problem that you were seeking to address?

Our initial problem was that it was not possible for clinical teams to understand how staffing changes may drive variations in quality and safety of care on their ICU unit, based on disjointed corporate and clinical data. However we discovered deeper cultural issues in the early stakeholder meetings. The discourse that occurred within different teams was lacking congruence, owing to multiple realities experienced across these different groups, as described in the figure below.

	<h2>Corporate teams</h2>	<ul style="list-style-type: none"> • "ICU meets national guidelines for staffing" Executive Director • "We have safety thermometer and quality metrics" Executive Director
	<h2>IT teams</h2>	<ul style="list-style-type: none"> • "We have multiple systems but no ways of joining the system information up" Data Analyst • "Linking corporate and multidisciplinary clinical data is so difficult that no-one has tackled it before" Head of Workforce
	<h2>ICU teams</h2>	<ul style="list-style-type: none"> • "We put information into the systems but don't get anything out" Physiotherapist • "Our staffing does not always match peaks and troughs of demand" ICU Lead Nurse

In the course of programme, we discovered fundamental system problems that needed addressing, in order to address our core problem, in particular:

- A gap between ICU team experiences day-to-day and perception of senior managers about ICU performance (ICU teams experienced hour by hour variations on the unit in relation to guideline ratios, depending on activity in the unit, whereas senior managers perceived guidelines to be met)
- Uni-professional staff planning (individual professions planned their staffing rosters independently of each other)
- No data linkage (thousands of data items collected in multiple, changing systems that were not linked together)
- Inadequate feedback of data (ICU team members had never seen the data - "How do you know what questions to ask, if you don't know what the data is?" ICU Lead Nurse)
- Missing and inaccurate data (lack of feedback to users leads to lack of user motivation to enter data correctly)
- Data on wards not detailed enough for statistical analysis (i.e. monthly rather than daily data)

Through our project, we addressed these problems, moving from the pre-pilot state listed in the table below, to the peri-pilot state by focusing on issues of team communication, planning and data usage.

Pre-pilot	During pilot
Uni-professional communication	Multidisciplinary team communication
Uni-professional planning	Multidisciplinary team planning
Subjective assessment of risk and safety	Objective measure of risk and safety
Siloed data	Shared data
Retrospective monthly data	Retrospective daily data
Count data	Statistically analysed data
Underutilised data	Monthly review of data
No improvement plan	Clearly defined improvement plan

Setting: 3 ICUs in multi-site NHS acute hospital Trust

Target group: Workforce team/ICU team members

Significant stakeholders: ICU multidisciplinary teams (including nurses, allied health professionals, doctors and pharmacists), HR workforce and e-rostering team, system/data managers and the executive team

Changes in environment: During the three years of the programme to date we have experienced multiple changes in executive team, including three different chief executives, two directors of finance, four directors of HR, two directors of estates and two directors of operations. The CQC rating in 2014 was 'requires improvement' which delayed the Trust timeframe for Foundation Trust status. At national level, we experienced the impact of the Mid Staffs report and its recommendations on the Trust, in terms of improved recording of patient and staffing data on wards and enhancements to our existing e-rostering systems to capture this data. In the ICU areas, the lead nurses of two intensive care areas have changed several times, which prevented sustained engagement with these areas with the programme.

What were the original aims of your project at the point of your proposal?

Our primary improvement, as set out in our proposal, was to improve clinical teams' access to and use of effective and integrated workforce and clinical information through the development of an early warning/predictive risk tool to enable them to anticipate workforce-related problems and respond rapidly to improve patient safety, patient experience and clinical team efficiency. The diagram outlines our process aims in our proposal:



We aimed to improve patient safety and the quality of patient care, by addressing the original problems we identified as described below:

A gap between ICU team experiences day-to-day and perception of senior managers about ICU performance	Co-designing a predictive tool that can be accessed and used by front-line teams, unit managers and senior managers to reach a unified consensus about unit issues, enabling the clinical team to escalate risk issues objectively and implement improvements in rostering to prevent deterioration in safety and quality
Uni-professional staff planning	Encouraging clinical and corporate teams to recognise the value and benefits of using integrated data to develop a multidisciplinary approach to team workforce planning
No data linkage	Identifying techniques to link data from different systems to enable an integrated perspective of the unit
Inadequate feedback of data	Improving the process of integrating workforce and clinical information, changing the level of access that teams have to information
Missing and inaccurate data	Providing regular, up-to-date and relevant information to teams about workforce, clinical and unit issues to encourage their involvement and ownership in data entry
Data on units/wards not detailed enough for statistical analysis	Identifying patient-level and workforce daily data for statistical analysis, testing this data for statistical relationships, using these statistical relationships to build evidence-based predictive models and incorporating these predictive models into an early warning/risk tool;

Factors that we anticipated might help and hinder the work are described in the table below:

Factors we thought might hinder the work	Factors we thought might help the work
Failing to find predictive relationships in	Supportive sponsor

data	
Cost improvement programmes	Enthusiasm for the preliminary project already undertaken in the Trust
Turnover in executive team	Close working relationships with Imperial College

Journey

What has happened throughout the lifetime of your project? What changes have you made to the design of your project along the way?

Pre-programme (Jan – July 12)

The early work of the Director of Infection Prevention and Control (DIPC), an academic epidemiologist and the Head of Workforce Planning with infection data and workforce data (e.g. bank/agency ratios, sickness levels) and evidence in the literature for relationships between staffing factors and clinical outcomes, mainly in intensive care units, informed our application. We thought that there was scope to explore relationships between staffing factors and other clinical outcomes (including infection) in a larger dataset to build a predictive tool for ward staff to use to anticipate the impact of staffing shortages on clinical outcomes to enable better planning for potential problems. Our intervention was initially to analyse the Trust-wide workforce dataset with clinical outcomes with a sub-study focusing on ICU, to provide data to build a predictive tool. We held stakeholder events to discuss the programme and involve people in early thinking about the projects.

Set up phase (Aug - Dec 12)

We initiated the programme by engaging stakeholders across the Trust to form the core project team and to create a broader network of clinicians from the various ICU sites. Our early stakeholder meetings created enthusiasm for and interest in the programme which made recruiting the project team easier (including patient reps, the ICU nurse lead, workforce lead, front-line nurse, physiotherapy lead, doctor lead). Once the project team was set up, we shared the process of attending divisional meetings to discuss the programme with their teams and to engage them as well. We established a smaller Programme Board, including two Executive Directors to oversee the whole programme, which met towards the end of the set up phase. Our project timeframes were delayed by the time-consuming process of gaining information governance (which involved six iterations of the application) for the programme. We ran data workshops with ICU team representatives to discuss what data was available and what clinical outcomes were most important to understand quality and safety.

Implementation Year 1 (Jan 13 – Dec 13)

Our data analyst started in April 13, which enabled us to begin the retrospective analysis of three-years of Trust staffing data (2010 – 2013) from the Electronic Staff Record, under the supervision of the Head of Workforce Planning. We worked with an epidemiologist/health economist to explore what data was available and began preliminary analysis of the data.

Increasing statistical expertise

We realised in August 2013, having conducted two international recruitments for a medical statistician, that we were unlikely to recruit someone with adequate practical or leadership experience to provide adequate statistical expertise into the project. With the help of Shared Purpose colleagues from University College London, we re-designed the project team by setting up a collaboration with Professor Scholtes at the University of Cambridge, who had developed non-linear predictive models of tipping points in healthcare at national level, and was interested in testing these predictions on unit-level health data. After a further two rounds of recruitment, we managed to recruit a post-doctoral medical statistician in March 2014 who could be supervised by Professor Scholtes and our in-house statistical advisor on

the project, Professor Paul Aylin. The recruitment problems were caused by an international shortage of medical statisticians and the fixed term nature of the contract.

Reducing our project focus

Following discussions with a statistical expert from Dr Foster, we realised that our original plan to use 3 years of monthly Trust-level workforce data on wards was not going to provide sufficient statistical power to identify meaningful relationships between workforce factors and clinical measures. At mid-implementation phase, having discussed the issue with Professor Scholtes, we redesigned our programme to focus on our sub-study, the three adult Intensive Care Units (ICUs) in the Trust. The close monitoring of patients meant that daily outcome data was held on all patients in the unit, which over 36 months provided sufficient statistical power to test relationships, should they exist. We had hoped to include neonatal and paediatric intensive care but despite initial positive meetings and discussions, staffing changes and competing priorities prevented projects in these areas developing.

Following early feedback from peer review, we strengthened our evidence-base by beginning a systematic review and set up an interview study to understand ICU staff perceptions of risk and safety around staffing, which we gained ethics approval for in November 13 and commenced interviews just after this.

Implementation Year 2 (Jan 14 – Dec 14)

We agreed a one-year no-cost extension to the project with the Health Foundation in January 2014 owing to the delay in statistician recruitment. We continued to analyse the ICU data and prepared a set of graphs showing staffing and unit profiles of the adult ICUs. We held positive workshops with the ICU professional groups to share this information and get feedback which was used to develop the prototype tool. We continued to systematically analyse the staffing and clinical outcome data using statistical modelling with Professor Scholtes. By Nov 14 our medical statistician had developed a prototype interactive tool, but without a predictive element, as the clinical outcome data available to us was either not sufficiently detailed to use in the statistical modelling or further modelling of outcome data such as mortality was required. We developed a Safety Scale to use in all the ICUs during the pilot phase of the project as we realised from initial reviews of the interview study that it was important to capture how ICU teams felt about their patient care on each shift. All the remaining interviews with the ICU staff were completed during this year. Our systematic review team developed our systematic review from initial search for papers through to quality assessment.

Changing the project scope

During this year, we realised that workforce rostering was a uni-professional process completed at different times, to different schedules and over different time periods with minimal communication between professions about the impact of one staffing issue on another. We realised that the project scope needed to extend to pilot a holistic process, involving the full multidisciplinary team, to encourage communication about workforce problems and discuss possible solutions that might involve different professional groups. As a result, the pilot study for 2015 was designed around a multidisciplinary team (MDT) process, to ensure that the prototype tool data was discussed by the MDT in monthly facilitated meetings.

Rethinking what we meant by ‘predictive’

Following discussions with clinical teams and a systematic review of the literature, we identified staffing metrics that might predict changes in clinical outcome measures. We underestimated the difficulties in finding suitably granular and complete clinical outcome datasets to base our statistical analysis on. Many of the datasets did not span the full three years of our retrospective study, the data was based on different definitions (e.g. for infections, either catheter associated or related blood stream infections), the data was held in different places and there were data inconsistencies between years. Instead, we shared staffing and unit data analyses with our clinical teams in data workshops. Clinicians found that data trends over the 24 hour clock enabled them to predict the unit profile and re-profile their staffing accordingly. This finding enabled us to redesign our project around a less scientific and more practical concept of the term ‘predictive’.

Implementation Year 3 (Jan 15 – Dec 15)

We used this year to pilot and evaluate our ICU tool, IPlan over six months from May – October 2015. Our pilot began in April 15 to collect one month of baseline data, including the implementation of the Safety Attitude Questionnaire (SAQ) as an evaluation tool to measure the safety climate on each unit. We collected over 100 SAQs.

Development of Safety Scale survey

Having reviewed the team interviews, we found that team members described varying perceptions of risk and safety associated with the same fictitious ICU scenario. We decided that it would be useful to design a tool to capture peoples’ perceptions of risk and safety during our pilot study and align the results with the quantitative data that we were using. We designed and developed a Safety Scale survey containing 6 simple questions (based on the interview study) for clinical team members to complete at the end of every shift. Our former Director of People and OD realised at a subsequent Board meeting that these questions mirrored the CQC domains reasonably closely.

Safety Scale questions	How safe was this shift: for you? for patients?	What level of patient risk did you identify on this shift?	How satisfied are you that all necessary care was given?	How satisfied are you with your job today?	How well run was this shift? By nurse leaders? By consultant leaders?
CQC Domains	Safe	Effective	Caring	Responsive	Well led

We implemented the Safety Scale survey as an on-line tool across all 3 ICUs for completion by teams over the pilot period. We provided training and presentations, posters and team briefings to ensure all the teams knew how and why we planned to use it. We held six multidisciplinary meetings (MDTs) on two ICUs over six months (with one ICU as a control), using the prototype tool which we named IPlan. The purpose of the MDTs was to encourage the ICU multidisciplinary team to undertake an iterative cycle of reviewing and improving the IPlan prototype tool. To achieve this, in each MDT we undertook a ‘Plan, Do, Study, Act’ PDSA cycle. The PDSA cycle is a well-known improvement tool for testing iterative changes to improve the quality of care provided. We planned to use the PDSA tool as a structure for testing iterative changes to the prototype tool and reviewing the effectiveness of the changes with the multidisciplinary teams. The format for each MDT was to discuss how: 1) the previous month had felt subjectively 2) the prototype tool presented

the objective quantitative and qualitative data from the previous month 3) whether the subjective perceptions and objective data were comparable and where there were discrepancies 4) the IPlan prototype could be improved to make the data more useful to the team 5) the impact of the changes made 6) how to act upon the findings in practice. Our IT analysts updated the prototype in between MDT meetings and the final set of meetings was spent reviewing the live IPlan tool and agreeing the steps for implementation. The benefit of the PDSA process was that it created engagement with and ownership of the IPlan system by the MDT as the clinical teams felt that they shaped the tool so that it was relevant for them and enabled them to justify their actions with quantitative data. As a result, the implementation process was straightforward and the final version of the IPlan tool was easily integrated back into the Trust QlikView team for 'go live.'

Developing IPlan tool on Trust QlikView system

At a Programme Board, our statistical expert recommended re-developing IPlan into QlikView, the Trust's main data intelligence system to ensure it was sustainable in the long term. By August 2015, our statistician had made a career move to a new role and we used the remaining allocation of funds for his role to recruit a QlikView contractor on a short term basis to redevelop the system in QlikView from September – November 2015, as our Trust QlikView team had insufficient capacity. The IPlan tool was converted from software called R and Shiny into QlikView and iterations of the QlikView prototype were shared and improved through the pilot MDT meetings. We went live with the QlikView system in early November, following implementation meetings with nurses, consultants, physiotherapists and senior managers.

In November 2015, we conducted a post-pilot Safety Attitude Questionnaire and evaluated this against the pre-pilot survey. We also validated the Safety Scale survey against quantitative data in the survey and finalised papers for publication explaining aspects of our work in more depth.

Who was involved in the project and how were those relationships managed?

We had a core group of people who were involved from the inception of the programme, who remained with the project the whole way through and were members of either the Project Steering group (the operational group that met fortnightly during setup, monthly during Implementation Year 1&2 and bimonthly up until May in Year 3) or the Programme Board (that met every 3 months). Some of these people have changed roles, moved to new projects or left the Trust but have found a way to continue to be involved in the programme because they fundamentally support its aims. This has been one of the strengths of the programme. These people have included:

Senior Nurse ICU HH

Senior Nurse ICU SMH

Senior Nurse ICU CXH

Team Leader ICU HH

Two patient representatives

Consultant in Intensive Care Medicine/Reader in Critical Care, Imperial College London

Consultant in Paediatric Intensive Care Medicine

Clinical Lead in Respiratory Physiotherapy

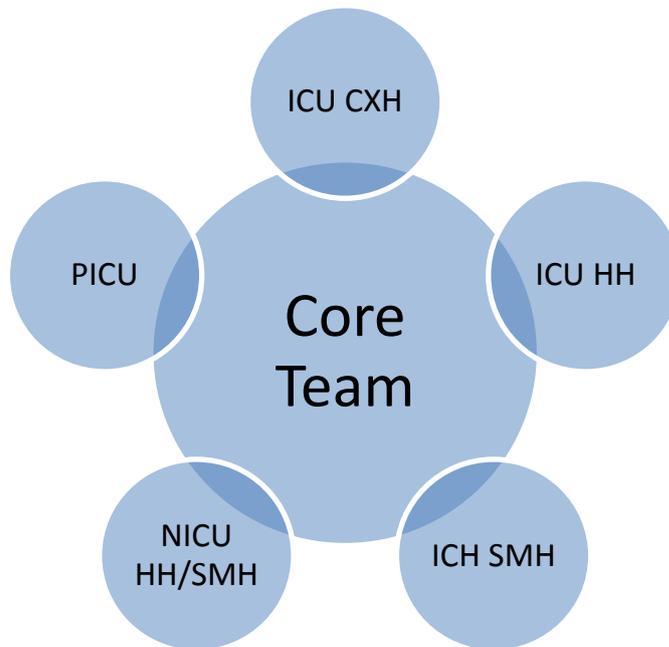
Physiotherapist Lead – Paediatric ICU

Audit and Research Manager, ICU

MAPS (e-rostering) Manager
 Associate Director of Nursing
 Head of Workforce
 Associate Director of Transformation (HR)
 Director of Infection Prevention and Control
 Head of Programme Management
 Director of CPSSQ (Evaluation)
 Professor of Implementation Science and Patient Safety (Evaluation)

In addition, we have created a network model to encourage the involvement of nurses, physiotherapists, pharmacists, consultants and junior doctors in all the intensive care areas as they wish and are able to be involved in the project. (see Figure 1) We have found that this flexible approach has sustained the project through significant changes. With the level of turnover and restructuring in the Trust which has affected key staff, in addition to the core team, we have needed to continually re-engage teams and recruit new people which have taken significant time and resource.

Figure 1 – Network model



Key stakeholders are:

The Director of People & OD and predecessors
 Director of Nursing and Medical Director
 Acting Director of Information and predecessor
 General Manager – ICU and predecessor
 Director and key staff within the Centre for Patient Safety and Service Quality (CPSSQ), Imperial College

We have attempted to keep an open, transparent and flexible approach to engagement. We have held workshops to engage clinical teams with the data, to listen and respond to their feedback. We have added new data items to the analysis and analysed the data in different ways, based on feedback from clinical teams. We have collaborated with our patient representatives, one of whom commented,

“I consider the approach used by the Shared Purpose IPlan project is very innovative in offering a different dimension of the PPI paradigm. Patient representatives’ engagement is not so much designed to call on their personal experience as health care patients and service users but more on observing and reporting from the “outside” on QI research and implementation work in highly specialised and specific acute care units. This externality may provide researchers with an ad hoc and flexible sounding board. As a lay partner, I have found this rich QI environment can inform other and non-directly connected patient representative interventions and activities, in areas such as patient safety and medicine optimisation for instance.”

We have maintained collaborative relationships with the evaluation team and the Tavistock consulting team, encouraging critical feedback. We used our knowledge capture journal in an open and collaborative manner, encouraging all the project team to complete it regularly, share it openly and use it as a tool for self-reflection and action learning, which provided helpful insights and at times, changed the direction of the project.

Impact

What has your project delivered – what difference has it made and in what ways?

What has our project delivered?	What difference has it made?	In what ways?
A predictive multidisciplinary on-line tool called IPlan that visualises data in new formats	<p><i>In practice:</i> Clinical teams are able to plan and profile their staffing more easily, understand staff perspectives on risk and safety by shift and explain their decision making and resource usage objectively to senior managers.</p> <p><i>To outcomes:</i> Although in the early stages, clinical teams have started to re-profile their healthcare assistant staffing to match the admission/discharge profiles with the aim of managing busy times better and reducing bank and agency usage.</p>	<p>Offers scope to deliver this approach via Imperial College Health Partners to other ICUs in the partnership and eventually other units/wards in partnership hospitals.</p> <p>Provides a system template for combining hospital data differently to present a holistic visual picture of a unit based on quantitative and qualitative data.</p> <p>Encourages clinical teams to plan together by role modelling MDT meetings.</p>
A daily Safety Scale survey to capture clinical team perceptions’ of risk and safety	<p><i>In practice:</i> Clinical team members feel that they have a mechanism to raise concerns or provide reassurance at the end of every shift, including out of hours and provide an explanation for it</p>	<p>Team leaders are able to review an objective measure of staff perceptions to identify and address problems or provide positive feedback at an early stage</p>

	<p>To outcomes: Team leaders are incorporating this feedback into a group that is reviewing staff satisfaction and development on the unit to identify changes that will improve staff wellbeing.</p>	
<p>A ground-breaking exploratory quantitative analysis of ‘tipping’ points between nursing hours per patient day and mortality at unit level</p>	<p>In practice: International health care providers and academics will understand the impact of a tipping point between staffing factors and clinical outcomes at unit level in health care.</p> <p>To outcomes: International health care providers can improve outcomes by monitoring and acting on changes to staffing factors, aware of the impact on clinical outcomes</p>	<p>Delivers a publication to explain unit-level tipping points in health care data</p>
<p>An innovative examination of staff perceptions of risk and safety in relation to staffing on the intensive care unit</p>	<p>In practice: Enables health care teams to understand and address the factors that underpin staff perceptions of risk and safety on the intensive care unit to improve safety and mitigate risks</p> <p>To outcomes: Enables clinical teams to improve or mitigate staff issues of safety and risk by identifying and addressing the factors that underpin staff perceptions of risk and safety on the intensive care unit</p>	<p>Delivers a publication in a practitioner journal to extend the learning to an international health care practitioner audience.</p> <p>Won first prize at a poster presentation at an international critical care conference in December 2015.</p>
<p>A systematic review of the literature on the effect of staffing factors on clinical outcomes</p>	<p>In practice: Provides practitioners with an aggregated picture of the impact of staffing factors on clinical outcomes to assist in implementing changes to practice to improve safety.</p>	<p>Delivers a publication in a practitioner journal to extend the learning to an international health care practitioner and academic audience.</p>
<p>A better understanding of the opportunities, challenges and limitations in data management in health care</p>	<p>In practice: Contribute to policy making at national level, raising awareness of skills shortages and big data opportunities and challenges.</p>	<p>Shared learning at the Health Foundation meeting on information management in February 2016.</p>
<p>A new co-designed way of working on information systems design and development</p>	<p>In practice: The system met clinical teams’ requirements as they had been actively involved through co-design from the conception of the project.</p>	<p>Clinical teams felt ownership of the end result and were proactive about implementing it in their area</p>

What outcomes have you seen, including any wider evidence of impact?

1. The most significant outcome is to create a user-focused predictive electronic system that enables any team to plan, profile and decision make based on easy access to integrated staffing, patient and unit data. Previously, clinical teams worked from gut instinct or a pre-determined template in deciding how to staff their unit and to attempt to explain their decision making about resource use.

Example: the story of Mel, senior nurse, intensive care:

During the MDT pilot meetings, Mel mentioned that one problem she faced was justifying increased staff usage on certain days. Mel suggested incorporating radiology data into the IPlan tool, to show the number of times nurses were required to escort patients to the radiology department, taking much needed staffing time away from the unit. We were able to integrate radiology data into the 24 hour graphic of unit admissions and discharges and differentiate the data by in-unit radiology and escorted radiology. Mel now uses this data at the Critical Care Improvement meeting to explain why the unit was busier at certain times and to justify the need for additional staffing to maintain high quality patient care.

In terms of wider impact, using a PDSA cycle to identify gaps in the system and incorporate additional features guided by users such as radiology data, clinical outcome data and allied health professional data has helped transform the IPlan tool into a fully integrated system that provides all the features needed to run a ward or unit operationally and to enable clinical teams to identify and act on trends in the data.

Imperial College Health Partners (ICHP) are interested to explore whether this system can be extended to other intensive care units within the partnership and potentially be developed to use with medical and surgical wards. We have shared the learning from the programme with them, so that they can commence discussions on the benefits of this system to others.

“Thank you very much for taking the time to meet with me yesterday. It was a really useful conversation, particularly to discuss the human and system barriers to implementation – fingers crossed that we will be able to learn from the amazing work that you have achieved and spread to other NHS organisations!” Project Lead Patient Safety, Imperial College Health Partners

2. A further outcome (which is a benefit that emerged beyond the original scope of the project) is to enable team leaders and clinical managers to understand, address and act on the perception of their front-line teams about the levels of risk and safety on the unit. This has been achieved through the Safety Scale survey, the results of which we have incorporated into the IPlan system so that teams can view this perception data against quantitative unit data.

The story of Fiona, senior nurse, intensive care:

Fiona was interested to know why the Safety Scale showed that on certain days, the majority of her team considered the unit to be safe or very safe, but one person considered the unit to be very unsafe. She explored with the team what issues they faced on those

days and found that one team member, who was less experienced and newer to the unit, was less able to cope than her more experienced colleagues and was reflecting this in her survey response. Fiona was able to provide additional support and mentoring for this person to ensure that they felt able to function competently and confidently on the shift and to maintain high quality patient care.

The Safety Scale is being statistically validated against quantitative data and assessed qualitatively to determine its effectiveness as a feedback tool. The Safety Scale has the potential to be used as an early indicator of risk and safety issues on a unit or ward. In light of the Mid Staffordshire report, having a mechanism for the clinical team to reflect on the staff satisfaction, leadership, risk and safety features of each shift, ensures that issues are made explicit and can be explored straight away. Our project highlighted the importance of considering perception data alongside quantitative data. Clinicians have told us anecdotally that their perception of the level of risk on a unit was borne out in reality. The Safety Scale provided a means of capturing this implicit data and making it as significant as other quantitative forms of information.

There is a temptation in health services, as elsewhere to rate objective, quantitative data as more important than other 'subjective' data. The desire for an elusive linear approach to managing health services contradicts the often messy, incongruent, multiple realities that are found in the clinical team accounts of what actually happens on the unit. In particular, this project identified a range of issues relating to power differentials, status and politics in relation to data management and sharing, how people perceive their workplace and their approach to working as a multidisciplinary team. These issues have emphasised the importance of human factors alongside the clinical and scientific factors in managing intensive care services.

3. A further outcome is the advancement of knowledge and learning for critical care practitioners, managers and academics that has resulted from all the background work to support the delivery of the first two outcomes. These have included a systematic review, a qualitative interview study on staff perceptions of risk and safety on the ICU and detailed statistical analysis of 'tipping points' in the staffing and clinical outcome data for which publications are being prepared.

Perspective from Steve Brett, consultant, intensive care:

This project provided an, 'Opportunity to conduct some deep human factors research which will help us understand the way we work- and eventually develop systems and processes which are in sympathy with this.'

The qualitative interview study on staff perceptions of risk and safety on the ICU was presented as a poster presentation at the Intensive Care Society State of the Art conference on 6th December at the Excel Centre in London – the presentation won first prize.

How did you measure and evaluate the impact and outcomes of your project?

Our approach to measurement

We have set out our approach to measurement of outcomes and impact in the table below. The evaluation team used the context, mechanism, outcomes framework, building on Health

Foundation work in 2014 that considered context, process and content around an intervention.

Area for measurement	Approach to measurement	Team
Co-designing information systems/MDT working/contextual factors	Thematic analysis of pilot study MDT meeting minutes	Evaluation
Project direction and progression	Thematic analysis of project and programme team interviews Thematic analysis of programme documentation 2012 - 2015	Evaluation
Safety Scale validity	Non-parametric correlation model	Project
Improving ICU team safety attitudes during pilot study	Pre and post pilot analysis of Safety Attitude Questionnaire (SAQ)	Project

Our approach to measuring and evaluating impact

We measured the impact of our project through the collection of case studies, i.e. outcomes section stories, showing how clinical teams had begun to use the IPlan tool in practice, during and after the pilot study. We plan to show impact through our publications, which are currently being prepared.

Changing our approach

Our approach to measurement and evaluation has changed over the course of the project. Our original plan outlined a quantitative approach to measuring the outcomes of the project. Half-way through the project we realised that our focus had shifted to changing the team culture around data usage through a co-design process of data sharing and information system development. We altered our evaluation methodology to take a more qualitative approach to capture the contextual and cultural dynamics throughout the project, whilst retaining some quantitative measurement around the pilot study process.

What has your project added to the discussion or evidence base for corporate and clinical teams working together in improvement?

Discussion

Our project has contributed to the discussion about corporate and clinical teams working together to improve planning and decision making using information with the overall aim of improving quality of care by more closely aligning staff availability with patients' needs. We have identified that clinical teams find it hard to work with the multiple data sources provided by corporate services from a corporate perspective. One reason for this is that they often do not recognise this data and therefore do not trust it or engage with it. Corporate teams often generate data without an understanding of the clinical environment. This is often the result of data provision to satisfy what are seen as management targets, rather than an appreciation of the operational realities of managing a unit on a daily basis. As a result, data is not combined in a way that makes sense to clinical teams. We have highlighted the importance of co-designing the approach to creating trusted, relevant and integrated information for clinical teams to use to improve staff and patient outcomes. The central tenet of this approach has been genuine engagement with clinical teams to understand what problems they face and what issues they need data to resolve.

We are informing the discussion about clinical information systems nationally and the issues around data management, storage and sharing in the health service. We are attending a data linkage event on 10th February 2016 at the Health Foundation to share our findings about the difficulties of combining different data sources, sharing data and managing data. We have produced an issues log (see Appendix 1 – using data and developing information in the NHS) to provide learning some of the key issues we identified and to inform a discussion on how to rethink the way corporate and clinical teams working together to produce useful information that aids the clinical teams in the management of wards or units.

We have qualitative evidence that taking a co-designed approach to designing and developing a unit-level information system has led to a more useful system that provides nearer to real-time data than existing systems as it was based directly on the feedback and suggestions from clinical teams. We found that taking this approach enabled the trust and engagement of clinical teams and the identification of useful data sources that we had not previously thought to include in the project.

We have begun work with the Information team to show the benefit of providing a holistic picture of a unit or ward that makes sense to a ward manager or team leader. Currently, all other business intelligence applications are developed in individual silos, e.g. a pressure ulcer module, a safety module, a people module, an activity module rather than taking a customer-focused approach of designing the system around the end-user so that they can see all the relevant modules in one place.

Evidence Base

We have added to the evidence base for corporate and clinical teams working together through our systematic review on the impact of staffing factors on clinical outcomes. Our review identifies the evidence base for a range of staffing factors impacting on a range of clinical outcomes in the adult, paediatric and neonatal intensive care environments.

We have added to the evidence base for relating staffing factors to clinical outcomes through the identification of 'tipping points' in staffing data and clinical outcome data. We have undertaken detailed modelling of factors identified in the literature to determine if a tipping point in relation to staffing factors and clinical outcomes can be found at unit level (evidence already exists at hospital level).

Clinical outcome data needs development

Our clinical outcome data is either less granular than we originally expected (showing weekly or monthly rather than daily data), overall numbers have been lower or there is significant missing data, so our predictive modelling has been less successful to date than anticipated. We hoped to be able to identify that, for example, there would be x% certainty that a reduction in staffing numbers of y would effect a z% change in a particular clinical outcome. We have preliminary data that may suggest a relationship such as this between minimum Nursing Hours per Patient Day and mortality. We are testing this further with additional data on levels of care. However, this line of enquiry has been less positive than we hoped. Instead, we have been able to build a tool that enables a clinical user to see their whole unit data in one place, using data visualisation to make this clearer. Feedback from our multidisciplinary pilot study meetings is that the graphic representation of this data in one place is enormously helpful to the multidisciplinary team, above and beyond the initial workforce use that we envisaged. Pharmacists felt they could use the data to explain changes in medication usage, nurses felt that they could understand the patient case mix better through seeing all the clinical indicators of case mix together and the physios found the in hours/out of hours information enabled a better understanding of their working day. Facilitated work will be needed to support the team in understanding how the data reflects the impact of workload on each other, as the culture of thinking from a uni-disciplinary perspective is very strong.

Although improvements have taken place in our Trust over the three years that we have undertaken the programme, we feel that there are national lessons to be learnt from our experiences with clinical data, which we expect to be reflected in other hospital Trusts. (See Appendix 1) A key lesson is that if clinical outcome data is to be used effectively for measuring healthcare improvements, we consider there is a need for significant improvements around clinical outcome data, including clearer national definitions, spelling out how the data is collected, analysed and reported, improved approaches for extraction and storage of data, the use of statistical methodologies and more effective feedback to clinical teams.

Standardisation of workforce data

Similar issues exist with workforce data. In our Trust, only nurses are currently recorded on our e-rostering system and although we found this information to be comprehensive as nurses are paid through this system, nurses are recorded against wards/units rather than individual patients which limits analysis. Consultant and junior doctor rosters are held on spreadsheets in individual departments and may not always reflect actual rostering arrangements which involve 'swops' and other amendments at short notice. For this reason we excluded doctors from the analysis. Allied Health Professionals were recorded on the Electronic Staff Record in 'books' but were not allocated to individual areas, as they were pragmatically allocated on daily operational basis according to relative priorities in the Trust on that day. However, they did record their contact time with patients on the Patient Administration System, with a significant system change from ICHIS to Cerner during the project. Pharmacists did not record their contact time in an area on any system, other than by proxy, through logging on and off the operational ICU ICIP notes system. The result of this variation is that it is difficult to build a multidisciplinary workforce perspective and its relationship with other factors on any particular ward or unit, without significant additional

work to identify, clean and link the data across the various systems. We consider that a more standardised way of recording staff time with patients would be beneficial nationally to assist with measuring workforce impact on other factors, especially clinical data. We know that this is the direction of travel for most Trusts but significant investment is required to get all staff groups on one system.

Using qualitative data to support a quantitative perspective

We have learnt about the benefit of using and incorporating qualitative data into the project. The development of the Safety Scale arose from feedback from team interviews about their perceptions of risk and safety in the ICU. We realised from early findings that the design and development of a Safety Scale would enable us to measure staff perceptions of risk and safety on wards or units on a daily basis, based on factors that were described as important in the interviews but were not described in the quantitative data. These included issues such as team dynamics, leadership, the subtleties of providing care that are not captured in operational or incident reporting systems, e.g. patients pulling out tubes, pharmacists correcting errors on prescription charts, the level of job satisfaction that individual team members experienced, whether team members felt they were operating safely and within their competence and whether they had noticed patients experiencing risk. We subsequently noticed that the Safety Scale reflected current Care Quality Commission thinking about the most important domains of practice. Although there was some suspicion from team members about using the Safety Scale in its early implementation over concerns about anonymity (for which reassurance was given), there was general acceptance once teams realised how the data was being used. We were asked to continue the Safety Scale following the pilot as clinical teams felt the feedback was valuable. We are validating the Safety Scale using quantitative data.

Maintaining engagement through organisational churn

We found engagement with clinical teams and corporate staff was easier than engagement with middle and senior management. The significant churn in executive directors, including three chief executives and two organisation-wide restructuring programmes, meant there was a significant turnover in staff and different organisational structures, which affected our ability to build sustainable relationships and communicate our message effectively. We overcame this with monthly briefings to the Trust Board through our executive sponsors and updates to middle managers who became involved with the programme.

What were the unintended consequences and side effects of your project?

The unintended consequences of our project:

- We realised through mapping the process of staff planning, that it was undertaken in isolation by individual professional groups. An unintended consequence of our project was realising the potential benefits of multidisciplinary liaison and discussion for staff planning and building multidisciplinary forums into the proposed pilot study. We made data visible to all members of the multidisciplinary team, who had previously never seen this data. This encouraged constructive dialogue and challenge between different professionals about their practice and active engagement with the data managers, who had previously not shared data so widely.
- We began to understand how important staff perceptions of safety and risk in relation to staffing were in terms of issues such as leadership, personality, team dynamics,

risk horizons and belief systems. We realised that these issues were not easily understood through the quantitative data and that we should develop a larger scale qualitative study to capture this information. This has led to the development of the Safety Scale, a further unintended consequence and a rich source of themes from the qualitative study to help understand the issues affecting staffing.

- A more negative unintended consequence is the extent to which data owners are protective about the data they maintain. In their efforts to ensure data accuracy, there is a tendency to restrict the availability of data, to delay the publication of data and an unwillingness to support the use of the data on different platforms.

The side-effects of our project are:

- Rethinking the delivery of business intelligence from a customer perspective. There are strong cultural and professional drivers in NHS Trusts for producing information from a department or professional perspective, but fewer drivers for thinking about information from a multidisciplinary perspective. Since we have presented data differently, this has encouraged a dialogue with the information department about the benefits of presenting data differently, including the rethinking of how data is presented via QlikView, the Trust's business intelligence platform.

In what ways would your intervention be useful or replicable for people working in another context?

- This intervention is replicable. We have ensured that we are using data that is available in the majority of hospital Trusts in England. This tool could be built in most business intelligence platforms, either QlikView or another similar platform.
- All Trusts will have varying levels of electronic data available. The key data sources are electronic rostering data, patient administration system (PAS) data and clinical information (for ICU this is contained in whichever system is providing the Critical Care Minimum Dataset), pressure ulcer data and a basic radiology dataset.
 - Specific contextual factors relating to these datasets include where and how the data is held, what access is available to the data and how regularly the data is updated. These issues are relevant contextual issues for all Trusts.
 - Our Trust datasets were not straightforward to bring into the QlikView platform as there were legacy problems which were beyond the scope of our project to resolve owing to the financial or people cost to address them. As a result, we have had to create workarounds to make the system work in the short to medium term.
- The advice for others on a project such as this is to:
 - build engagement with:
 - the clinical teams who will use and own the system
 - those managing datasets and their managers (in case of resistance about providing data)
 - the IT/information teams to facilitate access to the platform and to create workarounds where needed
 - senior Trust managers (to get support for an alternative devolved approach to information provision and use)

Start by:

- sharing the relevant datasets and forming graphs to share with clinical teams to discuss what information is useful and relevant to them, before building a system. Identify data that enables you to build:
 - a 24 hour perspective of admissions, discharges, staffing numbers and radiology data
 - a daily perspective of levels of care, patient and bed numbers, absence, permanent, bank and agency usage, nursing hours per patient day, allied health professional contacts and duration of contact, pressure ulcers, infections and mortality
 - discussing with the information team and clinical data managers what data is available and how feasible it is to link it into a business intelligence system
- The barriers and challenges to prepare for include:
 - Information governance issues about storing data in a different way
 - Resistance from those who gain power and status from controlling access to certain datasets
 - Bureaucracy in finance areas for approving different software
 - Resource issues in building a new module (we had to use a QlikView contractor as there was already a queue of projects ahead of ours)
 - Time constraints for clinical teams to participate in a co-design approach
 - Poor data quality (particularly clinical outcome data)
- The risks to be aware of are:
 - Datasets not easily linked into business intelligence platform (we encountered a range of issues including Trust data held remotely by commercial companies who were charging a large fee to provide the complete dataset and data on PAS system unable to be extracted owing to problems with reporting tool)
 - Time it takes to co-design a useful tool
- Efforts should be targeted towards clinical teams that show interest and enthusiasm for having this information and can see the potential benefits that it might bring.
- Once the system is live, it would be possible to measure the impact of the intervention through PDSA cycles, monitoring qualitative examples of improvements function of the ward/unit through case studies and quantitative examples of improvements in clinical outcomes such as pressure ulcers and staff outcomes such as improved job satisfaction on the Safety Scale.
- Use existing or develop new MDT meetings to introduce the project. The importance of engaging ICU leaders to support this process cannot be underestimated. Their buy-in will influence the level of participation and engagement of a regular team. The barriers and challenges to be aware of include:
 - time constraints for staff in participating in MDT meetings
 - level of understanding of data; where it came from, how it can be used
 - inadequate leadership time from senior or team leaders

What are your reflections on how change happens, new models of care and evaluating complex change?

How change happens

Complex change, of the exploratory type that is involved in developing an innovative information system, runs counter to the style of many change programmes within the NHS, which despite best intentions are often top down. We found that to achieve our change, it was best to keep it 'below the radar' otherwise we would experience pressure to conform to performance targets and timescales. We were supported in this by our Director of People and OD, who provided the space to work in a 'bubble' which gave us scope and time to experiment with new concepts, approaches and data configurations with clinical teams, which was essential to developing a useful system from their perspective.

We found that trying to use a linear project planning process was ineffective as it was difficult to plan how long the stages of an exploratory piece of work would take. When we had the people with the right skillsets in place, the project moved forward extremely quickly – beyond our original expectations. When we had people with insufficient skill sets the project moved extremely slowly and we failed to meet our objectives. We tried to adopt project approaches, such as 'agile' and 'scrum' from the IT industry to help us plan in short bursts and to check back with the client whether we were delivering their requirements.

We found that the network of existing relationships we had in place was crucial to making progress in some aspects of the project. Taking time at the beginning of the project to build strong relationships was very important to sustain the project through difficult times, such as cost pressures within the Trust, structural changes within the organisation and changes to project members. We think the project would have failed without these relationships.

New models of care

This change created a new paradigm for thinking about information provision for clinical teams. We took a customer-focused perspective and tried to build a system around the user, the team leader or senior clinical team member who was using the system to help run their unit. This approach compared with the current thinking where most systems are built to deliver external objectives or are built by departments to present their own siloed area of interest, e.g. safety, activity, finance, people, pressure ulcers etc. Little work has occurred to present a daily pattern of information tailored to the user that assists in their day-to-day running of their area. We encountered significant resistance in some areas to incorporating these siloed datasets into the system.

How to evaluate complex change

We found that qualitative methods captured more of the complexities of the change than our originally proposed quantitative methods. We found that the barriers and challenges were often cultural and professional and that these were better identified through qualitative work. Whilst we could evaluate components of the change through quantitative work, e.g. Safety Scale validation the contextual and process aspects of the change process were best identified through qualitative work.

Embed and spread

In what ways has your intervention been sustained?

Our intervention will be sustained in our organisation across our 3 ICUs beyond the funding period as our IPlan tool has been built into the Trust platform for business intelligence based on a commercially available software, used by a number of Trusts called QlikView. The Trust's strategic direction for business intelligence over the next five years is to use QlikView for business intelligence. IPlan for the 3 ICUs is now live in QlikView and all our ICU team leaders and senior clinician leads have access to the live tool and we have solutions in place for ensuring sustained daily or weekly 'back-end' data feeds into the system. We achieved this through using an external contractor to build the QlikView system based on our prototype that had already been developed in R and Shiny.

We have discussed the possibility of developing this work with Imperial College Partners to see if it can be extended beyond the 3 ICUs in the Trust to those ICUs in the partnership across London. We have also briefed our internal quality improvement team on the project, including the lead, Dr Bob Klaber and are sharing our final report with the team, so that they can explore the possibilities for using this approach in other wards and units within the Trust.

Our clinical teams have begun to integrate the use of IPlan into their everyday practice. On one site, IPlan will be used in their monthly MDT meetings. These will be attended by all of the consultants, the general manager, the clinical lead for respiratory physiotherapy, the senior nurse, the dietician, the pharmacist and the education lead. The team leaders are also setting up a team to look at staff satisfaction. They plan to review data from both Safety Scale within IPlan and Safe Care on a regular basis. They will have a monthly meeting with the senior nurse to feedback suggestions for improvements if they haven't already implemented them. We achieved this embedding of practice through a co-design process which ensured that the system met the clinical teams' needs.

We consider that there may be scope for the development of the Safety Scale which links to recommendations from the Francis Report and provides a mechanism to understand anonymised individual and team perspectives on safety and risk within a particular unit/ward. We will consider whether this development, once tested and validated through our pilot study, could be developed for wider rollout via Imperial College Health Partners, with whom we have held a positive preliminary meeting.

We plan to sustain the impact of the background work around our intervention through the publication of papers that reflect different aspects of the programme. We are developing two publications currently, our systematic review and a paper highlighting the themes that were identified in our qualitative study of staff perceptions of safety and risk in relation to staffing in adult intensive care.

What success have you had in spreading and publicising your work, and what are your future plans in this area?

Spreading our work

We have worked on spread of our innovation through the Trust by holding meetings with our Quality Improvement team, our human resources team, our Information/QlikView team and

our Nurse Directorate. We have shared the approach to developing integrated data from a user-perspective. Our aim is to encourage these teams to consider the benefits of integrating data to provide a more customer-focused approach to information provision.

We have held preliminary and positive discussions with Imperial College Health Partners to discuss the spread of our work to other partner sites.

Publicising our work

We have publicised our work to practitioners in the field of critical care. Our critical care consultant research lead, Dr Stephen Brett, gave an oral presentation at the 35th International Symposium on Intensive Care and Emergency Medicine in Brussels in March 2015. He presented early findings from our qualitative interview study in a presentation entitled 'Better understanding of human factors' in the session 'How to improve ICU quality?'

We had a poster accepted for The Intensive Care Society State of the Art 2015 meeting on 6th December to share the findings of our study on staff perceptions of risk and safety in relation to staffing in the ICU with an international audience of critical care practitioners. This poster won first prize in our section and a £100 prize which has been shared with the three ICUs for educational resources.

We are working on a set of publications that showcase different aspects of the project for publication in peer reviewed practitioner journals:

- Systematic review on the impact of staffing factors on clinical outcomes – draft in preparation for submission to Critical Care Medicine
- Qualitative study on staff perceptions of risk and safety in relation to staffing in adult ICU for submission to Critical Care Medicine
- Engaging adult intensive care unit (ICU) staff to co-design an information system: a plan do study act (PDSA) approach for submission to Implementation Science
- Evidence of tipping points at unit level: understanding the impact of levels of care/NHPPD on mortality (Journal to be agreed)

Appendix 1

Using data and developing information in the NHS

Issue	Description
No data linkage	<p>Data in the NHS is often held in many different systems that are not linked. This problem has been partially addressed in our Trust through the development of a data warehouse in the Information Department to store multiple datasets. We recognised the importance of linking previously unlinked data sources, for example joining together clinical data sources (e.g. the patient administration system (PAS) with the ICU specialist database (ACUBase)) or workforce data sources (e.g. the e-rostering nurse data (MAPS) with the Electronic Staff Record (ESR)). This was a time consuming process which required several methodologies, including the use of software such as 'Soundex', a phonetic algorithm for indexing names by sound, as pronounced in English and the use of statistical software R for coding purposes to clean and link the data. Using this approach, we developed more comprehensive datasets that contained additional information linked to either the patient or team member to supplement our analysis.</p>
Inadequate feedback of data	<p>We found that clinical teams had to rely on gathering information from many different information systems; rostering, AcuBase, PAS system, people system, pressure ulcer system and much of this information was presented as tables or in spreadsheets without much visual content. The data was more than one month out of date and often aggregated data to present a monthly position. Senior clinical leads described the process as time consuming and laborious and not providing them with the more up-to-date information to run their unit.</p>
Missing and inaccurate data	<p>We have identified significant issues with missing or inaccurate data as a result of errors and gaps in data entry, variability of data requirements from year to year and inadequacy of current reporting tools to extract all data. We discovered that linking data together using either staff or patient unique identifiers was extremely challenging owing to the amount of missing or inaccurate (incorrectly spelt/inconsistent spellings) data. We have fed back the percentages of missing data and inaccurate data to the teams. Despite cross-referencing our datasets with national datasets, as in the case of the NHS number, there are still a percentage of missing items. We have used range of methods to rectify inaccurate data where possible, with help from our clinical colleagues.</p>

<p>Overreliance on Excel</p>	<p>There is a strong reliance in most NHS information departments on the use of Excel as a data manipulation tool. However, to manipulate and combine large datasets, Excel is not sufficient as it does not contain enough rows. Coding in Excel is limited. We found that our statistician was able to work much more efficiently and effectively using R, statistical software that is widely available as open source software and has the added benefit of being free. R can also be used to undertake a range of statistical functions that are more easily undertaken than in Excel. Coding in R was required to match identifiers across different datasets.</p>
<p>Descriptive information analysis</p>	<p>Much information analysis in the NHS is uses very basic statistical techniques, such as addition, percentages and means and uses basic visual display tools such as histograms and pie charts. Data is often analysed within year and there is less emphasis on analysis of trends or patterns in data over time. (this is impeded by data definitions being changed from year to year). We found that clinical teams appreciated being able to view data in different ways which drew on a range of statistical techniques, beyond those often employed in traditional data analysis.</p>
<p>Data on units/wards not detailed enough for statistical analysis</p>	<p>Much performance data in the NHS is monthly which meant that if we were to analyse three years data this would provide only 36 data points which provided insufficient power for statistical analysis. Wards are now collecting daily data for safe staffing (the number of staff on duty and level of care score for individual patients) which provides further information and could now be incorporated into an information system. No electronic clinical information is routinely captured at ward level, unlike in the ICU, which would limit what the information system could show.</p>
<p>Scarcity of medical statistical resources</p>	<p>We discovered that medical statisticians of sufficient calibre to run a programme of this nature are extremely rare and it took four recruitments and revisualisation of how the medical statistical input would work with the recruitment of a Professor from the University of Cambridge to lead the work and support a post-doctoral medical statistician. This process delayed the programme by one year.</p>
<p>Developing predictive models</p>	<p>We have struggled to build predictive models owing to the varying quality and breadth of clinical outcome data. Whilst mortality data is reasonably robust and available on a daily basis (and we have a preliminary model for minimum Nursing Hours per Patient Day and mortality), most other clinical measures are submitted weekly or monthly, which prevents the development of robust statistical models which require daily data for sufficient power. The quality of data varies as data definitions change, different teams collate and compile the data, national requirements alter the priorities of collecting certain data items and detailed data is stored on systems that are only accessible by one or a few highly skilled individuals and the data is not available beyond one year in some cases.</p>

<p>Statistical analysis of previously unseen data</p>	<p>Through the thorough investigation, collation, cleaning and statistical analysis of available data, we have enabled professional groups to understand, question and evaluate the data that is entered onto systems by them or their colleagues. Even before it is used in the tool, they have used this data to re-assess the supply and demand for clinical services and support service improvements and developments, such as 7 day week working.</p>
<p>Developing metrics using combined patient and workforce datasets</p>	<p>We developed metrics (based on the literature) by combining daily data from both patient and workforce systems. For example, to develop the metric Nursing Hours per Patient Day (NHPPD) we combined nursing hours from our e-rostering system and divided them by number of patient days from our clinical ACUBase system.</p> $\text{NHPPD} = \frac{\text{Nursing hours for 24 hour period}}{\text{Patient days for 24 hour period}}$ <p>These metrics have provided the basis for our predictive modelling to identify relationships between variables and to model tipping points (critical changes in complex systems) in the data.</p>
<p>Lack of discussions between clinical and corporate teams about a user-focused approach</p>	<p>We found that the project enabled a dialogue between clinical and corporate teams about their data, including issues of access, timeliness, accuracy, efficacy and reliability. Over time, our discussions identified concerns about the siloed nature of staff planning owing to a strongly professional driven approach which prevented a holistic, unit-focused approach to planning. We discussed the lack of multidisciplinary information to support discussions about pressures on both supply (staff) and demand (patients) in terms of the units' capacity with the potential for impacting on clinical outcomes. As a result, we identified important information, e.g. sickness data, turnover data, admissions/discharges, that would be useful to help the multidisciplinary team plan which we incorporated into the IPlan tool.</p>

Appendix 2

Learning event posters



Posters for the 2015
learning event

These posters are in the attached PDF document. They have been included in picture format below.



Our project helped multidisciplinary teams to overcome systems problems such as uni-professional planning.

Organisational silos – by profession or hierarchy – prevent the Intensive Care Units (ICUs) from planning staffing as a cohesive team for the benefit of patients.



We identified a gap between ICU teams' experiences and senior managers' perceptions of performance within the units.

Corporate teams

"ICU meets national guidelines for staffing."
Executive director

"We have a safety thermometer and quality metrics in place."
Executive director

IT teams

"We have multiple systems, but no way of joining up the system information."
Data analyst

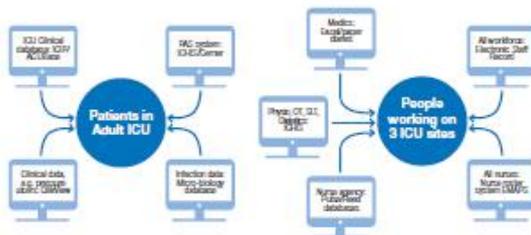
"Linking corporate and multidisciplinary clinical data is so difficult that no one has tackled it before."
Head of people planning

ICU teams

"We put information into the systems, but don't get anything out."
Physiotherapist

"Our staffing does not always match the peaks and troughs of demand."
ICU senior nurse

Disparate sets of incomplete data – in different formats, from multiple systems – make it hard for teams to plan and make decisions.



We moved from the pre-pilot state to the mid-pilot state by focusing on issues of team communication, planning and decision-making. This process used the improved holistic unit information provided by our interactive tool.

Pre-pilot	Mid-pilot
Uni-professional communication	Multidisciplinary team communication
Uni-professional planning	Multidisciplinary team planning
Subjective assessment of risk and safety	Objective measure of risk and safety
Siloed data	Shared data
Retrospective monthly data	Retrospective daily data
Count data	Statistically analysed data
Under-utilised data	Monthly review of data
No improvement plan	Clearly defined improvement plan

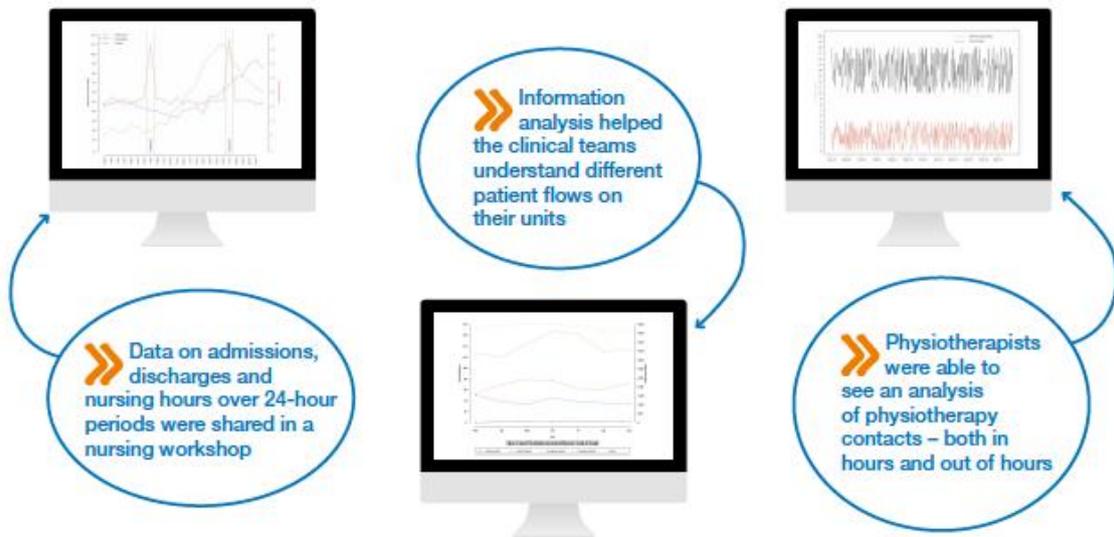


"I can't believe how many systems I use that I don't think about. It's interesting to look at all of the information."

Steve Thoresen, senior nurse



We reviewed extensive data from the Trust's three adult Intensive Care Units (ICUs) to identify trends that could be built into our interactive tool.



3 years Period of retrospective ICU data analysed by the Trust's statistician to understand trends and patterns. This information was presented to teams in workshops as 24-hour, monthly, weekly and yearly graphs.



A collaboration with the University of Cambridge enabled data modelling to explore relationships and develop evidence-based metrics.



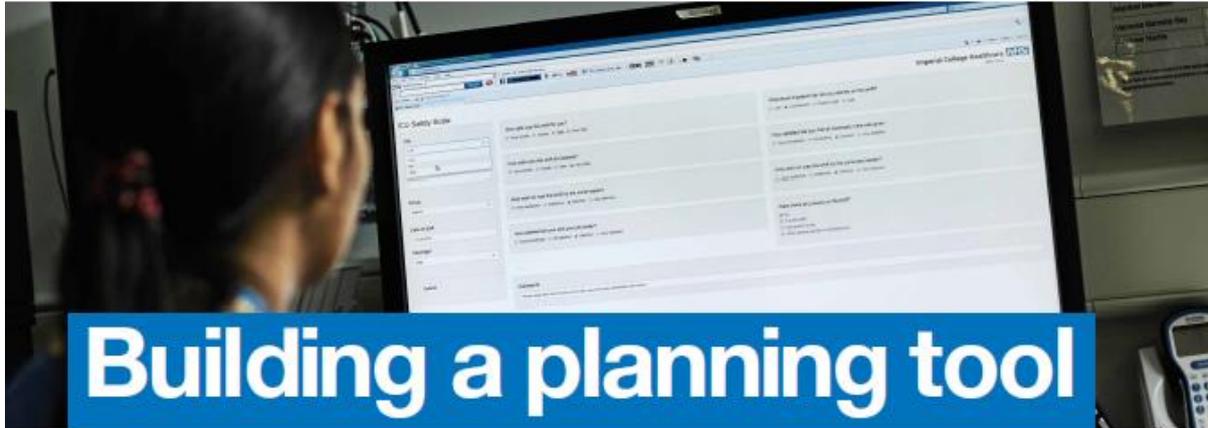
"Having seen how useful IPlan is to the ICU, I would like it to be rolled out to the cardiac ICU."

Simon Mackie, matron for cardiothoracic surgery



"It gives you a realistic visual graphic of how you've spent your day."

May Nel, clinical specialist physiotherapist



We developed a digital tool that collates disparate sets of data to improve decision-making around workforce planning.

» We used the Plan, Do, Study, Act cycle to develop and test our prototype IPlan tool over the course of six monthly multidisciplinary meetings.



» We wanted to understand people's perceptions of safety and risk – and so we developed the Safety Scale.



» IPlan gives clinical teams a clear picture of the multidisciplinary model of care needed for each shift. It gives ICU leaders the clear and accurate information they need for decision-making.

IPlan integrates:

- patient, workforce and Safety Scale data
- multiple patient and workforce data sources



IPlan provides:

- a holistic overview of daily supply and demand
- a multidisciplinary perspective
- a comparison of operational data with staff safety perspectives
- a flexible user-driven visualisation of key unit metrics



“The tool is capturing real-time data that is meaningful to use as ‘predictors’ in the future.”

Fiona Stubbs, senior nurse



Working together

We implemented an interactive tool that allows all ICU teams to review and analyse integrated multidisciplinary workforce and clinical data.

» We have made significant progress to resolve our issues around sharing clinical data, using a number of communication channels and projects.

<p>IPlan</p> <ul style="list-style-type: none"> An interactive tool that enables staffing to match the clinical unit profile, e.g. admissions and discharges Piloted May-Oct 2015 with multidisciplinary teams on two sites IPlan could be developed for any clinical ward or unit in an acute Trust 	<p>Qualitative interviews</p> <ul style="list-style-type: none"> 44 interviews conducted The aim was to improve understanding of ICU clinical teams' perceptions of risk and safety Themes included different risk horizons, differing outlooks (optimist/realist) and differing judgements (resilient/reliable), and their impact on safety 	<p>Safety Scale</p> <ul style="list-style-type: none"> An electronic survey to gauge staff perceptions of risk and safety at the end of every shift Easily accessible – a desktop link to this survey is available on every ICU computer on all three sites Survey data used within IPlan gives teams a sense of how their colleagues rated the shift 	<p>Multidisciplinary dialogue</p> <ul style="list-style-type: none"> Discussions held between clinical and corporate teams Topics included access, timeliness, accuracy, efficacy, and reliability of data for unit planning Professions within the clinical team now use IPlan to discuss workforce planning and decision-making
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» IPlan encourages proactive, rather than reactive, planning of workforce resources to make the environment for patients as safe as possible.

<p>Joint planning</p> <p>ICU leaders can share information about working together</p>	<p>Predictive</p> <p>Teams are able to understand trends and patterns in data to more accurately predict and adapt future staffing profiles</p>
<p>Integrated data</p> <p>IPlan presents a holistic story about the ICU</p>	<p>Supports decision-making</p> <p>ICU teams can plan and justify operational decisions, and inform clinical managers why resources are being used as they are</p>
<p>Visual and interactive</p> <p>IPlan's design makes it easy for clinical teams to interpret information</p>	

» Everyone within the Intensive Care Unit across the three sites was invited to give an opinion on the development of IPlan.

<p>Corporate teams</p> <p>"We can't assume a one-to-one ratio of nurse to patient." <i>Executive director</i></p>	<p>IT teams</p> <p>"It is great to see the integrated data is worthwhile. I wasn't sure I was providing enough data." <i>Medical statistician</i></p>	<p>ICU teams</p> <p>"Thank you for making the ICU Safety Scale so user-friendly." <i>Physiotherapist</i></p>
<p>"Variations in care can be subtle and not easily identified through existing outcome data." <i>Head of programme management</i></p>	<p>"It is enabling people to access data in a way they've never been able to before." <i>IPlan developer</i></p>	<p>"We can use IPlan to highlight the patient case mix linked to staffing." <i>ICU senior nurse</i></p>



"We'll have a better picture of when patients are being admitted to the unit, post operatively, and also times of discharge."

Melanie Denison, senior nurse

Appendix 3

IPlan video <https://vimeo.com/imperialcollegehealth/review/143007310/2e8de9c32f>