Article

Does clinical supervision of health professionals improve patient safety? A systematic review and meta-analysis

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Abstract

Purpose: To determine whether clinical supervision (CS) of health professionals improves patient safety.

Data sources: Databases MEDLINE, PsychINFO, CINAHL, EMBASE and AMED were searched from earliest date available. Additional studies were identified by searching of reference lists and citation tracking.

Study selection: Two reviewers independently applied inclusion and exclusion criteria. Thirty-two studies across three health professions [medicine (n = 29), nursing (n = 2) and paramedicine (n = 1)] were selected.

Data extraction: The quality of each study was rated using the Medical Education Research Study Quality Instrument. Risk ratios (RR) were calculated for patient safety outcomes of mortality, complications, adverse events, reoperation following initial surgery, conversion to more invasive surgery and readmission to hospital.

Results of data synthesis: Results of meta-analyses provided low-quality evidence that supervision of medical professionals reduced the risk of mortality (RR 0.76, 95% CI 0.60–0.95, I² = 76%) and supervision of medical professionals and paramedics reduced the risk of complications (RR 0.69, 95% CI 0.53–0.89, I² = 76%). Due to a high level of statistical heterogeneity, sub-group analyses were performed. Sub-group analyses provided moderate-quality evidence that direct supervision of surgery significantly reduced the risk of mortality (RR 0.68, 95% CI 0.50–0.93, I² = 33%) and direct supervision of medical professionals conducting non-surgical invasive procedures significantly reduced the risk of complications (RR 0.33, 95% CI 0.24–0.46, I² = 0%).

Conclusions: CS was associated with safer surgery and other invasive procedures for medical practitioners. There was a lack of evidence about the relationship between CS and safer patient care for non-medical health professionals.

Key words: clinical supervision, patient safety, complications, adverse events

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Introduction

Patient safety is a priority for healthcare systems as the incidence and cost of adverse events is high [1–4]. To achieve safe patient care, emphasis is placed on ensuring a ‘culture of safety’ that involves establishing a supportive environment where health professionals can identify errors or near misses and analyse why and how these may have occurred [5–7]. Within this environment, patient safety practices, such as clinical supervision (CS), can be implemented to address the problems identified and reduce the likelihood of injuries [8–11].

Currently, there is no common definition of CS and many studies that investigate its effects do not provide a definition [12]. For the purpose of this review, CS refers to the provision of guidance of clinical practice for qualified health professionals or health professional trainees who have completed their undergraduate or entry-level studies, by a more experienced health professional [13–15]. Similarly, there is no common agreement in the perceived role of CS. CS may be utilized to (i) facilitate professional, personal or educational development, (ii) provide emotional support or (iii) clarify the organizational requirements for the supervisee [13–16]. However, there does appear to be some consensus that one of the primary roles of CS in the healthcare setting is to maintain a high standard of patient care and ensure patient safety [13–16].

Patient safety has been investigated using both patient outcomes and measures of process [17]. Patient outcomes include measures of adverse events, complications, morbidity and mortality. These are the outcomes that healthcare systems aim to prevent through the implementation of patient safety practices. In comparison, measures of process allow for the identification of system and human errors, and near misses, which enable organizations to implement strategies on the assumption that improving these processes will lead to improvement of patient safety [17, 18]. Since error in process does not always lead to patient harm, near misses are important measures of process. Conversely, not all adverse events are caused by error and as such, it is vital that patient outcomes are emphasized in any evaluation of patient safety [19, 20].

One systematic review investigated the effects of health professional CS on patient-related outcomes [21]. The authors of the review concluded that CS may be beneficial at improving patient outcomes. However, the results cannot be generalized to patient safety, as improved patient outcomes are not necessarily indicative of safer patient care. Therefore, the aim of the current systematic review was to investigate whether CS of health professionals, including allied health, nursing and medical professions, improves patient safety.

Methods

Protocol and registration

This systematic review was conducted and reported with reference to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines for high-quality reporting of systematic reviews and meta-analyses [22] and has been registered in the PROSPERO database (registration number: CRD42015019901).

Eligibility criteria

To be eligible, studies had to meet the following criteria: (i) investigated CS of qualified, registered or postgraduate trainee health professionals; (ii) measured patient safety utilizing objective patient outcomes; (iii) investigated a model of CS where the supervisor had more experience/expertize than the supervisee and involved supervision of clinical practice; (iv) included a control group or historical comparison of health professionals who did not receive supervision or received less supervision; (v) were written in English.

Studies were ineligible if they met any of the following criteria: (i) investigated the effects of undergraduate student CS; (ii) investigated the effect of CS on the performance of the clinical supervisor; (iii) measured patient safety utilizing health professional/patient perception of patient outcomes or health professional compliance with risk prevention processes (e.g. compliance with completion of a patient falls-risk assessment tool); (iv) investigated supervision of simulated patient care scenarios; (v) investigated the effects of CS of non-healthcare professionals; (vi) investigated a peer-supervision model.

Studies that investigated supervision of undergraduate students, non-health professionals or utilized a peer-supervision model were excluded because they did not investigate a model of supervision consistent with our definition of guidance of clinical practice of qualified health professionals by a more experienced health professional [13–15]. Studies that investigated the effects of supervision on simulated patient care measured patient safety utilizing professional/patient perception or measured patient safety utilizing measures of compliance were excluded because they did not provide an objective measurement of patient safety outcomes. Studies investigating the effect of supervision on the performance of the supervisor were excluded because the aim of these studies is to investigate whether the addition of supervision responsibilities negatively impacts the performance of experienced health professionals/supervisors.

Information sources

From the earliest available date until 27 May 2015, the electronic databases MEDLINE, PsychINFO, CINAHL, EMBASE and AMED were searched. Citation tracking on Google Scholar and manual searching of the reference lists of included articles and previously published reviews was also conducted to ensure that all relevant studies were located.

Search

The concepts of intervention and outcome were combined with the ‘AND’ operator. Intervention was searched using the following key words: supervis*, seniority, mentor*, debrief*, reflective practice or oversight. Outcomes were searched using the following key words: patient outcomes, clinical outcomes, clinical risk, patient risk, patient safety, patient harm, morbidity, mortality, complication or adverse event. Synonyms were searched for each concept and combined with the ‘OR’ operator. An example search strategy is provided in Online Appendix 1.

Study selection

Two reviewers independently screened the articles by title and abstract utilizing the pre-determined eligibility criteria. Full text copies of articles that were not definitely excluded on title and abstract were retrieved for detailed examination. The two reviewers then reapplied the eligibility criteria with discussion to reach a consensus. Where consensus could not be met, a third reviewer was consulted. Agreement between the reviewers was reported with the kappa statistic (κ).
Data collection process
Pre-designed spreadsheets were used to extract data on participants, interventions, outcome measures and results. The primary outcome measures were objective patient outcomes indicative of patient safety: mortality, adverse events/complications, surgical complications, reoperation following initial surgery, including conversion to more invasive surgery, failure to cure and readmission to hospital/ward.

Supervision interventions were classified into three categories: direct supervision of clinical practice, debriefing/reflective practice and a combination of both direct supervision and debriefing/reflective practice. Direct supervision refers to supervision of clinical practice where the supervisor is personally present, either face-to-face or using a communication device, during the occasion of service and has the potential to immediately influence patient care [23]. Debriefing/reflective practice refers to supervision of clinical practice that occurs after patient contact and requires the supervisee to critically reflect on their clinical performance prior to any alteration in patient care [24].

Risk of bias in individual studies
Studies were critically appraised for risk of bias by two reviewers independently using the Medical Education Research Study Quality Instrument (MERSQI) [25]. The MERSQI consists of 10 items that reflect 6 domains of study quality: study design, sampling, type of data (subjective or objective), validity, data analysis and outcomes [25]. The maximum score for each domain is 3 with a total score range of 5–18 [25]. The MERSQI has been shown to have excellent inter-rater, intra-rater and internal consistency reliability; and evidence of criterion validity [25, 26]. A score of 11 or higher was interpreted as a study of higher quality [26]. All trials were assessed independently by two reviewers. Inter-rater agreement was expressed with $\kappa$. Any disagreements between reviewers were resolved through discussion. If consensus could not be reached, a third reviewer was consulted.

Synthesis of results
Risk ratios (RR) of events were calculated from objective patient outcome data. Meta-analyses of dichotomous outcomes were conducted utilizing the inverse variance method and random-effects model. All meta-analyses were conducted using Review Manager software [27]. In the case of high levels of statistical heterogeneity ($I^2 \geq 50\%$), heterogeneity was investigated using sub-group analysis. If combining data were not appropriate, the reporting of results was provided in a table with a descriptive synthesis.

Risk of bias across studies
The Grades of Recommendation, Assessment, Development and Evaluation (GRADE) approach [28] was applied to each meta-analysis to determine the quality of evidence. This approach entailed downgrading the evidence from high to moderate to low quality based on criteria. Downgrading the evidence one place (e.g. high to moderate quality) would occur if: (i) a randomized controlled trial design was not utilized by the majority of studies in the meta-analysis, (ii) the MERSQI score was $< 11$ for the majority of studies in the meta-analysis, (iii) there was substantial heterogeneity between the trials ($I^2 \geq 50\%$) [29] and (iv) there was a large confidence interval ($> 0.5$).

Results
Study selection
The database search yielded 6144 records. Sixty-six articles were retrieved for full text review following application of the eligibility criteria to title and abstract. Twenty-nine studies fulfilled the inclusion criteria when applied to full texts. Twenty records were identified for full text review from reference lists of included articles and citation tracking. Three of these articles fulfilled inclusion criteria, hence the final yield was 32 studies (Fig. 1). Agreement between reviewers was very good ($\kappa = 0.924$).

Study characteristics and risk of bias within studies
The 32 studies represented the following specialties: nursing [30, 31], paramedicine [32] and medicine [33–61]. The 29 medical studies investigated supervision of the following interventions: surgical procedures [33, 35, 36, 39, 40, 42–45, 47, 48, 50, 52–54, 56–61], central venous catheter insertion [49, 51], emergency intubation [55], clinical management of patients with a traumatic injury [38, 46], clinical management of children suffering a code event [37], clinical management of children admitted to the emergency department [34] and resuscitation of patients suffering a cardiac arrest [41]. Studies investigating supervision of surgery investigated the following surgical specialties/procedures: thyroid [33], colorectal [35, 45, 52, 56], cardiac [36, 50], lower limb amputation [39], orthopaedic [40, 47], trauma [42], appendectomy [43, 57], gastrointestinal [44, 59], vascular [53], inguinal hernia repair [54], hypospadias repair [58], cholecystectomy [61] or a variety of specialties/surgical procedures [48, 60]. The majority of surgical studies investigated the effects of supervision of trainees [33, 35, 36, 39, 42–45, 47, 48, 50, 53, 54, 56–58, 60], with three studies investigating supervision of qualified surgeons [40, 52, 61] and one study investigating supervision of a combination of trainees and qualified surgeons [39]. Of the included studies, 28 investigated the effects of direct supervision of clinical practice [30, 33–40, 42, 43, 45–61], three investigated the effects of reflection or debriefing of clinical practice [32, 41, 44] and one investigated the effects of a combination of direct supervision of clinical practice and reflection/debriefing of clinical practice [31]. The mean MERSQI score was 15.4, with individual study scores ranging from 11.3 to 16.9 (inter-rater agreement $\kappa = 0.928$), indicating that all studies included in this review were of higher quality. No study utilized a randomized controlled trial design, with included studies utilizing retrospective cohort [35, 36, 38, 40, 42, 43, 45, 47, 48, 50, 52–54, 58, 60], prospective cohort [39, 44, 49, 55–57, 59, 61] and pre-post designs [30–34, 37, 41, 46, 51]. Refer to Online Appendix 2 for a summary of the key characteristics and results of each study reviewed, and to Online Appendix 3 for a detailed description of the supervision intervention investigated by each study.

Synthesis of results
Effect of supervision of health professionals on patient mortality
All studies investigated supervision of medical professionals. Meta-analysis of 14 trials with 20 474 participants provided low-quality evidence that supervision of medical professionals significantly reduced the risk of patient mortality when compared to medical professionals who received less or no supervision (RR 0.76, 95% CI 0.60–0.95, $I^2 = 76\%$) (Fig. 2). One trial included in the meta-analysis investigated the effect of reflective supervision and found no significant reduction in patient mortality [41].
Because of high levels of heterogeneity ($I^2 = 76\%$), a sub-group analysis was performed to investigate the effect of supervision of surgeons on mortality. Sub-group analysis of nine trials with 6484 participants provided moderate quality evidence that direct supervision of surgery significantly reduced the risk of patient mortality when compared to unsupervised surgeries ($RR = 0.68$, $95\% CI 0.50–0.93$, $I^2 = 33\%$) (Fig. 3). Of the 4266 patients who underwent supervised surgery, 240 died (5.6\%), compared to 177 of 2218 (8.0\%) patients who underwent unsupervised surgery.

Effect of supervision of health professionals on patient complications
Meta-analysis of 23 trials with 104 625 participants provided low-quality evidence that supervision of health professionals significantly reduced the risk of patient complications when compared to health professionals who received less or no supervision ($RR = 0.69$, $95\% CI 0.53–0.89$, $I^2 = 76\%$) (Fig. 4). One trial included in the meta-analysis investigated the effect of reflective supervision and found that supervision was associated with a higher risk of complications in patients requiring intubation [32]. One trial investigated the effect of supervision of paramedics [32] and the remaining trials investigated supervision of medical professionals.

Because of high levels of heterogeneity ($I^2 = 76\%$), a sub-group analysis was performed to investigate the effect of supervision of invasive clinical procedures and surgery on complications. Sub-group analysis of three trials with 23 609 participants provided moderate-quality evidence that direct supervision of medical professionals conducting invasive procedures, two trials investigating central venous catheter placement [49, 51] and one trial investigating emergency intubation [55], significantly reduced the risk of patient complications.
complications compared to unsupervised procedures (RR 0.33, 95% CI 0.24–0.46, I² = 0%) (Fig. 5).

Sub-group analysis of 16 trials with 66,447 participants provided low-quality evidence that direct supervision of surgery had no significant impact on risk of complications when compared to unsupervised surgeries (RR 0.85, 95% CI 0.67–1.07, I² = 61%) (Fig. 6).

The definitions and measures utilized by each study to quantify surgical complications are described in Online Appendix 4.

Two trials investigating the effect of supervision of nursing professionals on patient complications could not be included in the meta-analysis due to insufficient data. One trial [30] reported a 77% reduction in medication errors by directly supervised nursing staff. The second trial [31] investigated the effects of a combination of direct supervision and debriefing/reflective practice of clinical practice. This trial found that the introduction of a nurse mentor who directly supervised clinical practice and facilitated reflective practice, significantly reduced the risk of pressure ulcers and failure to rescue of patients in hospital.

Effect of supervision on the need for reoperation following initial surgery

Meta-analysis of nine trials with 10,699 participants found no difference in the rate of reoperation following initial surgery between directly supervised and unsupervised surgeries (RR 1.16, 95% CI 0.92–1.47, I² = 0%) (Fig. 7).

Meta-analysis of three trials with 241 participants provided moderate-quality evidence that direct supervision of surgery significantly reduced the risk of patients requiring conversion of their surgery (e.g., laparoscopic surgery converted to open surgery) when compared to unsupervised surgeries (RR 0.39, 95% CI 0.22–0.69, I² = 0%) (Fig. 8). Of the 126 patients who underwent supervised surgery, 15 required conversion of their surgery (11.9%), compared to 30 of 115 (26.1%) patients who underwent unsupervised surgery.

Discussion

Supervision of health professionals is associated with a reduced risk of patient mortality and complications. However, due to the high degree of heterogeneity, the quality of this evidence is low and may not be applicable across all health disciplines or areas of clinical practice. Sub-group analysis provided moderate-quality evidence, with acceptable levels of heterogeneity, indicating that (i) direct supervision of surgery is associated with a reduced risk of conversion of surgery and patient mortality and (ii) direct supervision of
non-surgical invasive clinical procedures is associated with a reduced risk of complications. These analyses provide evidence that supervision improves patient safety when provided to medical professionals performing surgical or invasive procedures.

The results of this review indicate that the relative risk of patient mortality is reduced by approximately one-third when inexperienced surgeons are supervised in the operating theatre. The average total operative training time for trainee surgeons is 3963 hours over a 5-year period \[62\]. Additionally, participation of surgical trainees in common surgical procedures has been shown to increase the total operative time \[63\]. Therefore, ensuring that a qualified surgeon is present in the operating room for every hour of training may be practically difficult and would be a significant expense for health services. When direct supervision of inexperienced surgeons in the operating room is not possible, alternative measures should be taken to ensure the inexperienced surgeon can operate independently without compromising the safety of patients undergoing surgery.

Prior to allowing the trainee surgeon to operate independently, patient, trainee and surgery factors need to be considered and the responsibility ultimately lies with the trainee’s supervisor. The supervisor must consider (i) the level of skill the trainee possesses in the particular surgical technique, (ii) the complexity of the patient’s condition and surgical technique, (iii) the level of insight that the trainee has into their own ability and (iv) the trainee’s belief in their own ability and their comfort with performing the surgery independently \[64\]. Establishing a judgement on these factors is not a simple task \[65\]. However, even when the trainee is competent, comfortable and aware of their ability to perform the surgery independently, the results of this review suggest that it would be preferable that some form of supervision (e.g. supervisor on-call in the hospital) is employed to ensure patient safety.

Direct supervision of non-surgical invasive clinical procedures also appears to be associated with a reduced risk of patient harm. Complications that result from invasive procedures, such as infection secondary to central venous catheter insertion, transfusion, infusion, injection or vaccination, are in the top 10 medical errors with the largest annual cost to health services \[66\]. Given the significant cost of patient harm secondary to medical errors that occur...
during invasive procedures, supervision may be a cost effective strategy to decrease the risk of harm to patients undergoing invasive procedures.

While there was low-quality evidence to suggest that supervision of health professional practice reduces complications, our sub-group analysis provided moderate-quality evidence that supervision is most effective at reducing the risk of complications when it is provided to professionals performing invasive procedures. It is likely that direct CS of invasive procedures, where there is a higher risk to patient safety, is more critical than direct supervision of non-invasive or less invasive procedures. However, it is possible that CS of less invasive procedures could have benefits apart from patient safety, such as improved patient functional outcomes.

One limitation of this review is the absence of studies that investigate CS of allied health professionals and its effect on patient safety outcomes. Allied health professions generally perform less invasive interventions when compared to medical and nursing professionals, and this may be why there are few published studies exploring the

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**Figure 6** The effect of direct supervision of surgery versus no direct supervision on surgical complications. Quality of evidence (GRADE): low. Reason for downgrade: Trials not randomized controlled trials, I² ≥ 80%.

**Figure 7** The effect of direct supervision of surgery versus no direct supervision on the rate of reoperation following initial surgery. Quality of evidence (GRADE): low. Reason for downgrade: Trials not randomized controlled trials, large confidence interval.

**Figure 8** The effect of direct supervision of surgery versus no direct supervision on the rate of conversion of surgery. Quality of evidence (GRADE): moderate. Reason for downgrade: Trials not randomized controlled trials.
effect of allied health CS on safer patient care. However, CS of allied health professionals has been identified in government policies as a critical component of clinical governance [67]. Therefore, it is important to confirm that patient safety risk associated with allied health interventions can be reduced through effective CS [67].

Another limitation of this review is the absence of studies that utilized a randomized controlled trial design. Studies in medical and surgical education do not commonly utilize a randomized controlled trial design [68–70]. Without adequate randomization of participants, there is less surety that the differences observed between groups are attributable to the intervention and not any other factor. Therefore, it is more difficult to attribute the improvement in patient safety to the supervision intervention and this is reflected in the downgrade in quality of evidence using the GRADE approach.

Lastly, performing meta-analyses of trials that included variable models of supervision, patient diagnoses and clinical interventions may affect the validity of our results secondary to a high level of heterogeneity. However, we have provided a measure of heterogeneity (I²) to ensure transparency and have performed sub-group analyses of categorized variables to reduce heterogeneity.

Conclusions
Although CS was associated with safer surgery and other invasive procedures for medical practitioners, there was relatively little evidence about the relationship between CS and safer patient care for non-medical health professionals. Further research is required to establish the effect of CS of the non-medical health professions on patient safety outcomes.

Supplementary material
Supplementary material is available at INTQHC online.

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