Patient safety is a high priority in healthcare and much time, effort and money is being invested into studying how it can be improved upon. Around 10% of patients admitted to NHS hospitals every year experience some kind of health care related harm. Estimates show that half of these incidents could be prevented. The Department of Health’s Patient Safety Research Portfolio (PSRP) is a national drive to study errors made in healthcare, measure them and find ways of preventing them in the future.

This briefing paper is based on work undertaken by a team of researchers led by Professor Marc de Leval, professor of cardiothoracic surgery at Great Ormond Street Hospital for Children NHS Trust and coordinated by Dr Ken Catchpole, human factors researcher at the Institute of Child Health, University College London. The study, first published in 2005, looks at errors made in the operating theatre by observing operations at first hand, recording them for closer scrutiny and evaluation of non-technical skills such as human error, system problems and teamwork, questioning health professionals to assess safety culture, and using computer simulations to study how hospital systems might increase the chances of surgical error. It is being highlighted now as part of a new drive to promote all the many pieces of research into patient safety carried out by the PSRP.

This briefing paper is aimed at healthcare professionals working in the UK and abroad, patients and carers using NHS services, academics and health service managers.

### Key Messages:

| Adverse events in surgery are more likely to be due to a coincidental buildup of several minor failures rather than due to an individual’s incompetence or negligence | Healthcare professionals need more evidence of the prevalence and nature of error in surgery and the benefits of sticking to safety practices |
| Improved training in team work and communication might help reduce the incidence and impact of errors in surgery | Briefing surgical teams and de-briefing them can help avoid, capture and mitigate present and future failures |
| A key barrier to patient safety is the fact that staff feel information from adverse incident reports will be used badly or not used at all, so feel it is pointless reporting incidents. There is an uneasy relationship between healthcare management and healthcare staff over patient safety issues | Using computer models can be valuable in helping examine errors in healthcare organisations |
|  | Fundamental changes are needed in healthcare in the UK to achieve high levels of safety in surgery |
Background:
There is a growing trend for greater scrutiny of healthcare, NHS organisations and the staff who work in them. Patient safety, preventing medical errors and reporting of adverse events are all a priority for the government. A drive to tackle these issues began shortly after the publication of a report by the Chief Medical Officer Sir Liam Donaldson in 2000 that looked into adverse events in the NHS. It found that 400 people die or are seriously injured every year because of an adverse event involving a medical device and 10,000 people a year have a serious adverse reaction to drugs.

Other estimates say there are around 850,000 adverse events a year in NHS hospitals with a resulting cost of £2billion in additional hospital stays. This also leads to clinical negligence claims that cost the NHS around £400million a year. As well as setting up the National Patient Safety Agency (NPSA) in 2001, the government launched a large scale research programme to:
- explore the size and nature of the problem
- understand the factors causing harm
- develop interventions to reduce errors
- assess how effective have the attempts to reduce errors been
- implement ways of guaranteeing change in people and organisations.

A significant proportion of adverse clinical events are linked to surgery which is seen to be a high risk area.

Surgery is the setting where all parts of healthcare – diagnostics, treatments, technologies, skills, teamwork, infrastructure, management – all have some influence on the events than happen while a patient is in the operating theatre. Looking at the human factors in this setting is crucial in identifying and reducing error with the intention of improving patient safety.

Aims of the Study:
The aims of the project were to:
- identify in advance latent or underlying conditions that may influence operating theatre team performance
- develop an integrated video and trained observer method for identifying active errors in the operating theatre
- apply operational research techniques to examine links between latent conditions and safety
- develop error management strategies to reduce the frequency of latent conditions and active errors.

About the Study:
The researchers carried out their work at two UK hospitals, looking at paediatric cardiac surgery initially and then orthopaedic surgery settings. Paediatric cardiac surgery was chosen because, although there is a low volume of such operations, it is considered to be extremely complex and a high risk area of surgery, whereas orthopaedic surgery is very high volume and reasonably non-complex. They identified and assessed errors in surgery using direct observation, video recordings to evaluate non-technical skills; assessed safety culture and how resilient health care organisations were; and used computer simulations to examine aspects of hospitals and how they operate that might increase the chances of surgical error.

Practical findings:
Identifying and reducing errors in the operating theatre
The researchers said that examining the causes of errors in the healthcare system rather than blaming individuals was essential to avoid adverse events in the future. To assess errors in surgery, the researchers used three methods, direct observation by expert observers, using video recordings to play back events, and evaluating the non-technical skills – teamwork and communication – apparent during each operation.

They found that small and apparently unimportant errors in surgery can accumulate to create bigger problems and patient safety incidents, which indicated a need to reduce these small problems. Much could be learned from other industries, they said, such as the use of non-technical skills in how to reduce these small problems and avoid or deal with errors better when they happened.

Paediatric cardiac surgery
In paediatric cardiac surgery, 24 cases were studied over a 10-month period. The researchers wanted to develop a method for measuring systems deficiencies in surgery, examine the types of failure in cardiac surgery and how often they happened, and investigate the change from a minor to a major failure. They found that in the 24 operations studied, there were 366 minor failures and seven major failures though all patients in the study survived.

The minor failures (of which there were 29 different types), were most commonly to do with communication and coordination, absences from theatre, and equipment failure. Longer and more risky operations were likely to have a large number of minor failures as increasing demand on the surgery team increased the chance of human error, said the researchers. The common minor errors happened often and were tolerated and not reported.

Using video recordings of operations was useful for examining the causes and origins of failures, said the researchers, which may have begun a long time before the failure became obvious. However, there were ethical difficulties in using the recordings.

Orthopaedic surgery
In orthopaedic surgery, 20 cases were studied, mostly involving total knee replacement surgery and total hip replacement surgery. All the operations were successful, but the researchers noted 421 minor failures and one major failure, which was resolved. The major failure came about indirectly as a result of several other issues such as uncertainty, high workload, task requirements, non-technical errors and the introduction of new technology into the operating theatre.
There were 20 different types of minor error and the most common were distractions, equipment management failures, safety consciousness failures and coordination and communication failures. Most often noted threats to safety were cultural and organisational problems and, as with paediatric cardiac surgery, non-technical errors happened more often than technical errors. People on the surgical team had considerable skills and competence, the researchers said, because decision making and diagnostic errors were the least frequent type of failure noted.

**Major failures**

Eight major failures were identified across both types of surgery, which represented clear risks to the patient. All were associated with a sequence of minor failures. They either accumulated or happened at a critical phase in the operation. This effect was amplified in high risk cases because they are longer and more difficult, often feature more minor failures, and because they generally have more critical phases.

The most serious failure – a potentially dangerous bleed – was triggered by a single event that is known to be a potential complication with that particular operation, but was exacerbated by a further sequence of small problems.

Other problems included one where a surgeon forgot a key surgical step, and another where blood was being filtered from the patient but was accidentally not returned. Despite these failures, all the patients recovered from surgery. Two of these failures were briefly described in the post-operative surgical report, the researchers found, but no other record of these events was kept, so nothing was learned by the operating teams about how these situations might be avoided in the future.

**Non-technical skills and errors in surgery**

The researchers looked at non-technical skills in healthcare, meaning the cognitive or mental skills (decision-making, planning, situation awareness) and social or inter-personal abilities (team working, communication, leadership), that people possess and a team show during simulated or real events. It is likely, they said, that the ability of a surgical team to work well together has a huge impact on operative performance.

The researchers gathered non-technical data from observing minor errors, and from independent video observation using a scale derived from the aviation industry.

Non-technical errors were much more common than technical ones, and they concluded that because non-technical performance of people in the surgical team can influence the success of surgery (particularly cardiac surgery), it should be assessed alongside technical performance.

They also found that teamwork between surgeon, anaesthetist and perfusionist (the health professional who operates the heart-lung machine during cardiac surgery) was critical in cardiac surgery, whereas the key relationship in orthopaedics was between the surgeon and the scrub nurse.

**Assessment of safety culture and resilience of institutions**

The researchers piloted three tools to assess safety culture and resilience of healthcare organisations. The first tool was called the Checklist for Assessing Institutional Resilience (CAIR) which studied the structure and procedures in place for monitoring, avoiding and managing errors at organisation level.

The second was the Incident Reporting and Attitude Survey (IRAS), which collected data from healthcare practitioners on the management of and attitudes to the collection and distribution of safety information and critical incidents.

The third was the Operating Theatre Team Management Attitudes Questionnaire (OTTMAQ), which examined the staff’s perception of team and individual performance in relation to safety in surgery. Collecting data for the CAIR was intensive, said the researchers, and it took staff up to 25 minutes to complete each of the IRAS and OTTMAQ questionnaires. Despite considerable efforts to encourage staff to participate, there was a low response rate, which limited the conclusions that could be drawn from the data.

Nevertheless, the researchers said this showed organisation weaknesses in areas such as dissemination of findings of incident reports and investigations to clinical staff, and involvement of clinical staff in patient safety discussion at management level. IRAS and OTTMAQ data were similar, and showed that attitudes to safety were better in comparison to other similar studies.

Overall, healthcare staff felt that information regarding incident reports would either be badly used or not used at all. This discouraged them from error reporting. However, in general, the participants said staff should raise concerns they have over the actions of others regardless of hierarchy or professional boundaries and many said team members should openly discuss their differences with each other.

**Mathematic modeling**

Another part of the work done by the researchers was to use computer simulations of healthcare organisations to see how they affected patient safety. Computer simulation is one way of predicting system behaviour using a mathematical model of interaction between different parts of a complex system. They looked at various simulations involving patient admission and discharge, bed management on the ward, diagnostic procedures, and cross-matching of blood.

The researchers found that using this simulation method was feasible and helped to identify latent safety issues in a hospital’s system as well as helping to evaluate alternative strategies for reducing threats to patient safety.
Summary of main findings:

- During 24 operations carried out in paediatric cardiac surgery, there were seven major failures and 366 minor failures noted by an expert observer, but no serious injuries.

- During 20 operations carried out in orthopaedic surgery, there were 421 minor failures and one major failure, which was resolved, but no serious injuries.

- Some minor errors that happen frequently during surgery are usually tolerated and not reported afterwards. None of the events reported in the study appeared in any incident report or were learned from.

- The non-technical performance of people in the surgical team can influence the success of surgery, particularly in cardiac surgery.

- Adverse events in surgery are likely to be linked to several frequently recurrent, coincidental and cumulative human errors that are likely to happen because of threats that lie in the system rather than because of individual incompetence or negligence.

- Some staff are reluctant to report incidents because they feel such information will be used badly or not used at all.

- Staff said that improving communication would be the most effective way of improving patient safety.

Conclusions, recommendations and implications for practice and policy:

- Non-technical performance of healthcare staff should be assessed alongside technical performance in the future because the former can have a significant impact on how successful surgery is. Future research could look into developing suitable assessment scales for non-technical performance.

- The opportunity for errors should be reduced by using things like checklists and standard operating procedures to promote consistency of care, and discourage interruptions, absences and violations of safety practice.

- Future researchers could look into using computer simulation methods more as these have the potential to work well alongside other methods of studying errors in healthcare.

- Safety managers should ensure that healthcare staff are involved in the analysis and feedback of incident reports – this could encourage more comprehensive patient safety related reporting.

- Useful lessons could be learned by NHS organisations from consulting and working with other industries and safety specialists.

- Future research could look into evaluating the worth of pre-operation briefings and post-operation debriefings as a way of improving patient safety.

- Efforts should continue into understanding the how, why, and when errors happen in operating theatres and the ethical and cultural barriers to effective safety research should be examined further and removed when possible.

Further information:
The full report, this research summary and details of other Patient Safety Research Portfolio work can be seen at http://www.pcpoh.bham.ac.uk/publichealth/psrp/commissioned.shtml

About the Patient Safety Research Portfolio:
The Patient Safety Research Portfolio (PSRP) was created in 2001 as a programme to promote research into patient safety. It followed a report published by chief medical officer Sir Liam Donaldson in 2000 that looked at learning from adverse events in the NHS. The PSRP is funded by the Policy Research Programme at the Department of Health and reports directly to the CMO. The programme has also commissioned research on behalf of the National Patient Safety Agency (NPSA).

It funds research aimed at reducing errors that lead to bad outcomes for patients by:
- measuring the types and frequency of error
- analysing root causes to identify problems and how lessons can be learned
- specifying and testing interventions
- making sure that useful findings from research are distributed widely across the country

The programme is based at the University of Birmingham’s Department of Public Health and Epidemiology and is directed by Professor Richard Lilford. The PSRP team has a history of building capacity in the area of patient safety and is currently involved in evaluating The Health Foundation’s Safer Patients Initiative and has recently published a series of papers on methods for patient safety research. The views expressed in this publication are those of the authors and not necessarily those of the PSRP, the Department of Health or the NPSA.

For further information about the PSRP visit our website at http://www.pcpoh.bham.ac.uk/publichealth/psrp/ or contact:

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