An evaluation of three methods of in-hospital cardiac arrest educational debriefing: the cardiopulmonary resuscitation debriefing study

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Conflicts of interest

The authors have no conflicts of interest to declare.

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Abstract

Background: The use of cardiac arrest educational debriefing has been associated with improvements in cardiopulmonary resuscitation (CPR) quality and patient outcome. The practical challenges associated with delivering some debriefing approaches may not be generalisable to the UK health setting. The aim of this study was to evaluate the deliverability and effectiveness of three cardiac arrest debriefing approaches that were tailored to UK working practice.

Methods: We undertook a before/ after study at three hospital sites. During the post-intervention period of the study, three cardiac arrest educational debriefing models were implemented at study hospitals (one model per hospital). To evaluate the effectiveness of the interventions, CPR quality and patient outcome data were collected from consecutive adult cardiac arrest events attended by the hospital cardiac arrest team. The primary outcome was chest compression depth.

Results: Between November 2011 and July 2014, 1198 cardiac arrest events were eligible for study inclusion (782 pre-intervention; 416 post-intervention). The quality of CPR was high at baseline. During the post-intervention period, cardiac arrest debriefing interventions were delivered to 191 clinicians on 344 occasions. Debriefing interventions were deliverable in practice, but were not associated with a clinically important improvement in CPR quality. The interventions had no effect on patient outcome.

Conclusion: The delivery of these cardiac arrest educational debriefing strategies was feasible, but did not have a large effect on CPR quality. This may be attributable to the high-quality of CPR being delivered in study hospitals at baseline.

Trial registration: ISRCTN39758339

Introduction

In-hospital cardiac arrest is a major health problem, which carries a significant mortality burden. Data from the UK National Cardiac Arrest Audit reports an incidence of 1.6 events per 1000 hospital admissions, of which 18.4% patients survive to leave hospital.[1]

Cardiac arrest educational debriefing is a technique where clinicians review cardiac arrest performance using data collected during the cardiac arrest with a view to improving subsequent practice.[2] Its use is recommended in international resuscitation guidelines.[3, 4] A variety of debriefing approaches are described in the literature, but the most effective approach remains unclear.[2-4] A common approach is weekly group educational meetings at which clinical staff review recent cardiac arrest events.[5-7] In an American hospital, the implementation of this educational debriefing approach was associated with a significant improvement in cardiopulmonary resuscitation (CPR) quality and return of spontaneous circulation (ROSC).[5] In a study covering 131 US hospitals, the presence of at least monthly debriefings was independently associated with improved survival to discharge.[8]

The CPR Quality Improvement Initiative was a three-centre cohort study that examined the effect of realtime audio-visual feedback and weekly group educational debriefing on CPR quality and patient outcome in a UK hospital trust.[9] In the CPR Quality Improvement Initiative study, we identified challenges in delivering weekly group educational debriefing that might preclude its widespread adoption. In particular, delivery was resource-intensive and it was often challenging to release clinical staff to attend meetings. This highlighted the need to develop debriefing approaches better tailored to UK working practices. We developed three such debriefing approaches, using the process described by Medical Research Council framework for the development and evaluation of complex interventions.[10] The aim of this follow-on study was to test the feasibility of delivering these approaches and to assess their effect on CPR quality and patient outcomes.

Methods

Study design and setting

The Cardiopulmonary Resuscitation Debriefing (CODE) study was a before/ after study, conducted at three hospitals. The three study hospitals comprise Heart of England NHS Foundation Trust, a large NHS Trust with over 1400 beds. The hospitals are geographically distinct, although there is rotation of clinical staff between sites.

Table one summarises the hospital characteristics and their approaches to CPR quality feedback and educational debriefing during the pre-intervention and post-intervention study periods. Some of the patient and process outcome variables for the pre-intervention period have been previously reported.[9]

Cardiac arrests at study hospitals are attended by a multidisciplinary emergency team, which is activated through a bleeper system. The team leader is an Advanced Life Support provider, whilst other clinical team members are either Advanced Life Support or Immediate Life Support providers. Treatment is delivered in accordance with current Resuscitation Council (UK) guidelines.[11]

Approvals

The study was approved by the Oxford C Research Ethics Committee who authorised a waiver of initial consent in accordance with the Mental Capacity Act. Consent to continue was obtained from surviving patients or their representative if they lacked capacity.

Study participants

The study recruited both patient and staff participants. Patient participants were consecutive adult patients (aged ≥ 18 years) who had a cardiac arrest at the study hospitals that was

attended by the hospital emergency team. This included patients that had an out-of-hospital cardiac arrest and who were admitted to the hospital with CPR ongoing. Patients that had a valid do not attempt cardiopulmonary resuscitation (DNACPR) order at the time of the cardiac arrest were excluded.

Staff at hospital one were eligible to attend cardiac arrest debriefing meetings if they were involved, or potentially involved, in the care of cardiac arrest patients. Staff at hospitals two and three were eligible to receive cardiac arrest debriefing if they attended a cardiac arrest where accelerometer data were collected and where the CPR had lasted at least five minutes. At hospitals one and two, staff provided consent to study participation at the time of receiving the intervention. Staff at hospital three were sent feedback, but were only recorded as having received it if they replied to the email to confirm that they had reviewed the feedback and consented to study participation.

Interventions

Educational debriefing interventions were developed through synthesis of systematic review, process and qualitative data that were collected during the pre-intervention period.[12, 13] This process utilised the theoretical domains framework and prioritised the development of interventions that would be deliverable in the UK setting.[14] Interventions were allocated by hospital, based on the character of the hospital and where it was thought they would work most effectively. The focus of each intervention was improvement in CPR delivery.

Hospital one: staff received monthly group debriefing, enabling the measurement of the effect of reducing the frequency (weekly to monthly) of the group debriefing intervention that hospital one staff received during the pre-intervention period of the study. Hospital two: staff received an individual verbal debrief, that lasted approximately five minutes and was intended to be delivered within four days of the cardiac arrest. Hospital three: written feedback sheets were emailed to cardiac arrest attendees following the cardiac arrest event.

All interventions were delivered by the first author (KC). Full details of each intervention are included in the electronic supplement.

Study data collection

Cardiac arrest events were identified through review of the emergency call log maintained by the hospital switchboard. For each eligible cardiac arrest, a core data set was collected, which comprised patient demographic, cardiac arrest, CPR quality and patient outcome data. Data items were based on standardised definitions.[15, 16]

Demographic data and cardiac arrest characteristics were contemporaneously collected and recorded on a local database by a member of the cardiac arrest team. Patient outcome data were collected from clinical records and discharge summaries.

During the study period, most hospital cardiac arrest trolleys were equipped with a Phillips MRX QCPR defibrillator (Philips Healthcare, Andover, Massachusetts). These defibrillators incorporate a puck attachment. When placed on a patient's chest during cardiac arrest, the accelerometer collects CPR quality metric data (compression depth, compression rate, flow-fraction, compression incomplete release, and peri-shock pause). Data are automatically extracted (Phillips Heartstart Event Review Pro 4.2 software, Phillips Healthcare, Andover, Massachusetts, USA). Full details of the device are described elsewhere.[17, 18] Where the puck device is not used, transthoracic impedance data (chest compression rate, flow-fraction, peri-shock pause) may be extracted manually from the defibrillator record using manufacturer software (QCPR Review V2.1 software, Laerdal Medical, Stavanger, Norway).

Cardiac arrest events were included in the analysis of CPR quality outcomes only if the record contained at least five one-minute data periods. For eligible cases, the first five one-minute periods of available data for each CPR quality metric were extracted. This approach

has been used in previous studies, and provides a consistent measure of the emergency team's best CPR performance.[5, 9, 18]

Outcome measures

The primary study outcome was chest compression depth, which is associated with defibrillation success in in-hospital cardiac arrest and survival in out-of-hospital cardiac arrest.[19-22] Initial audit data showed a chest compression depth standard deviation of 13.67, such that a sample size of 40 patient participants per hospital site in each study period was required to detect a clinically important 10mm improvement in chest compression depth at 90% power and significance level of 0.05.[23]

Secondary outcomes included other CPR quality metrics and patient outcomes. CPR quality metrics included chest compression rate, flow-fraction, pre-shock pause, post-shock pause, and incidence of incomplete release. Patient outcomes included ROSC, hospital survival and neurological outcome at hospital discharge. ROSC was defined as a spontaneous circulation that persisted for at least twenty minutes. Neurological outcome was measured using the cerebral performance category (CPC), and was analysed dichotomously as good (CPC 1/2) or poor (CPC 3/4/5) neurological outcome.

Process evaluation

To assess feasibility of intervention delivery within the NHS, process data were collected during the intervention period. These data included the number and clinical grade of clinicians that were offered and who received debriefing, including reasons for non-delivery. We also estimated the time required to deliver each intervention.

Data analysis

Data were analysed using SPSS statistical software (SPSS Version 22.0, IBM, Chicago, Illinois, USA). Categorical demographic data are summarised using raw frequencies and

percentages, and compared using the χ^2 or fisher-exact test. Continuous variables were assessed for normality. Normally distributed data are reported as mean and standard deviation (SD) and compared using a t-test. Non-normally distributed data are reported as median and interquartile range (IQR) and compared using the Mann Whitney U test. In addition, the mean and standard deviation are reported for these data to facilitate comparison with other studies.

Outcome analyses for CPR quality and patient outcome data compare the pre-intervention and post-intervention periods, both within each hospital and across all three hospitals. For normally distributed continuous outcomes, differences are reported as mean difference and 95% confidence interval (CI). Differences for dichotomous outcomes, such as delivery of guideline-adherent care and patient outcomes, are presented as odds ratio and 95% CI and obtained by fitting logistic regression models. Patient outcome analyses are adjusted for baseline patient characteristics and exclude out-of-hospital cardiac arrests and events where the patient had previously participated in the study. CPR quality analyses are not adjusted for baseline patient characteristics. For all analyses, a p-value ≤ 0.05 is considered statistically significant.

Results

1222 events were screened for eligibility, of which 1198 (782 pre-intervention; 416 post-intervention) cardiac arrest events were eligible for study inclusion (figure one). CPR quality data were available for 602 episodes (367 pre-intervention; 235 post-intervention), of which 508 episodes (302 pre-intervention; 206 post-intervention) included accelerometer data. Eligible events included 154 (113 pre-intervention; 41 post-intervention) out-of-hospital cardiac arrests, and 58 events (36 pre-intervention; 22 post-intervention) where the patient had previously participated in the study. The required sample size was achieved at all hospital sites in both study periods.

Process evaluation data demonstrated that interventions were deliverable (table two). During the post-intervention period, 191 unique clinicians received debriefing interventions on a total of 344 occasions. At hospital one, eleven meetings were held which were attended by 85 clinicians. Individual debriefing at hospital two was offered on 211 occasions, and delivered 94 times. At hospital three, feedback sheets were sent 252 times. There was evidence of direct contamination between sites; ten clinicians received interventions at more than one hospital site.

Patient demographic data were broadly similar within hospital sites, although small statistically significant differences were noted in relation to patient category and whether the cardiac arrest event was witnessed (table three). Across all hospitals, there was an increase in the incidence of witnessed cardiac arrests, a decrease in the incidence of out-of-hospital cardiac arrest and differences in patient type between study periods.

In relation to the primary outcome, interventions were not associated with a change in chest compression depth at hospitals two and three (table four). There was a small statistically significant increase in chest compression depth between the pre-intervention and post-intervention periods across all hospitals (51.4 ± 10.4 v 54.3 ± 12.0, p=0.004), which was seemingly primarily driven by an improvement at hospital one (53.2 ± 10.4 v 57.2 ± 12.4, p=0.005). As a result, the likelihood of patients receiving a chest compression depth greater than 50mm increased at hospital one and across all hospitals in the post-intervention period (electronic supplement).

In relation to other CPR quality metrics, the intervention at hospital three was associated with a reduction in chest compression rate (117.4 ± 12.1 v 113.7 ± 9.8, p=0.04), such that a greater proportion of patents received a chest compression rate of 100-120 compressions per minute during the post-intervention period (odds ratio 2.01, 95% CI 1.00-4.07, p=0.05) (table four/ electronic supplement). Across all hospitals, there was a reduction in median pre-

shock pause duration (4.2 seconds (IQR 2.3-11.0) v 3.0 (IQR 2.0-5.9), p=0.05). There were no other observed statistically significant changes in CPR quality between study periods.

There was no difference between study periods in relation to any patient outcome, either within any hospital or across all hospitals (table five).

Our experience of delivering interventions enabled us to estimate that researcher time to deliver written feedback was ten hours per month, whilst monthly group debriefing and individual oral debriefing took 15.5 and 16.5 hours per month respectively (electronic supplement).

Discussion

This three-centre before/after study assessed the deliverability of three cardiac arrest educational debriefing strategies and assessed the effect of these interventions on CPR quality and patient outcomes. The study demonstrated that intervention delivery was feasible in the UK setting, with interventions being delivered on a total of 343 occasions over the 11-month study period. The time required to deliver interventions ranged from 10 to 16.5 hours per month, and so is considered feasible to deliver within a healthcare organisation.

The study also examined the effect of interventions on CPR quality. There was a general improvement in CPR quality by cardiac arrest teams across all hospital sites. Some statistically significant improvements were observed, but the effect size of these improvements were small and their influence on clinical outcomes uncertain..[21, 24, 25] The study found no evidence that interventions were associated with an effect on patient outcome, but the study was not powered to detect such differences.

The finding that interventions were deliverable is unsurprising, as a key consideration in developing the interventions was that they were deliverable in practice. The lack of effect observed on CPR quality outcomes is surprising, given that previous studies have generally shown cardiac arrest educational debriefing to be associated with a positive effect on CPR quality.[12] There are three possible explanations for this negative result: the interventions are ineffective in all circumstances; the interventions were implemented poorly; or that the interventions were ineffective in this particular context.

The suggestion that the interventions are ineffective in all circumstances is unconvincing given that similar interventions have been associated with improvements in CPR quality in previous studies.[26-28] It is curious that an improvement in chest compression depth was observed at hospital one, where the frequency of the debriefing intervention was reduced. This suggests the presence of face-to-face debriefing *per se* may be more important than the dose given. This would be consistent with the recent US evaluation of hospital characteristics and outcome which found that monthly and quarterly debriefings were independently associated with improved survival to discharge (adjusted odds ratio 8.55 (95% CI 1.79 to40.00) for monthly and 6.85 (95% CI 1.49 to31.30) for quarterly).[8]

It is also unlikely that interventions were ineffective due to poor implementation. Over the study period, 191 unique clinicians received a debriefing intervention, Hospital three staff were only recorded as having received an intervention if they replied by email to confirm they had reviewed the feedback, such that this figure likely underestimates the true number of staff that actually received a debriefing intervention. Some practical challenges were experienced in delivering interventions. The short duration or absence of data following many arrests meant they were unsuitable to be debriefed. Furthermore, all study interventions were delivered by a single researcher and hospital geographical spread meant each hospital was usually visited only two or three times per week. As key process data are infrequently reported in previous debriefing studies, it is not possible to make direct

comparison with debriefing studies where the intervention has been shown to be associated with improvements in CPR quality.[5, 7, 26, 27] Importantly, if interventions were implemented as part of standard practice, they would likely be delivered by resuscitation officers based predominantly at one hospital which would make delivery more straightforward.[29]

The most likely explanation for study findings is that interventions were ineffective in the context in which they were implemented. This study was carried out in an NHS Trust, which had hosted the CPR Quality Improvement Initiative study over the preceding four years.[9] It is noteworthy that baseline CPR quality and patient outcome data in this study compare favourably with that described by Edelson et al and the National Cardiac Arrest Audit (electronic supplement).[1, 5] These comparisons highlight the relatively high quality of care being delivered both at baseline and throughout this study.

Findings in this study contrast with previous studies, which have typically reported a clinically and statistically significant improvements associated with the use of cardiac arrest educational debriefing.[5, 7, 26, 28, 30] A meta-analysis of cardiac arrest debriefing reported that the intervention was associated with an improvement in flow-fraction (mean difference 6.80, 95% CI 4.19 to 9.40, $p<0.001$) and return of spontaneous circulation (odds ratio 1.46, 95% CI 1.01-2.13, $p=0.05$).[12] However, baseline CPR quality in index studies was typically poor. The Cochrane systematic review on healthcare audit and feedback found that feedback interventions are more likely to be effective if the quality of baseline care delivery is poor.[31] The corollary to this is, as observed in this study, that interventions are less likely to be effective if the quality of baseline care delivery is high.

As such, cardiac arrest educational debriefing may provide little additional benefit in high-performing organisations. If implemented, organisations should closely monitor the effectiveness of any debriefing intervention. There is a need for study reports of cardiac

arrest debriefing interventions to provide a full report of the intervention and to describe the context in which it was delivered.

This study's main limitation stems from its methodology. As a before/ after study undertaken in a single NHS trust, the design was prone to a number of biases. The chosen methodology was selected primarily on practical grounds and was considered reasonable given the primary study aim was to assess the feasibility of intervention delivery, rather than to be a definitive effectiveness trial. Key biases stemmed from the before/ after design, such that it was not possible to control for underlying secular trends, and the use of a single NHS Trust as the study setting, which increased the risk of intervention contamination between study sites.[32-34] We also observed a number of differences in baseline patient demographics between the two study periods, which may have influenced study findings. A further limitation is that we were unable to accurately record individual clinician exposure to cardiac arrest following receipt of the debriefing intervention and it is unclear whether there was any difference in staff characteristics between debriefing recipients and non-recipients. Finally, integration of the study with the CPR Quality Improvement Initiative study created imbalances between baseline interventions at hospital sites, such that it was not possible to directly compare interventions.

Conclusion

The delivery of each of these three cardiac arrest educational debriefing interventions was feasible in the UK setting. Interventions were not, however, associated with large improvements in CPR quality or patient outcomes. This finding may be attributed to high-quality CPR delivery at baseline, such that clinically important improvements in CPR quality were difficult to achieve.

[1] Nolan JP, Soar J, Smith GB, et al. Incidence and outcome of in-hospital cardiac arrest in the United Kingdom National Cardiac Arrest Audit. Resuscitation. 2014;85:987-92.
[2] Couper K, Perkins GD. Debriefing after resuscitation. Curr Opin Crit Care. 2013;19:188-94.
[3] Morrison LJ, Neumar RW, Zimmerman JL, et al. Strategies for Improving Survival After In-Hospital Cardiac Arrest in the United States: 2013 Consensus Recommendations: A Consensus Statement From the American Heart Association. Circulation. 2013;127:1538-63.
[4] Greif R, Lockey AS, Conaghan P, et al. European Resuscitation Council Guidelines for Resuscitation 2015: Section 10. Education and implementation of resuscitation. Resuscitation. 2015;95:288-301.
[5] Edelson DP, Litzinger B, Arora V, et al. Improving in-hospital cardiac arrest process and outcomes with performance debriefing. Archives of internal medicine. 2008;168:1063-9.
[6] Nadler I, Sanderson PM, Van Dyken CR, Davis PG, Liley HG. Presenting video recordings of newborn resuscitations in debriefings for teamwork training. BMJ quality & safety. 2011;20:163-9.
[7] Jiang C, Zhao Y, Chen Z, Chen S, Yang X. Improving cardiopulmonary resuscitation in the emergency department by real-time video recording and regular feedback learning. Resuscitation. 2010;81:1664-9.
[8] Chan PS, Krein SL, Tang F, et al. Resuscitation practices associated with survival after in-hospital cardiac arrest: A nationwide survey. JAMA Cardiology. 2016. Epub ahead of print 6 April 2016. DOI:10.1001/jamacardio.2016.0073
[9] Couper K, Kimani PK, Abella BS, et al. The System-Wide Effect of Real-Time Audiovisual Feedback and Postevent Debriefing for In-Hospital Cardiac Arrest: The Cardiopulmonary Resuscitation Quality Improvement Initiative. Crit Care Med. 2015;43:2321-31.
[10] Craig P, Dieppe P, Macintyre S, Michie S, Nazareth I, Petticrew M. Developing and evaluating complex interventions: new guidance. London, Medical Research Council, 2008. (Accessed 17 March 2012 at

http://www.mrc.ac.uk/consumption/idcplg?IdcService=GET_FILE&dID=15585&dDocName=MRC004871&allowInterrupt=1).

[11] Resuscitation Council (UK). 2010 Resuscitation Guidelines. London, Resuscitation Council (UK), 2010. (Accessed 13 March 2010 at http://www.resus.org.uk/pages/GL2010.pdf).

[12] Couper K, Salman B, Soar J, Finn J, Perkins GD. Debriefing to improve outcomes from critical illness: a systematic review and meta-analysis. Intensive Care Med. 2013;39:1513-23.

[13] Couper K, Griffiths F, Perkins GD. “Getting resus at the forefront”: A qualitative study of the mechanisms of cardiac arrest debriefing. Resuscitation. 2014;85, Supplement 1:S83-S4.

[14] Francis JJ, O'Connor D, Curran J. Theories of behaviour change synthesised into a set of theoretical groupings: introducing a thematic series on the theoretical domains framework. Implementation Science. 2012;7:35.

[15] Kramer-Johansen J, Edelson DP, Losert H, Kohler K, Abella BS. Uniform reporting of measured quality of cardiopulmonary resuscitation (CPR). Resuscitation. 2007;74:406-17.

[16] Jacobs I, Nadkarni V, Bahr J, et al. Cardiac arrest and cardiopulmonary resuscitation outcome reports: update and simplification of the Utstein templates for resuscitation registries. A statement for healthcare professionals from a task force of the international liaison committee on resuscitation. Resuscitation. 2004;63:233-49.

[17] Aase SO, Myklebust H. Compression depth estimation for CPR quality assessment using DSP on accelerometer signals. IEEE Transactions on Biomedical Engineering. 2002;49:263-8.

[18] Abella BS, Alvarado JP, Myklebust H, et al. Quality of cardiopulmonary resuscitation during in-hospital cardiac arrest. JAMA. 2005;293:305-10.

[19] Edelson DP, Abella BS, Kramer-Johansen J, et al. Effects of compression depth and pre-shock pauses predict defibrillation failure during cardiac arrest. Resuscitation. 2006;71:137-45.

[20] Stiell IG, Brown SP, Christenson J, et al. What is the role of chest compression depth during out-of-hospital cardiac arrest resuscitation? Crit Care Med. 2012;40:1192-8.
[21] Stiell IG, Brown SP, Nichol G, et al. What Is the Optimal Chest Compression Depth During Out-of-Hospital Cardiac Arrest Resuscitation of Adult Patients? Circulation. 2014;130:1962-70.
[22] Vadeboncoeur T, Stolz U, Panchal A, et al. Chest compression depth and survival in out-of-hospital cardiac arrest. Resuscitation. 2014;85:182-8.
[23] Machin D, Campbell MJ, Tan SB, Tan SH. Sample size tables for clinical studies. Chichester: Wiley-Blackwell; 2009.
[24] Idris AH, Guffey D, Pepe PE, et al. Chest Compression Rates and Survival Following Out-of-Hospital Cardiac Arrest. Critical Care Medicine. 2015;43:840-8.
[25] Cheskes S, Schmicker RH, Christenson J, et al. Perishock pause: an independent predictor of survival from out-of-hospital shockable cardiac arrest. Circulation. 2011;124:58-66.
[26] Wolfe H, Zebuhr C, Topjian AA, et al. Interdisciplinary ICU Cardiac Arrest Debriefing Improves Survival Outcomes. Crit Care Med. 2014;42:1688-95.
[27] Zebuhr C, Sutton RM, Morrison W, et al. Evaluation of quantitative debriefing after pediatric cardiac arrest. Resuscitation. 2012;83:1124-8.
[28] Lyon RM, Clarke S, Milligan D, Clegg GR. Resuscitation feedback and targeted education improves quality of pre-hospital resuscitation in Scotland. Resuscitation. 2012;83:70-5.
[29] Resuscitation Council (UK). Quality standards for cardiopulmonary resuscitation practice and training. London, Resuscitation Council (UK), 2013. (Accessed 8 March 2014 at http://www.resus.org.uk/pages/QSCPR_Acute.htm).
[30] Lukas R-P, Gräsner JT, Seewald S, et al. Chest compression quality management and return of spontaneous circulation: A matched-pair registry study. Resuscitation. 2012;83:1212-8.

[31] Ivers N, Jamtvedt G, Flottorp S, et al. Audit and feedback: effects on professional practice and healthcare outcomes. Cochrane Database of Systematic Reviews. 2012;Issue 6:CD000259.

[32] Eccles M, Grimshaw J, Campbell M, Ramsay C. Research designs for studies evaluating the effectiveness of change and improvement strategies. Quality & safety in health care. 2003;12:47-52.

[33] Shojania KG, Grimshaw JM. Evidence-Based Quality Improvement: The State Of The Science. Health Affairs. 2005;24:138-50.

[34] Keogh-Brown MR, Bachmann MO, Shepstone L, Hewitt C, Howe A, Ramsay CR, et al. Contamination in trials of educational interventions. Health Technol Assess. 2007;11:iii, ix-107.