Improving team information sharing with a structured call-out in anaesthetic emergencies: a randomized controlled trial

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Editor’s key points

- Effective response to a critical incident typically includes a call for help, rapid transfer of relevant information, and collaboration.
- The clinical value of structured procedures and algorithms is often questioned.
- This study found that the adoption of a structured call-out tool led to improved anaesthetist behaviours when responding to simulated critical incidents.
- Anaesthetists generally performed less well with inviting solutions from support staff.

Background. Sharing information with the team is critical in developing a shared mental model in an emergency, and fundamental to effective teamwork. We developed a structured call-out tool, encapsulated in the acronym ‘SNAPPI’: Stop; Notify; Assessment; Plan; Priorities; Invite ideas. We explored whether a video-based intervention could improve structured call-outs during simulated crises and if this would improve information sharing and medical management.

Methods. In a simulation-based randomized, blinded study, we evaluated the effect of the video-intervention teaching SNAPPI on scores for SNAPPI, information sharing, and medical management using baseline and follow-up crisis simulations. We assessed information sharing using a probe technique where nurses and technicians received unique, clinically relevant information probes before the simulation. Shared knowledge of probes was measured in a written, post-simulation test. We also scored sharing of diagnostic options with the team and medical management.

Results. Anaesthetists’ scores for SNAPPI were significantly improved, as was the number of diagnostic options they shared. We found a non-significant trend to improve information-probe sharing and medical management in the intervention group, and across all simulations, a significant correlation between SNAPPI and information-probe sharing. Of note, only 27% of the clinically relevant information about the patient provided to the nurse and technician in the pre-simulation information probes was subsequently learnt by the anaesthetist.

Conclusions. We developed a structured communication tool, SNAPPI, to improve information sharing between anaesthetists and their team, taught it using a video-based intervention, and provide initial evidence to support its value for improving communication in a crisis.

Keywords: communication; education, medical, continuing; leadership; patient safety

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Effective teamwork underpins the safe management of anaesthetic crises,¹–⁷ and shared mental models are a critical requirement for effective teamwork.⁵–⁷ Shared mental models lead to a common understanding of the situation, the plan for treatment, and the roles and tasks of the individuals in the team. This is often described as the team being ‘on the same page’.

A fundamental requirement in developing a shared mental model is sharing of information among team members, including relevant patient background, working diagnoses, and treatment plans. This allows team members to anticipate each other’s actions and needs; recognize changes in the clinical situation; and adjust strategies as needed. Without a shared mental model, the cognitive resources of the different members of the team cannot be fully utilized as they will lack the necessary information to contribute ideas.⁸ Establishing a shared mental model can be expedited if the team leader proactively shares information and invites input. When the leader verbalizes his or her own mental model of the situation, other team members may realize they have information the
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leader needs, or may have alternative suggestions and contributions, promoting collaborative decision-making. We refer to this verbal situation assessment as a call-out.

Our observations of anaesthesia teams in previous studies suggest that anaesthetists do not consistently perform a call-out in an emergency, and the team may be unclear about the clinical situation, the management goals, or the plan. We undertook a systematic review of the literature on call-out (also called recap or step-back), and found no studies evaluating interventions to improve call-out, or describing its clinical efficacy (see Appendix: search strategy).

While the literature on structured clinical handover is extensive, we found no formal structure for call-out communication to improve crisis management.

We developed a call-out tool based on a review of published literature and modelled on the SBAR (Situation, Background, Assessment, Response) handover tool, using a process of expert consensus among five specialist anaesthetists with expertise in teamwork and communication training. We identified six key components and encapsulated these in six steps in the acronym ‘SNAPPI’: Stop the team; Notify of the patient’s status; Assessment of the situation; Plan what to do; Priorities for actions; and Invite ideas. The six steps, and the literature supporting each step, are described in Table 1.

Our overall aim is to improve patient safety by improving communication in a crisis. In this study, we investigated if a video-based intervention modelling a structured call-out—the SNAPPI—would improve call-out in subsequent simulated cases, and if improved call-out affected information sharing and medical management during simulated crises.

Our primary hypothesis was that a video-based educational intervention modelling call-out would improve the score for call-out by anaesthetists in a post-anaesthesia care unit (PACU) simulated crisis, measured by SNAPPI score. Secondary hypotheses were that high SNAPPI score would be associated with: increased sharing of clinical information between team members, measured by the transfer of information probes between them in a simulation (where information probes are items of clinically relevant information given to participants pre-simulation and tested in a post-scenario questionnaire);

the number of diagnostic options the anaesthetist shared with the team; and with better medical management of a simulated crisis measured against a pre-defined checklist.

Methods

This study was approved by the Central Regional Ethics Committee (CEN/11/EXP/053). Participants provided written informed consent.

Study design

We used a randomized, blinded, pre- and post-test study design, where the unit of study was the anaesthetist, working with a PACU nurse and an anaesthetic technician (a qualified assistant).

Anaesthetists were randomly assigned to the intervention or control groups and undertook a baseline simulation—one of the two simulated PACU scenarios (simulation order randomized).

Before the simulation, the nurse and technician each received three unique items of information, not given to the anaesthetist, about the case (Table 2, information probes). The probes were clinically relevant, important for establishing a differential diagnosis, and plausible for nurse or technician to know. This ‘information probe’ method enabled quantification of information shared between team members. Participants were not aware that they had different information about the case, as would be entirely plausible in the clinical environment.

In a post-simulation test, participants independently answered true/false questions to determine their knowledge of the information probes. For nurses and technicians, this tested knowledge of the probes they had received pre-simulation, measuring the success with which the probe had been ‘planted’. For all participants, it also tested knowledge of probes they could only have learnt if the information probe was shared by others during the simulation.

After the baseline simulation, anaesthetists viewed a 15 min video, either the intervention or control. In the intervention video, an anaesthetist explained the SNAPPI acronym and

| Table 1 The SNAPPI call-out acronym and supporting evidence |
|------------------|--------------------------------------------------|
| Behaviour | Description and supporting evidence |
| **S** Stop and get the attention of the team | Use the ‘step-back method’ to reassess; declaring an emergency is more effective |
| **N** Notify the team of the problem | Notify team members concisely of the problem; talking to the room enhances diagnosis accuracy |
| **A** Assessment—provide your assessment of the situation | Describe the situation, provide an assessment, where it is heading; use ‘transparent thinking’; re-assess and re-evaluate the situation; high performing anaesthetic teams show more situation assessment; explicit reasoning enhances diagnosis accuracy |
| **P** Plan—share your plan for treatment | Good teamwork involves planning the taskwork; the leader’s plan should be clearly articulated; distribute the workload |
| **P** Prioritize—what order should tasks be done | Prioritizing treatment and explicit task distribution enhance teamwork |
| **I** Invite ideas from the team | Leaders should encourage others to speak up and exchange information; collaborative problem solving is effective; relative to physicians, nurses report it is difficult to speak up |
demonstrated its use in simulated crises. The control video demonstrated the Difficult Airway Society (DAS) algorithms.\textsuperscript{32}

E-mail reminders of key points in their respective videos were sent to all anaesthetists 2 weeks post-intervention.

Follow-up simulations were set at 4–6 weeks post-intervention, to test for retention of knowledge of SNAPPI over time. Anaesthetists returning for the follow-up simulation, worked with different nurses and technicians naive to the simulations. Information probes and post-simulation tests were administered as in the baseline simulations.

Trained, blinded raters scored the SNAPPI in baseline and follow-up simulations against a pre-defined scoring rubric on an eight-point scale. The number of information probes shared between team members was measured in a post-test simulation. The number of diagnostic options shared with the team and the score for medical management was calculated from video review.

**Participants and sampling**

All anaesthetists, anaesthetic technicians, and PACU nurses at two major teaching hospitals were invited to participate, and we accepted volunteers on a first-come basis. Nurses and technicians each completed two simulations: one simulation (A or B) with one anaesthetist; the other simulation (B or A) with a different anaesthetist. Different nurses and technicians were recruited for the follow-up simulations. Sample size calculations were based on demonstrating an increase of one point in the SNAPPI score, a power of 0.9, and an \( \alpha \) of 0.05.

**Simulations**

We used a 3G SimMan (Laerdal Medical, Norway) simulator in a simulated PACU environment with real drugs, fluids, equipment, and disposable items. The two simulations were each 15 min long. Simulation A portrayed cardiovascular collapse due to local anaesthetic toxicity, and simulation B portrayed hypoxia due to pulmonary embolus. In both simulations, the nurse was given a structured, realistic handover of the patient in PACU by a faculty member playing the role of a nurse, and the technician was sent into the room with additional notes or equipment, at which stage the patient became physiologically unstable; the pair initially managed the patient together and called in the anaesthetist. The simulation was designed to be a diagnostic dilemma with multiple options requiring initial general measures to stabilize the patient followed by a period of relative stability where the group could consider the underlying causes and treatment options. Simulations were preceded by a structured familiarization with the environment and followed by a 10 min educational debrief on crisis management principles. All simulations were video-recorded for subsequent analysis.

**Scoring SNAPPI**

The SNAPPI was taught to participants as six clear steps (Table 1) and for each occasion in the simulation where the anaesthetist attempted to convey information to the other participants, we scored this attempt against these six steps, with each step being scored as done or not done. In addition, two global points awarded for overall order and clarity (0, random unconnected pieces of information, or not clearly directed to the team; 1, a good attempt to announce a summary of the situation to the team; 2, logical order, clear, and directed containing most or all steps in the SNAPPI). As one or more SNAPPIs could occur in a simulation, the final score was single best SNAPPI score (out of eight) plus a point for each other SNAPPI that included four or more of the six steps.

Two raters piloted this eight-point scoring tool on a sample of 10 videos of simulated scenarios and made modifications to the descriptors for scoring each step were made to improve clarity. Inter-rater agreement in the pilot was good with an intra-class correlation coefficient (ICC) of 0.75.

SNAPPI was then scored by two raters external to the study and blinded to the intervention, and to baseline or follow-up.

**Rater training**

The scoring system was explained in detail to the two raters and they scored a video with the trainer (research fellow) and discussed scoring decisions. The two raters then independently scored 10 of the videos and compared scores and reconciled differences. They then scored the next 10 videos and again reconciled scores. They continued in this way until their
scores were within one point of each other, at which stage they rated the remaining videos independently.

**Measuring team information sharing**

**Team information probe-sharing**

To measure if information probes were shared with other team members, we defined team information probe-sharing as the percentage of information probes shared relative to the maximum possible information probe-sharing, counting only those probes that had been properly planted with the nurse and technician before the simulation. For example, if the nurse and technician each learned all three of their probes, the nurse and technician could learn a maximum of three each (from each other), and the anaesthetist could learn a maximum of six, so the maximum score for information probe sharing was 12. However, if the nurse and technician each learnt only two of their three probes, the nurse and technician could learn a maximum of two each, and the anaesthetist could learn a maximum of four, so the maximum score for information probe sharing was eight.

**Verbalizing diagnostic options**

For each simulation, a list of 10 possible diagnostic options was determined by two specialist anaesthetists (J.M.W., J.T.). The videos were reviewed by another anaesthetist (David Heather) who was not present at the study days and blinded to baseline/follow-up and intervention/control, and the number of diagnostic options the anaesthetist verbalized to the team was counted, producing a score out of 10. A research fellow (M.B.) scored 10 of the videos as a reliability check.

**Measuring medical management**

Medical management was scored using a checklist of 10 clinically important, observable actions based on accepted management guidelines for initial response to an unstable patient and specific response to the particular problem, and derived through an iterative process between two specialist anaesthetists (J.M.W., J.T.) and scored as either done or not done. Scoring was done by an anaesthetist (David Heather) who was not present at the study days and blinded to baseline/follow-up and intervention/control. A research fellow (M.B.) scored 10 of the videos as a reliability check.

**Blinding**

The participants and all those undertaking scoring of the videos were blinded to intervention or control, and the latter were also blinded to baseline or follow-up simulation. Those in the control room running the simulations and those conducting the educational debrief after the baseline simulations were blinded to the intervention or control group allocation. The educators facilitating the intervention or control session were aware of the group allocation as were those conducting the educational debrief after the follow-up scenario, which occurred after completion of all data collection.

**Statistical analysis**

ICCs were calculated to quantify the inter-rater and intra-rater agreement when scoring call-out. The two raters’ scores for the call-out score were averaged for further analyses. To test if the intervention improved call-out scores, we used a general linear mixed model (GLM) which made allowance for the pairs of observations on each participant. To compare the changes from baseline to follow-up between the control and intervention groups, participant was entered as a random factor, observation (baseline/follow-up), randomized group (control/intervention), and technician and nurse experience (having previously been involved in a case) as fixed factors. To allow for possible differential case duration, this was entered as a covariate in the model, potentially improving the precision for the comparison as recommended by Vickers and Altman.\(^{33}\) The size of the intervention effect was estimated using partial \(\eta^2\) for group mean differences.

For the secondary hypotheses testing associations between call-out scores and information sharing scores or medical management scores across all cases, we used a GLM to allow for the paired participant observations. The correlation coefficients were calculated from the residual variances from these models.

In a post hoc analysis, we tested the effect of the intervention on information sharing and medical management using the same statistical model used for the primary hypothesis. Statistical significance was set at \(P<0.05\). We used IBM SPSS v19 for all analyses.

**Results**

Forty-three anaesthetists completed both baseline and follow-up simulations. Owing to technical problems with recording, only 40 anaesthetists had paired video data suitable for analysis. Anaesthetists completed follow-up simulations at a mean of 37 days post-baseline (24–91 days, median 29, \(\text{SD} \ 17.2\)).

Participant post-simulation tests showed the information probes were successfully planted with the nurses and technicians 78% of the time (60–91% depending on the probe). On average, anaesthetists learned 27% (10–49%) of all the probes provided to the nurse and technician in the pre-simulation briefings, and 34% of the successfully planted probes. The average percentage of available information-probes shared between team members across all the simulations was 32%.

The mean scores (range, \(\text{SD}\)) for SNAPPI, team information probe sharing, verbalized diagnostic options, and medical management are displayed in Table 3. There was a large and significant effect of the intervention on SNAPPI scores. The team information probe sharing increased by 24% from baseline to follow-up in the intervention group and by 8% in the control group, but this did not reach significance. The number of verbalized diagnostic options increased significantly in the SNAPPI group. There was a trend to increased scores for medical management which did not reach statistical significance.
We found good inter-rater agreement between the two raters for SNAPPI scores (ICC = 0.77). When scoring numbers of verbalized diagnoses options on the sample of 10 videos, the two raters agreed on more than 90% of the scores. The same two raters also agreed on more than 90% of the items on the medical management checklist in a sample of 10 videos.

We found statistically significant correlations between SNAPPI scores and information probe-sharing score (0.37, P = 0.02) and verbalized diagnostic options score (0.39, P = 0.01). We found no significant correlation with SNAPPI score and score for medical management.

**SNAPPI steps**

Of the six steps of the SNAPPI acronym, ‘Notify the team of the problem’, ‘Assessment—provide your assessment of the situation’, and ‘Plan—share your plan for treatment’ were all exhibited by anaesthetists at least once in more than 90% of the simulations. However, the other SNAPPI steps were observed less frequently: Stop and get the attention of the team, 27%; Prioritize—what order should tasks be done, 64%; Invite ideas, 29%.

Of note, 68% of anaesthetists in the intervention arm at follow-up invited ideas from the team, whereas this score in all other conditions (both baseline simulations and control group follow-up simulation) ranged from 20 to 26%.

**Discussion**

We found that a video-based educational intervention modelling a structured call-out (SNAPPI) significantly improved SNAPPI scores by anaesthetists in PACU simulated crises (P < 0.001), supporting our primary hypothesis.

There was also a significant improvement in information sharing as shown by the increase in the number of verbalized diagnostic options (P = 0.043). While we found a trend to increased information probe sharing and medical management scores in the intervention group, this did not reach statistical significance. However, we do see a clear trend to improvement as all of the measured variables (verbalized diagnostic options, information probe sharing, and medical management) increased in the intervention group relative to the control group. Furthermore, we demonstrated a significant correlation between SNAPPI scores and information probe sharing and verbalized diagnostic options scores across all participants, lending some weight to the proposition that a more structured call-out may have a positive influence on information sharing within a team. Thus, our secondary hypotheses are partially supported.

Of note, only 27% of the clinically relevant information about the patient provided to the nurse and technician in the pre-simulation information probes was subsequently learnt by the anaesthetist. In the debriefs after scenarios, participants agreed it was common to have different information about a case. A number of studies have explored reasons why information is not shared between members of healthcare teams, including inhibition from speaking up because of a perceived hierarchy; lack of confidence in the relevance of their information; an assumption that the team leader already knew the information; or not perceiving it as within their area of responsibility. This large loss of patient information is of concern and warrants further investigation into more effective handover practices.

Structured communication techniques have been shown to increase information sharing. These include briefings, structured handovers, such as ISBAR, and checklists including the WHO Surgical Safety Checklist. We are aware of one large systematic review currently underway to determine which structured communication tools would be most useful to teach to undergraduates, but we are not aware of any tools available for sharing clinical information within an existing team in a crisis situation. Sharing information is one important component of constructing a shared mental model. This is an important deficiency given that more explicit coordination is a feature of high-performing teams during unfamiliar, ill-structured, or critical situations.

**Shared mental models and clinical outcomes**

SNAPPI is designed to improve information sharing between team members, with potential to create a shared mental model of the clinical situation within the team. Shared mental models are linked to team performance across many industries. In healthcare, sharing of clinical information and the resulting construction of shared mental models has also been linked to improved team performance.

**Table 3** Mean scores (standard deviation, SD) for outcome measures at baseline and follow-up for the control and intervention groups, and effect size of the intervention. *P < 0.05; †P < 0.001; NS, non-significant. ²Effect size (partial η²) of the difference between control and intervention in the improvement from baseline (as described in text). See Cohen (p. 283) for η² values where 0.0099 constitutes a small effect, 0.0588 a medium effect, and 0.1379 a large effect.
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reduction in surgical complications using a checklist, timely antibiotic administration after structured team briefings, and improved medical management with more information sharing. Furthermore, there is evidence that structured handovers improve patient outcome, including decreasing unexpected deaths, and adverse events. A key mechanism for this enhanced performance may be through the reduction in uncertainty, which shared mental models facilitate. However, sharing of clinical information during a crisis may be lacking.

**Limitations**

Our sample size was powered to demonstrate that SNAPPI can be learnt, retained, and demonstrated in a simulated case 4–6 weeks after a simple educational intervention. Low numbers may have limited our ability to identify significant effects for our secondary hypotheses. Even so, the trends we found suggest that there are links between improved SNAPPI and measures of information sharing. The data we provide here can guide power calculations for further investigation into the links between structured call-out in a crisis and outcome.

We tested our participants in simulations and did not demonstrate transfer of the behaviour to clinical practice which is a limitation of our study. While we have previously demonstrated that communication in simulations is a valid measure of communications in clinical practice, ideally we would measure transfer of the behaviour to clinical environment. There are obvious difficulties involved here, not the least of which is identifying moments of crisis to be observed.

Our ultimate goal is to improve patient safety. The outcome measures in this study are limited to the processes involved in patient management and not patient outcome. The link apparent between SNAPPI and enhanced shared mental models, and the evidence in the literature that shared mental models enhance patient outcomes, suggests that further research linking structured call-out with outcomes is warranted.

**Conclusion**

We have developed a structured communication tool to improve sharing of information between anaesthetists and their team in a crisis, given it the acronym SNAPPI, and effectively taught it using a brief, video-based intervention. We have provided some evidence to support its value in promoting information sharing between team members. Results from this study will inform the design of a larger study of the use of structured team communications to develop shared mental models in a crisis with the ultimate aim of improving outcomes for patients.

**Authors’ contributions**

J.M.W.: study conception and design, scenario design, running study days, and writing the manuscript. J.T.: study conception and design, scenario design, participant recruitment, running study days, and review of article for important intellectual content. M.B.: participant recruitment, data collection, data management, data analysis, literature review, and drafted the write-up. R.F.: study conception and design, scenario design, contributed to study days and video-intervention, and review of manuscript. A.G.: study conception and design, created the video intervention, review of article for important intellectual content, and review of manuscript. W.L.N.: study conception and design, scenario design, participant recruitment, running study days, and review of manuscript. C.F.: study design, statistical advice, data analysis, review of article for important statistical content, and review of manuscript.

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**Declaration of interest**

None declared.

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Appendix

Literature review strategy

We searched MEDLINE, EMBASE, Psych Info, Web of Science, Google Scholar (first 20 pages of results), and Science Direct (first 20 pages of results) using the search strategy [('call-out' or 'call out' or 'step back' or 'step-back' or 'recap') and ('communication' or 'Teamwork' or 'Behaviour' or 'Behavior' or 'safety')]. This returned 1498 titles. Examining the titles, we found 51 articles that suggested a context of communication, teamwork, team communication, or team training in healthcare. Review of these abstracts revealed 10 articles potentially relevant to call-out at a clinical crisis (simulated or real), which we obtained for full-text review. Four articles mentioned the call-out/step-back method specifically, although none described a tool for structuring call-out, and none evaluated the impact of call-out on outcomes. A list of articles reviewed is available from the authors.

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<th>Articles describing call-out in healthcare teams</th>
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<td>Johnson and Kimsey(^{13})</td>
<td>Describes implementing the Team STEPPS Program, which includes teaching ‘Call-out’, equivalent to ‘Notify’ step of SNAPPI</td>
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<tr>
<td>Robel and colleagues(^{14})</td>
<td>Describes development of a course that includes ‘a call-out procedure’, no further details</td>
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<tr>
<td>Brindley and Reynolds(^{15})</td>
<td>General review of verbal communication in critical care, suggests using the ‘step-back’ method to force a pause or time out to reassess</td>
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