# Improving Surgical Safety Checklist Completion Using A Distributed Responsibility Model Among Operating Room Team Members

Mehr Jain[1,3],
James D. O'Leary
MM, MD[2,3],
Unni Narayanan
MD[4,5],
James Robertson
MD[2,3],
Andrea Sepa[6],
Christopher
Calderone MD[5,7]

[1]University of Ottawa, Faculty of Medicine
[2]Department of Anesthesia, University of Toronto
[3]Department of Anesthesia and Pain Medicine, The Hospital for Sick Children
[4]Division of Orthopaedic Surgery, The Hospital for Sick Children
[5]Department of Surgery, University of Toronto
[6]Perioperative Services, The Hospital for Sick Children
[7]Division of Cardiovascular Surgery and Cardiology, Labatt Family Heart Centre, The Hospital for Sick Children

## ABSTRACT

**Background.** Surgical safety checklists are a standard of care for safe operating room practice, but their use has not been associated with reductions in adverse perioperative outcomes in some settings. Non-adherence and partial checklist completion may contribute to this lack of effect.

**Objective.** To examine whether a novel multifaceted surgical safety checklist approach, that utilizes distributed responsibility of checklist item completion (by allocation of questions and responses among operating room staff and a memory aid), increases surgical safety checklist compliance.

**Methods.** A multicomponent strategy consisting of a novel surgical safety checklist focused on distributed responsibility of checklist item completion was evaluated in orthopaedic operating rooms at The Hospital for Sick Children in Toronto from July to August 2016. The intervention consisted of a wall-mounted reusable checklist with questions and responses designated to specific operating room team members. Team training was provided beforehand, operating room team leaders were identified to promote the intervention, and revisions to the checklist content and process were implemented based on feedback on feasibility and clinical sensibility. Checklist compliance was assessed by checklist item completion using a before-and-after study design.

**Results.** We assessed 45 and 59 surgeries in pre-intervention and intervention groups, respectively. Overall, 87% (1,354/1,560) of checklist items were observed. Checklist item completion significantly increased in the post-intervention group (77% [615/802]) compared to the pre-intervention group (27% [150/522]) (P<0.001).

**Conclusions.** These findings suggest that a multicomponent strategy of designating responsibility for item completion and use of a memory aid among operating room team members can improve compliance with surgical safety checklist item completion.

## RÉSUMÉ

**Contexte.** Les listes de contrôle de sécurité chirurgicale sont norme de soins pour une pratique sûre au bloc opératoire mais leur utilisation n'a pas été associée à une réduction des résultats adverses péri-opératoires dans certains contextes. La non-adhérence et le remplissage partiel des listes de contrôle peuvent contribuer à cette absence d'effet.

**Objectif.** Examiner si une nouvelle approche multidimensionnelle de la liste de contrôle de sécurité chirurgicale utilisant la responsabilité répartie des tâches, par la répartition des questions et des réponses parmi le personnel du bloc opératoire et un aide-mémoire, augmente la conformité à la liste de contrôle de sécurité chirurgicale.

**Méthodes.** Une stratégie à plusieurs volets consistant en une nouvelle liste de contrôle de sécurité chirurgicale axée sur la responsabilité répartie de l'exécution des tâches a été évaluée dans les blocs opératoires orthopédiques de l'hôpital des enfants de Toronto (Hospital for Sick Children) de juillet à août 2016. L'intervention consistait en une liste de contrôle murale réutilisable avec des questions et réponses destinées à des membres spécifiques de l'équipe du bloc opératoire. Une formation préalable a été offerte à l'équipe, des chefs d'équipe du bloc opératoire ont été désignés pour promouvoir l'intervention, et des révisions du contenu et du processus de la liste de contrôle ont été mises en œuvre basés sur les commentaires en rapport avec la faisabilité et la sensibilité clinique. La conformité à la liste de contrôle a été évaluée en complétant les éléments de la liste de contrôle à l'aide d'un plan d'étude avant-après.

**Résultats.** Nous avons évalué 45 et 59 interventions chirurgicales dans les groupes de pré-intervention et d'intervention respectivement. Dans l'ensemble, 87 % (1354/1560) des éléments de la liste de contrôle ont été observés. Le taux d'achèvement des points de la liste de contrôle a augmenté de manière significative dans le groupe post-intervention (77 % [615/802]) par rapport au groupe pré-intervention (27 % [150/522]) (P<0,001).

**Conclusion.** Ces résultats suggèrent qu'une stratégie multidimensionnelle consistant à désigner la responsabilité de la réalisation des tâches et l'utilisation d'un aide-mémoire parmi les membres de l'équipe du bloc opératoire peut améliorer l'adhérence à l'exécution des éléments de la liste de contrôle de sécurité chirurgicale.

**Keywords:** Surgery, Safety, Checklist, Surgeon, Intervention

# RESEARCH

## INTRODUCTION

Preventable adverse events in surgical healthcare are common, but are amenable to reduction using patient safety initiatives and systematic improvements in clinical care.[1,2] Surgical safety checklists have been shown to improve perioperative safety and reduce preventable adverse events in many healthcare scenarios, such as in the case of delays to antibiotic administration or scheduling delays; however, their effectiveness is not consistent and can be influenced by contextual factors.[3-8] Such situational factors are known to influence the success or failure of checklists in practice. Particularly, relevant factors include the existing professional cultures and infrastructure for patient safety initiatives, and the quality of communication and collaboration in the operating room (OR).[9,10] Methods used for implementation and educational strategies on the use of surgical checklists to promote use among healthcare professionals also influences their effectiveness.[11] Examples of successful strategies used to increase effectiveness of checklist implementation include demonstration of the checklist process to team members, incorporation of the checklist process into the existing OR routine, and an emphasis of the applicability of checklist items to all team members.[12-14]

The use of surgical safety checklists in Ontario has been mandated by the local government for all surgeries since September 2009.[15] The suggested surgical safety checklist for use in Ontario was adapted by the Canadian Patient Safety Institute from the World Health Organization template, but is subject to modification by individual hospitals to account for differences in patient populations and local practices.[16,17] For example, pediatric surgical healthcare differs from adult care in terms of perioperative risk, procedure complexity, and patient involvement in decision making.[18-20] Furthermore, the successful use of surgical safety checklists in pediatrics requires that differences between children, in terms of preoperative anxiety, the capability to provide assent or consent, and the provision of family-centered care be recognized when undertaking the checklist.

Despite this widespread introduction of surgical safety checklists in Ontario and acknowledgment of its benefits by users, there has been no largescale reductions in perioperative adverse outcomes observed for either adult or pediatric populations.[15,21,22] Partial and non-compliance are significant factors associated with marked reductions in the magnitude of the effectiveness of the checklist in Ontario.[6] A previous observational study at the Hospital for Sick Children in Toronto (SickKids) indicated that completion of checklist items was poor. The aim of this project was to improve surgical safety checklist compliance through the evaluation of item completion using a novel, multicomponent checklist focused on distributed responsibility among OR staff.[23]

## METHODS

According to the policy activities that constitute research at SickKids Ontario, this work met the criteria for operational improvement activities exempt from ethics review. We obtained approval for this QI project from the local Quality and Risk Management Department. A waiver of written informed consent was also granted to observe OR staff completing surgical safety checklists during the project.

### Setting and population

Orthopaedic ORs were chosen for the setting of the intervention because a previous project at SickKids indicated that specialty specific checklists may increase compliance.[23] Moreover, orthopaedic procedures require most of the items on the surgical safety checklist to be considered, such as the side of surgical site, the display of essential imaging, and the availability of surgery-specific equipment and implants. All orthopaedic procedures undertaken in these ORs were eligible for inclusion. Non-orthopaedic and out-of-hours (6pm to 8am) procedures were excluded.

### Intervention design

Using a before-and-after study design, we prospectively evaluated the effect of a multicomponent QI intervention aimed at improving completion of surgical safety checklist items among team members in a convenience sample of children who underwent orthopaedic surgery at SickKids from June to August 2016. The novel surgical safety checklist process and content was developed by the hospital's Perioperative Service Surgical Safety Checklist committee consisting of anesthesiologists and nurses. This new surgical safety checklist used during the project consisted of 15 questions with 21 items that required responses, and the content of the checklist was adapted from the Canadian Patient Safety Institute Canadian surgical safety checklist to meet local OR systems and practices.

**Figure 1. Surgical safety checklist wall-mounted reusable memory aid used in the operating room during the study intervention.**

A prior QI project at the hospital indicated poor division of responsibility of various aspects of the checklist, and at this time a memory aid to assist checklist completion was not routinely used.[23] The current intervention included a reusable wall-mounted checklist in each OR to guide surgical safety checklist completion. This was intended to aid item recall as a memory aid, engage team members through team training, and provide a framework for checklist questions and responses designated to specific OR team members. Each section of the 3-part surgical safety checklist (briefing, timeout and debriefing) was led by a designated team member. During checklist completion, there was verbal confirmation of each checklist question and response by the responsible team members, a written confirmation by checkmark on the wall-mounted checklist to confirm the response, and initials of the designated respondents were included beside each item on the wall-mounted checklist **(Figure 1)**. The wall mounted checklist also served as a constant visible memory aid. Team training was provided beforehand on the use of the wall mounted checklist, OR team leaders were identified to promote the intervention, and revisions to the checklist content and process were implemented in small Plan, Do, Study, Act (PDSA) cycles based on feedback on feasibility and clinical sensibility.

### Data collection
Prior to the intervention, surgical safety checklist completion was assessed for one month in June 2016. The intervention was introduced in July 2016 and observed from July to August 2016. In the period immediately preceding or during the study, there were no other changes in clinical practices, education, or safety initiatives in the operating room directly related to surgical safety checklists. The same observer assessed checklist completion in the pre and post intervention group.

Procedure details and demographic data on patients undergoing surgery were collected, including age, American Society of Anesthesiologists' (ASA) physical status classification, scheduling of surgery (elective or urgent) and procedure type.[24] To assess the impact of the intervention, checklist item completion and time to complete checklist were recorded. All observations and data collection before and after the intervention were completed by the same investigator (MJ). Survey and observational data from the operating room were recorded using Research Electronic Data Capture (REDCap) hosted by SickKids, Toronto.[25]

### Statistical Analysis
Descriptive statistics were reported as appropriate for the

data distribution. Differences in the proportions of item completion between groups were tested using Fisher's Exact Test as the sample size was small. 95% confidence intervals (CI) were calculated where appropriate. Statistical significance was defined as two-tailed p<0.05. Multiple comparisons were not adjusted for, as the intended use of the data was for QI and analyses were considered to be exploratory. All statistical analyses were performed with Microsoft Excel and STATA 15 (STATACorp LP, College Station, TX)

## RESULTS

We identified 45 and 59 orthopaedic surgeries for before and after project intervention, respectively. Demographic characteristics of children in the cohort are summarized in **Table 1**. The majority of procedures were elective, and most children were either ASA physical classification status 1 or 2.

| Characteristic | Pre-intervention N = 45 | Post-intervention N = 59 |
|---|---|---|
| **Age in years, *median (IQR)*** | 8 (5 - 13) | 11 (8 - 14) |
| **Scheduling of surgery, *n (%)*** | | |
| Elective | 35 (79) | 54 (92) |
| Emergent | 10 (22) | 5 (8) |
| **ASA Physical Status Classification, *n (%)*** | | |
| 1 | 26 (58) | 23 (39) |
| 2 | 10 (22) | 21 (36) |
| 3 | 8 (18) | 13 (22) |
| 4 | 1 (2) | 2 (3) |
| 5 | 0 (0) | 0 (0) |

ASA, American Society of Anesthesiologists; IQR, interquartile range

*Table 1.* **Characteristics of children undergoing orthopaedic surgery before and after the project intervention.**

In total, 86.8% (1,354/1,560) of all checklist items were assessed for the surgeries included in the cohort. Mean (standard deviation) time to complete all sections of the intervention-guided checklist was 188 (53) seconds. Checklist item completion significantly increased 29% (150/522) after implementation in comparison to 77% (615/802) before implementation (p<0.001).

For each of the sections (briefing, time-out, and debriefing) of the checklist, item completion significantly increased after the intervention. Briefing item completion increased from 21% (70/340) to 81% (410/504) (p<0.001), time-out item completion increased from 47% (73/156) to 75% (172/228) (p<0.001) and debriefing item completion increased from 13% (7/56) to 47.1% (33/70) (p<0.001).

Percentage responses to individual checklist questions are summarized in **Table 2**. Ten of the 15 questions showed higher item completion in the post-intervention group. Checklist items that did not differ between groups were identification of patient allergies (79% vs. 88%, p=0.4), patient weight confirmation (66% vs. 73%, p=0.5),

| Item | Pre-intervention N = 45 | Post-intervention N = 59 | P |
|---|---|---|---|
| *Briefing* | | | |
| Patient has confirmed identity, site, procedure, consent | 3 | 68 | <0.001* |
| Is the site marked | 26 | 86 | <0.001* |
| Is essential imaging displayed | 8 | 86 | <0.001* |
| Is there a risk of blood loss >7 mL/Kg | 0 | 80 | <0.001* |
| Is essential equipment and/or implants available | 26 | 79 | <0.001* |
| Anesthesia checks completed | 0 | 88 | <0.001* |
| Does patient have a known allergy | 79 | 88 | 0.4 |
| Have essential laboratory investigations been checked | 0 | 86 | <0.001* |
| Patient weight confirmed | 66 | 73 | 0.5 |
| *Time Out* | | | |
| Confirm that all team members have introduced themselves by name and role | 0 | 56 | <0.001* |
| Surgeon verbally confirms with anesthetist and nurse: patient, site and procedure | 90 | 84 | 0.6 |
| Anticipated critical events | 0 | 79 | <0.001* |
| Antibiotic prophylaxis within 60 minutes | 97 | 83 | 0.03 |
| *Debriefing* | | | |
| Nurse verbally confirms with the team the name of the procedure recorded, that instrument, sponge and needle counts are correct, and whether there are any equipment problems that need to be addressed. | 7 | 57 | <0.001* |
| Surgeon, anesthetist, and nurse review important intra-operative events and key concerns | 18 | 37 | 0.2 |

* Statistical significance was defined as two-tailed P < 0.05.

*Table 2.* **Completion percentage of surgical safety checklist item completion before and after the multicomponent study intervention.**

confirmation of patient, site, and procedure during the time-out (90% vs. 84%, P=0.6), and review of intra-operative events and key concerns during the debriefing (18% vs. 37%, p=0.2) as shown in **Table 2**.

## DISCUSSION

In a paediatric specialist hospital setting, the proposed multicomponent strategy of conducting the surgical safety checklist, through distributed responsibility and use of a memory aid, was found to significantly increase surgical safety checklist completion. Increases in surgical safety checklist completion were evident for all sections of the checklist (briefing, time-out, and debriefing), and most checklist questions were found to be better answered after the introduction of the project intervention.

The findings of this project suggest that this multicomponent strategy of distributed responsibility and using a memory aid can be an effective method to increase surgical safety checklist compliance in tertiary pediatric settings in Ontario. Adherence to surgical safety checklists was known to be already poor in this setting and there was only partial completion of the checklist for most procedures before the project intervention. Whether the magnitude of change observed here can be replicated in other settings with higher rates of checklist adherence and engagement is unknown. Nonetheless, our results are consistent with those of Vazquez-Gonzalez et al., who used a similar approach consisting of a reusable checklist board, team training, and role allocation, and found improved checklist completion and quality in two large university hospitals.[26] Similarly, Wolff et al. found that a system of checklists and reminders of best practice integrated into patient medical records improved hospital inpatient care for patients with stroke or acute myocardial infarction.[27]

Completion of surgical safety checklists can strengthen the perceived quality of teamwork and communication in the OR and reduce preventable errors due to failures in team interactions.[28] This may be a function of communication during checklists improving open dialogue among team members and promoting a culture of patient safety; however, when surgical safety checklists are used suboptimally there is a suggestion that they can have a negative effect on the function of the OR team by disrupting otherwise positive communication.[29] When adherence is low or when checklists are completed by team members as a "box ticking exercise", miscommunication, omission of critical information, and disruption of other safety checks can occur.

Adherence to surgical safety checklist completion is influenced by many factors, including approaches used for checklist implementation, team education and engagement, local leadership, integration into existing practices, and individual beliefs.[8,30-32] To be successful, safety initiatives targeting increased surgical safety checklist adherence need to first identify these local barriers to checklist implementation. It is arguable that a multicomponent or multifaceted strategy is required to successfully address the complex interaction of factors that can influence individual and team behaviors in the OR and to translate evidence into meaningful changes in practice.[33]

One of the key reasons for our decision to distribute responsibility among OR team members was to overcome individual reasons for poor communication and negative power relationships that can exist among healthcare providers with traditionally different hierarchical statuses.[10] While the checklist itself is a cognitive aid and serves to increase precision and focus under stressful conditions, the process of adding a physical wall-mounted checklist also served to add a memory aid for checklist content. Although checklists improve performance, errors and omission of critical steps can still occur.[34,35] Even with the introduction of the wall-mounted reusable checklist, a large proportion of items (23%) in this project were still not completed. This highlights the importance of other factors influencing compliance, and the need to educate healthcare providers and effectively promote safety initiatives.

In each of the three checklist sections, adherence was found to be increased overall after the intervention but there was no difference found for some individual checklist items. Most of the individual checklist items without significant improvement already had higher completion rates (all greater than 60%) before the study intervention, and although there was a trend for improvement for most of these, the convenience sample size used was sufficient to detect only large effect size differences.

Limitations of this project include a possible Hawthorne effect from the presence of an observer during surgical safety checklist completion.[36] Secondly, outcome assessor

and surgeries observed were not randomized; however, the same trained observer and setting was used for both pre- and post-intervention observations, mitigating differential effects between study groups. Healthcare initiatives with a focus on communication often cannot be implemented as single component interventions due to the complexity of human factors that influence outcomes. As a result, in this project we cannot comment on the effects of individual elements of the multicomponent strategy used in this study and other contributing factors that are required to implement changes in clinical practice, such as education and leadership. Finally, this QI project was primarily intended to improve local care and the findings may not be generalizable to other settings and populations. Adherence to the surgical safety checklist in this population was already low and the same magnitude of benefit may not be seen in settings with higher checklist completion rates. The current project demonstrated improvements in checklist compliance, but other aspects of success should be considered in future projects, including whether user satisfaction is perceived to be improved and if clinically important outcomes, such as rates of preventable adverse events, can be reduced by this type of intervention.

## CONCLUSIONS

A multicomponent strategy with distributed responsibility in surgical safety checklist completion (through allocation of questions and responses among team members and use of a memory aid) was associated with significant improvements in checklist item completion, both for individual checklist sections and the overall checklist. These findings suggest that this is a feasible approach for improving surgical safety checklist completion when compliance is low.

## REFERENCES

1. De Vries EN, Ramrattan MA, Smorenburg SM, Gouma DJ, Boermeester MA. The incidence and nature of in-hospital adverse events: a systematic review. Qual Saf Health Care 2008;17:216-23.
2. Baines R, Langelaan M, de Bruijne M, Spreeuwenberg P, Wagner C. How effective are patient safety initiatives? A retrospective patient record review study of changes to patient safety over time. BMJ Qual Saf 2015;24:561-71.
3. Haynes AB, Weiser TG, Berry WR, et al. A surgical safety checklist to reduce morbidity and mortality in a global population. N Engl J Med 2009;360:491-9.
4. Weiser TG, Haynes AB, Dziekan G, et al. Effect of a 19-item surgical safety checklist during urgent operations in a global patient population. Ann Surg 2010;251:976-80.
5. Bliss LA, Ross-Richardson CB, Sanzari LJ, et al. Thirty-day outcomes support implementation of a surgical safety checklist. J Am Coll Surg 2012;215:766-76.
6. van Klei WA, Hoff RG, van Aarnhem EE, et al. Effects of the introduction of the WHO "Surgical Safety Checklist" on in-hospital mortality: a cohort study. Ann Surg 2012;255:44-9.
7. Haugen AS, Softeland E, Almeland SK, et al. Effect of the World Health Organization checklist on patient outcomes: a stepped wedge cluster randomized controlled trial. Ann Surg 2015;261:821-8.
8. Gagliardi AR, Straus SE, Shojania KG, Urbach DR. Multiple interacting factors influence adherence, and outcomes associated with surgical safety checklists: a qualitative study. PLoS One 2014;9:e108585.
9. Helmreich RL. On error management: lessons from aviation. BMJ 2000;320:781-5.
10. Lingard L, Espin S, Whyte S, et al. Communication failures in the operating room: an observational classification of recurrent types and effects. Qual Saf Health Care 2004;13:330-4.
11. Tang R, Ranmuthugala G, Cunningham F. Surgical safety checklists: a review. ANZ J Surg 2014;84:148-54.
12. Conley DM, Singer SJ, Edmondson L, Berry WR, Gawande AA. Effective surgical safety checklist implementation. J Am Coll Surg 2011;212:873-9.
13. Fourcade A, Blache JL, Grenier C, Bourgain JL, Minvielle E. Barriers to staff adoption of a surgical safety checklist. BMJ Qual Saf 2012;21:191-7.
14. Rydenfalt C, Johansson G, Odenrick P, Akerman K, Larsson PA. Compliance with the WHO Surgical Safety Checklist: deviations and possible improvements. Int J Qual Health Care 2013;25:182-7.
15. Urbach DR, Govindarajan A, Saskin R, Wilton AS, Baxter NN. Introduction of surgical safety checklists in Ontario, Canada. N Engl J Med 2014;370:1029-38.
16. Surgical Safety Checklist [Internet]. CPSI. [cited 2018 Feb 18]. Available from: http://www.patientsafetyinstitute.ca/en/Topic/Pages/Surgical-Safety-Checklist.aspx.
17. World Alliance for Patient Safety. WHO surgical safety checklist and implementation manual. World Health Organization; 2008 [cited 2018 Feb 13]. Available from: http://www.who.int/patientsafety/safesurgery/ss_checklist/en/.
18. Habre W, Disma N, Virag K, et al. Incidence of severe critical events in paediatric anaesthesia (APRICOT): a prospective multicentre observational study in 261 hospitals in Europe. Lancet Respir Med 2017;5:412-25.
19. O'Leary JD, Dexter F, Faraoni D, Crawford MW. Incidence of non-physiologically complex surgical procedures performed in children: an Ontario population-based study of health administrative data. Can J Anaesth 2018;65:23-33.
20. Fiks AG, Jimenez ME. The promise of shared decision-making in paediatrics. Acta Paediatr 2010;99:1464-6.
21. O'Leary JD, Wijeysundera DN, Crawford MW. Effect of surgical safety checklists on pediatric surgical complications in Ontario. CMAJ 2016;188:E191-8.
22. Sewell M, Adebibe M, Jayakumar P, et al. Use of the WHO Surgical Safety Checklist in trauma and orthopaedic patients. Int Orthop 2011;20:818-22.
23. Mahmood T, Haji F, Damignani R, et al. Compliance does not mean quality: an in-depth analysis of the safe surgery checklist at a tertiary care health facility. Am J Med Qual 2015;30:191.
24. Saklad M. Grading of paitents for surgical procedures. Anesthesiology 1941;2:281-4.
25. Harris PA, Taylor R, Thielke R, Payne J, Gonzalez N, Conde JG. Research electronic data capture (REDCap)--a metadata-driven methodology and workflow process for providing translational research informatics support. J Biomed Inform 2009;42:377-81.
26. Vazquez-Gonzalez A, Luque-Ramirez JM, Del Nozal-Nalda M, Barroso-Gutierrez C, Roman-Fuentes M, Vilaplana-Garcia A. [Effectiveness of an intervention to improve the implementation of a surgical safety check-list in a tertiary hospital]. Rev Calid Asist 2016;31 Suppl 1:24-8.
27. Wolff AM, Taylor SA, McCabe JF. Using checklists and reminders in clinical pathways to improve hospital inpatient care. Med J Aust 2004;181:428-31.

28. Russ S, Rout S, Sevdalis N, Moorthy K, Darzi A, Vincent C. Do safety checklists improve teamwork and communication in the operating room? A systematic review. Ann Surg 2013;258:856-71.

29. Whyte S, lingard L, Epsin S, et al. Paradoxical effects of interprofessional briefings on OR team performance. Cogn Technol Work 2008;10:287-94.

30. Hannam JA, Glass L, Kwon J, et al. A prospective, observational study of the effects of implementation strategy on compliance with a surgical safety checklist. BMJ Qual Saf 2013;22:940-7.

31. Borchard A, Schwappach DL, Barbir A, Bezzola P. A systematic review of the effectiveness, compliance, and critical factors for implementation of safety checklists in surgery. Ann Surg 2012;256:925-33.

32. Treadwell JR, Lucas S, Tsou AY. Surgical checklists: a systematic review of impacts and implementation. BMJ Qual Saf 2014;23:299-318.

33. Harvey G, Kitson A. Translating evidence into healthcare policy and practice: Single versus multi-faceted implementation strategies - is there a simple answer to a complex question? Int J Health Policy Manag 2015;4:123-6.

34. Hales BM, Pronovost PJ. The checklist--a tool for error management and performance improvement. J Crit Care 2006;21:231-5.

35. Arriaga AF, Bader AM, Wong JM, et al. Simulation-based trial of surgical-crisis checklists. N Engl J Med 2013;368:246-53.

36. McCambridge J, Witton J, Elbourne DR. Systematic review of the Hawthorne effect: new concepts are needed to study research participation effects. J Clin Epidemiol 2014;67:267-77.