Surgical Safety Checklist:
A Redesign Using Human Factors Guidelines

J.M. Davies, MSc, MD, FRCPC, Department of Anesthesia, University of Calgary

J.K. Caird, PhD, Department of Psychology, University of Calgary

Developed in collaboration with the In-Country (Canada) Working Group under the auspices of the Canadian Patient Safety Institute

Acknowledgements

The authors thank Dr. Bryce Taylor of the University Health Network, Toronto and Paula Beard of the CPSI for their helpful comments about this article.

The authors also wish to acknowledge all the members of the In-Country (Canada) Working Group for their thoughtful and extensive input and feedback into the Human Factors redesign portion of development of the Canadian version of the Surgical Safety Checklist.

Introduction

Human Factors is a specialty area that is commonly taught in industrial engineering and psychology departments and uses a body of knowledge about human characteristics and capabilities and limitations that are relevant to design.[1] The aim of Human Factors is to optimize the interactions among people, machines, procedures, systems and environments.

The purpose of this paper is to describe how a number of guidelines from Human Factors (HF) were applied to a revision of the Surgical Safety Checklist developed by the World Health Organization (WHO).[2] This revision of the Surgical Safety Checklist was undertaken by the In-Country (Canada) Working Group, organized by the Canadian Patient Safety Institute (CPSI), to promote the ultimate goal of surgery, that is, enhanced patient well-being.

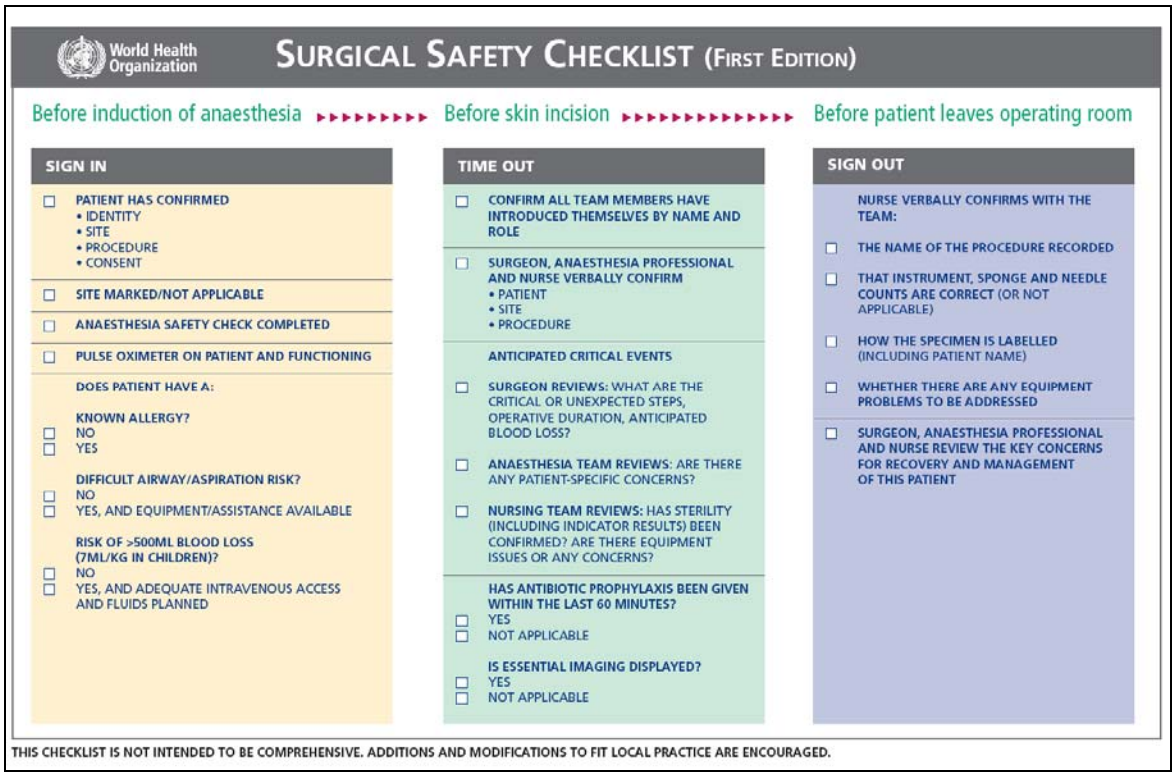
A Human Factors guideline is a summary of empirical knowledge that can be quickly applied to a design and various HF guidelines and principles were used to improve the legibility, organization and comprehension of information and critical procedures for a final Canadian version of the checklist.[*] The process of developing the final checklist is illustrated in the paper by changes to the design, based on application of the HF guidelines.

Background to the Surgical Safety Checklist

The Surgical Safety Checklist (SSC) is part of a program by the WHO called Safe Surgery Saves Lives, which is aimed at improving global health care in general, and increasing hand washing and reducing surgical complications in particular.[3] A number of recommended safe practices were identified by the WHO to reduce the frequency of surgical complications, many of which are avoidable.[2] Nineteen recommended practices were integrated into a general form, which is shown in Figure 1 below and appears on the WHO website.[4] The aim of checklist implementation was to change surgical systems and team behavior during three phases of any operation: before the induction of anesthesia, before incision and before leaving the OR. Eight hospitals in eight countries measured surgical complications before and after use of the SSC, which was modified to reflect variations in language and flow of care among the eight surgical sites. After implementation of the SSC, negative outcomes for inpatients showed significant decreases. These negative outcomes included surgical site infection, unplanned return to the OR, and death. On average, complications were decreased 36%, an actual decrease from 11% to 7% across the eight

[*] The authors note the distinction between a true checklist and the SSC, which represents a list of items to be checked. Interested readers are referred to Degani A & Wiener EL. (1990). *Human factors of flight-deck checklists: The normal checklist (Tech. Rep. 177549)*. Moffett Field, Ames Research Center, National Aeronautics and Space Administration (NASA). http://ntrs.nasa.gov/archive/nasa/casi.ntrs.nasa.gov/19910017830_1991017830.pdf

centres. There was also an actual 3% (significant) decrease in complications in the four so-called "higher income" centres, of which Toronto was a member.[3]



World Health Organization

SURGICAL SAFETY CHECKLIST (FIRST EDITION)

Before induction of anaesthesia ▸▸▸▸▸▸▸▸▸ Before skin incision ▸▸▸▸▸▸▸▸▸▸▸▸▸ Before patient leaves operating room

SIGN IN

- ☐ PATIENT HAS CONFIRMED
  - IDENTITY
  - SITE
  - PROCEDURE
  - CONSENT
- ☐ SITE MARKED/NOT APPLICABLE
- ☐ ANAESTHESIA SAFETY CHECK COMPLETED
- ☐ PULSE OXIMETER ON PATIENT AND FUNCTIONING
- DOES PATIENT HAVE A:
- KNOWN ALLERGY?
  - ☐ NO
  - ☐ YES
- DIFFICULT AIRWAY/ASPIRATION RISK?
  - ☐ NO
  - ☐ YES, AND EQUIPMENT/ASSISTANCE AVAILABLE
- RISK OF >500ML BLOOD LOSS (7ML/KG IN CHILDREN)?
  - ☐ NO
  - ☐ YES, AND ADEQUATE INTRAVENOUS ACCESS AND FLUIDS PLANNED

TIME OUT

- ☐ CONFIRM ALL TEAM MEMBERS HAVE INTRODUCED THEMSELVES BY NAME AND ROLE
- ☐ SURGEON, ANAESTHESIA PROFESSIONAL AND NURSE VERBALLY CONFIRM
  - PATIENT
  - SITE
  - PROCEDURE
- ANTICIPATED CRITICAL EVENTS
- ☐ SURGEON REVIEWS: WHAT ARE THE CRITICAL OR UNEXPECTED STEPS, OPERATIVE DURATION, ANTICIPATED BLOOD LOSS?
- ☐ ANAESTHESIA TEAM REVIEWS: ARE THERE ANY PATIENT-SPECIFIC CONCERNS?
- ☐ NURSING TEAM REVIEWS: HAS STERILITY (INCLUDING INDICATOR RESULTS) BEEN CONFIRMED? ARE THERE EQUIPMENT ISSUES OR ANY CONCERNS?
- HAS ANTIBIOTIC PROPHYLAXIS BEEN GIVEN WITHIN THE LAST 60 MINUTES?
  - ☐ YES
  - ☐ NOT APPLICABLE
- IS ESSENTIAL IMAGING DISPLAYED?
  - ☐ YES
  - ☐ NOT APPLICABLE

SIGN OUT

NURSE VERBALLY CONFIRMS WITH THE TEAM:

- ☐ THE NAME OF THE PROCEDURE RECORDED
- ☐ THAT INSTRUMENT, SPONGE AND NEEDLE COUNTS ARE CORRECT (OR NOT APPLICABLE)
- ☐ HOW THE SPECIMEN IS LABELLED (INCLUDING PATIENT NAME)
- ☐ WHETHER THERE ARE ANY EQUIPMENT PROBLEMS TO BE ADDRESSED
- ☐ SURGEON, ANAESTHESIA PROFESSIONAL AND NURSE REVIEW THE KEY CONCERNS FOR RECOVERY AND MANAGEMENT OF THIS PATIENT

THIS CHECKLIST IS NOT INTENDED TO BE COMPREHENSIVE. ADDITIONS AND MODIFICATIONS TO FIT LOCAL PRACTICE ARE ENCOURAGED.

Figure 1. The "Safer Surgery Checklist', developed by the World Health Organization (WHO, July, 2008)

Background to the Redesign of the Surgical Safety Checklist (SSC)

If the SSC is used in more hospitals and countries, then the potential to reduce surgical complications is expected to be amplified many fold. In Canada there are plans to extend application of the SSC, from the single Canadian hospital involved in the WHO study (the University Health Network at the University of Toronto). The version of the SSC that the UHN used during the study is shown in Figure 2. When Figures 1 and 2 are compared, a number of differences in the words and layout are apparent. However, as noted at the bottom of Figure 1, users of the original WHO SSC were encouraged to modify the form to fit local practice.

With this in mind, in an effort to promote use of the SSC in hospitals throughout Canada, the CPSI became involved in modifying the original (WHO) and UHN versions of the form, to develop a version that would be applicable to users in Canadian hospitals. A diverse group of

healthcare and Human Factors professionals, the In-Country (Canada) Working Group provided input into the modifications. Using the Checklist in Figure 2 as a point of departure, the goal of the Working Group was to improve the legibility, organization and comprehension of the SSC, and improve, where indicated, specific items in the Checklist that would reflect the needs of Canadian surgery.

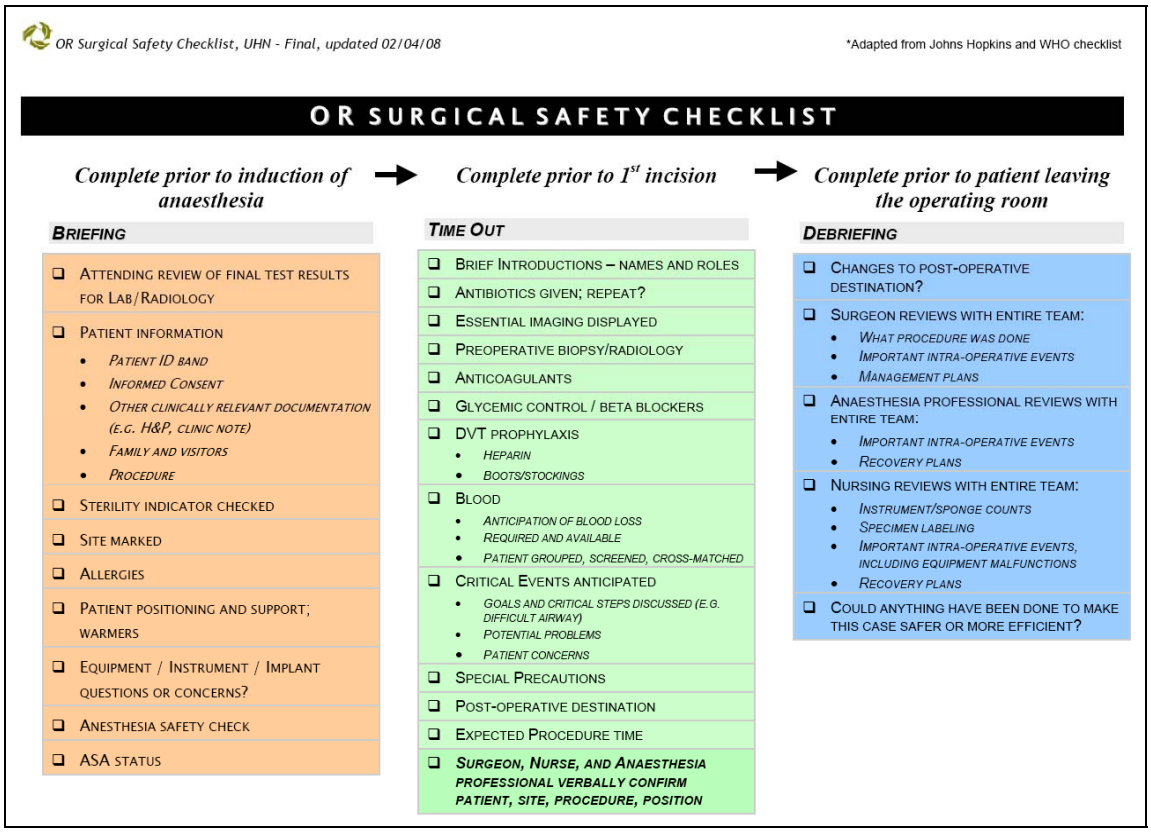


Figure 2. The OR Surgical Safety Checklist, University Health Network, University of Toronto (February, 2008)

Redesign of the Surgical Safety Checklist

Appearance, Legibility and Organization

As shown in Figure 2, the SSC fits onto a single page, which 'works' in healthcare. The form is horizontally oriented on the page – that is, it is in landscape format. However, the form is shaded, using three different colours, which then raise the question as to whether or not these colours are important or make reference to anything in particular. Colour needs to be used for a specific reason and this reason should be clearly obvious, e.g., 'red' generally connotes 'danger' or 'stop', while 'green' tends to be associated with safety or 'go'. Colours, however, may reduce readability

through a reduction in the contrast between writing and background.[5] For example, blue or orange may reduce contrast, while red/green combinations may prove difficult for those who have red-green colour deficiencies.

The font used in the original SSC form is of a non-serif type (e.g., Helvetica), which is appropriate for short lengths of text. The small details of serif fonts, such as Times New Roman, are more difficult to see in lower light levels and with a number of changes to lenses of the eyes. The use of all caps, however, means that readers are not able to perceive the 'shape' of the word, thus making reading more difficult and slowing the overall rate of reading.[5] While this may be occasionally useful, in this example, all caps are not the ideal choice. The use of bolded text may improve readability – depending on the font and the size, by increasing contrast with the background. Italics, in general, slow the rate of reading, although, again, this may occasionally be useful.

The layout of the text - such as the spaces between words and characters - can help enhance perception of words. More space or compression of words and letters tends to slow reading by affecting the number of words that are processed with each eye fixation, as the eyes move across a page.[5] Also important in a form's layout is the use of text, symbols and objects. These should be of optimal size, contrast and comprehensibility. And as with all other aspects, designers may have to anticipate, evaluate and make tradeoffs, which require understanding the context of where the text, symbol or object will be placed. It is not enough simply to make the form look 'good'.

Comprehension

Apart from appearance of the form, the use of specific content or language can improve or interfere with comprehension. First, any specific 'vocabulary' that is used should be common and understood by the greatest number of users to maximize all users' understanding.[5] For instance, the term, "Sign in" may not be understood by all. With respect to abbreviations, their use should be limited, with full words written out whenever possible. If space constraints require abbreviations, then a consistent rule for their use should be developed and consistently applied. The correct abbreviation should also be used. For example, 'cc' refers to solid objects while 'ml' refers to liquids. Should the content include items in a sequence, then the items should be ordered from first to last in sequence, which somewhat assists memory.

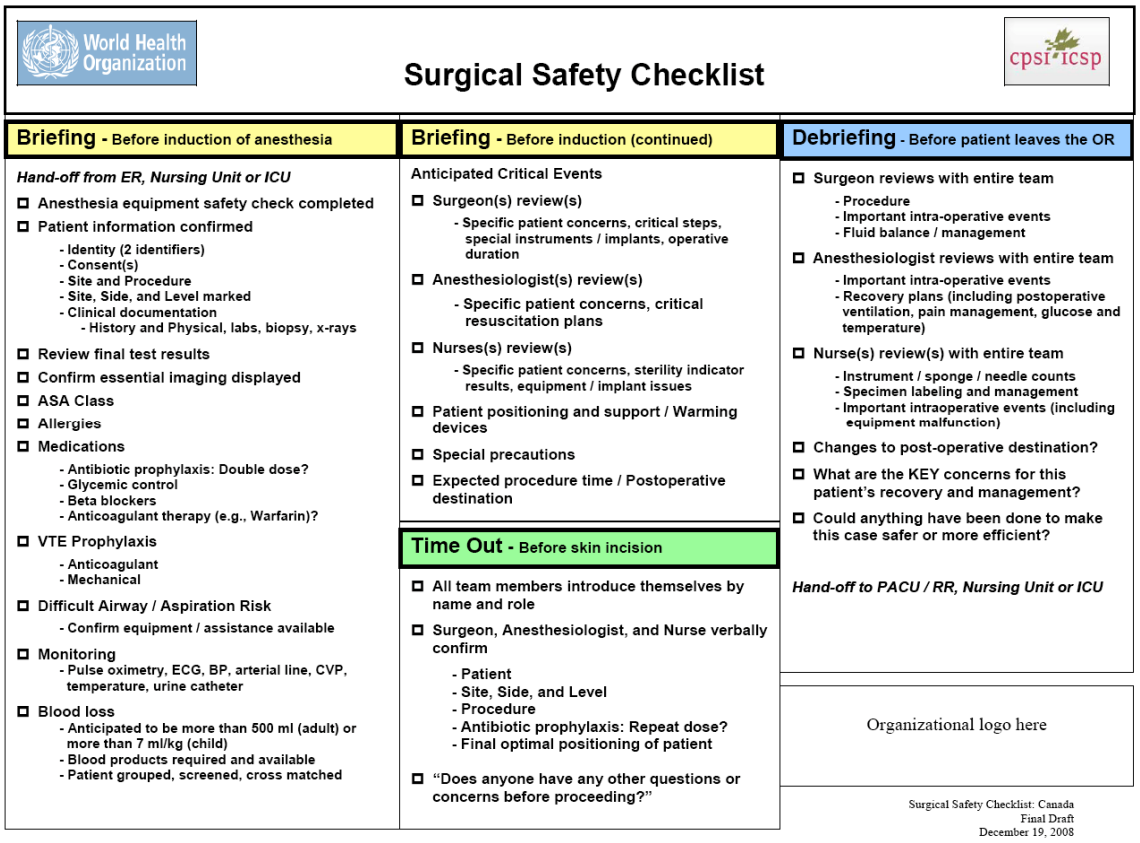


Figure 3. A draft version of the CPSI Surgical Safety Checklist (December, 2008)

Based on application of the guidelines described above, Figure 3 was developed. The Working Group also changed a number of content items to incorporate additional recommended practices in Canada, e.g., post-operative fluid balance / management, and inclusion of the 'Go / No go' question, "Does anyone have any other questions or concerns before proceeding?". This was thought to be an important addition for two reasons, the first of which is patient safety. The second reason is that requiring input to this question from all members of the team is consistent with use of the SSC as a vital team-building exercise.

The use of white space and bolded text is to facilitate reading by those users with 'older' eyes and those working under varying lighting conditions. The band of colour in the Heading was intended to provide consistency for those from the University Health Network (and others) who were familiar with yellow, green and blue indicating the three operative phases. The choice of italics for the hand-off to and from the OR was intended to generate a pause on the part of users, to think about the transition of the patient coming into and then leaving the OR Suite.

Boxes that appear before specific items or practices can be used to facilitate the checking of each Item, but also provide a visual indication of higher order items. Specific information is then grouped below these primary procedures, e.g., "Specific patient concerns" is below "Nurse reviews". Specific items are elaborated to improve comprehension, e.g., "equipment malfunction" for "important intraoperative events".

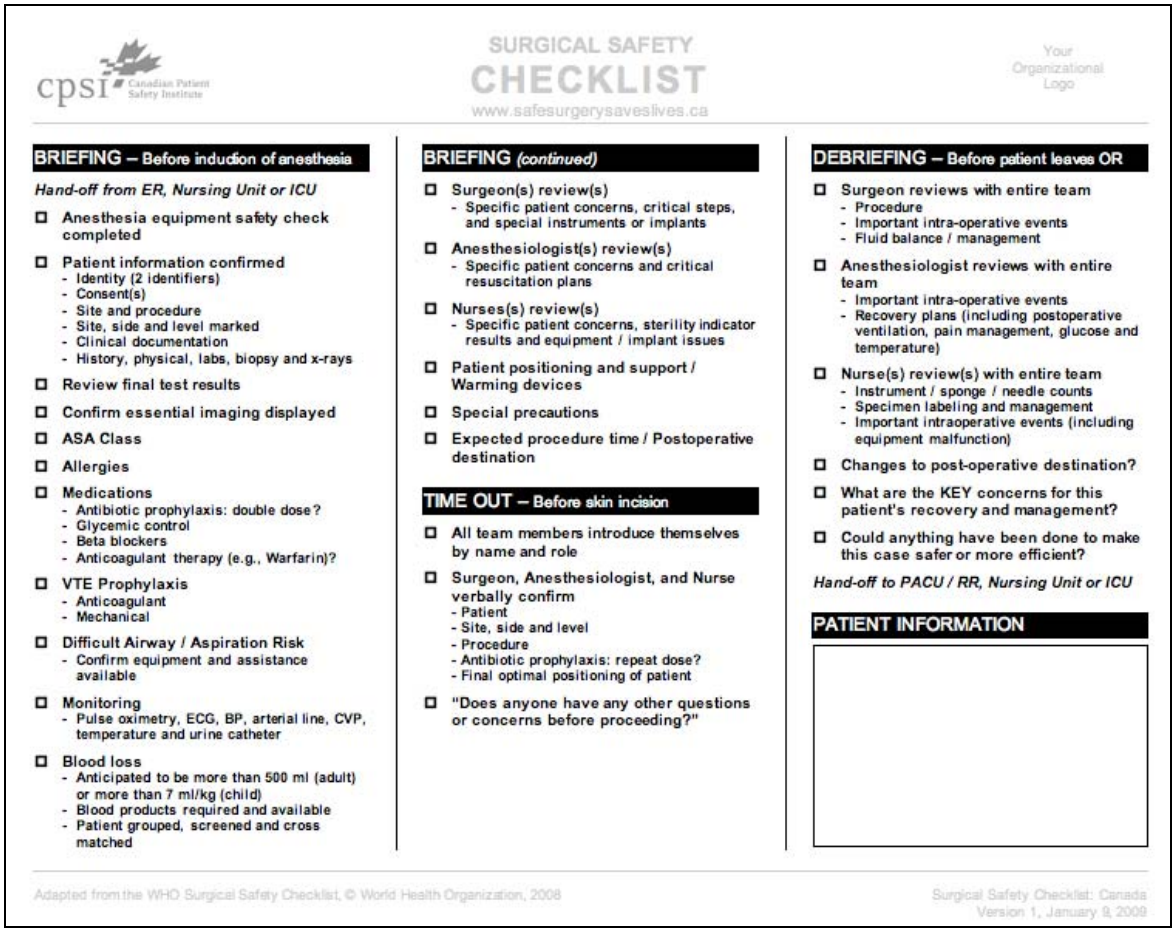


Figure 4. The final landscape checklist available from the Canadian Patient Safety Institute (CPSI, 2009)[6]

A last series of design decisions, which involved a graphic designer, resulted in the final version of the SSC,[6] which is available in horizontal (landscape) and vertical (portrait) versions from the CPSI website. The decision to make the checklist black and white, for ease of printing, resulted in the loss of colour. (Users who wish to re-colour the Headings could do so, but need to consider that the colour and shading chosen will have implications for the SSC's legibility and meaning.) As shown, the white lettering embedded in a black bar is not necessarily ideal for print and contrast reasons, but part of the compromise that occurs with every design.

Summary

Content input from the In-Country Working Group and application of Human Factors principles to a revision of the Surgical Safety Checklist (SSC) produced a form that is easier to read and understand. With the widespread deployment of the SSC by CPSI, these Human Factors improvements will aide in producing safer outcomes for patients undergoing surgery within the Canadian healthcare system. Those from other countries who are adapting the WHO checklist for their own use may find the redesign principles and final version beneficial and may wish to incorporate some of these Human Factors guidelines into their own forms. The authors hope that widespread use of the SSC will contribute to amplifying further reductions in surgical complications.

References

1. Chapanis A. *Human Factors in Systems Engineering*. Toronto: John Wiley, 1996.
2. World Health Organization (2008). *World Alliance for Patient Safety: WHO guidelines for safe surgery*. Geneva: WHO. http://www.who.int/patientsafety/safesurgery/knowledge_base/WHO_Guidelines_Safe_Surgery_finalJun08.pdf
3. Haynes AB, Weiser TG, Berry WR, et al. A surgical safety checklist to reduce morbidity and mortality in a global population. *New England Journal of Medicine* 2009; 350(5), 491–499.
4. Original WHO Checklist http://www.who.int/patientsafety/safesurgery/tools_resources/SSSL_Checklist_finalJun08.pdf
5. Wickens CD, Lee JD, Liu Y, Becker SG. *An Introduction to Human Factors Engineering (2nd Ed.)*. Upper Saddle River, NJ: Pearson, Prentice Hall, 2004.
6. Final CPSI checklists http://www.patientsafetyinstitute.ca/SSSL/checklists.html