

Anaesthetists' non-technical skills

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Key points

- Deficiencies in anaesthetists' non-technical skills can contribute to medical error and adverse events.
- The ANTS tool is a skills taxonomy and behavioural rating system.
- ANTS is used for training, workplace assessment, self-reflection, simulator debriefing, and incident analysis.
- Anaesthetists require basic training in NTS and specialist ANTS training in order to use the tool effectively.

Summary. This review presents the background to the development of the anaesthetists' non-technical skills (ANTS) taxonomy and behaviour rating tool, which is the first non-technical skills framework specifically designed for anaesthetists. We share the experience of the anaesthetists who designed ANTS in relation to applying it in a department of anaesthesia, using it in a simulation centre, and the process of introducing it to the profession on a national basis. We also consider how ANTS is being applied in relation to training and research in other countries and finally, we discuss emerging issues in relation to the introduction of a non-technical skills approach in anaesthesia.

Keywords: clinical competence; decision-making; educational measurement/methods; interprofessional relations; task performance and analysis

Non-technical skills

The term 'non-technical skills' is used by a number of professions but was first applied to safety by the European civil aviation regulator in relation to airline pilots' behaviour on the flight deck. Non-technical skills can be defined as 'the cognitive, social, and personal resource skills that complement technical skills, and contribute to safe and efficient task performance'.¹ In essence, they enhance workers' technical skills, and typically include situation awareness, decision-making, team work, leadership, and the management of stress and fatigue. Deficiencies in non-technical skills can increase the chance of error, which in turn can increase the chance of an adverse event. Good non-technical skills (e.g. vigilance, anticipation, clear communication, team coordination) can reduce the likelihood of error and consequently of accidents. To identify non-technical skills for a given job or task, various forms of task analysis can be used: analysis of incidents, and studies of behaviour during routine tasks or emergencies, can reveal which workplace behaviours are associated with adverse outcomes or their avoidance. The resulting evidence base informs the content of non-technical skills taxonomies. In European aviation, pilots are trained and individually assessed on non-technical skills that are protective for flight safety.² Similarly, in other high-risk work settings, for example, nuclear power plants, assuring competence in non-technical skills is a key component of licensing and revalidation.³

In contrast, little attention had traditionally been paid to the behavioural components of safe medical practice. Anaesthesiologists in the USA were among the first to adapt the

aviation Crew Resource Management (non-technical) skills approach for anaesthetic training. For example, Gaba and colleagues devised an Anaesthetic Crisis Resource Management course as part of their simulation centre training programme.⁴ Within a few years, anaesthetists in other countries began to establish high-fidelity simulation centres and the first Scottish simulation facility was established in 1997, directed by Maran and Glavin. They recognized that for training and evaluation, they needed to have methods of measuring not only the anaesthetists' technical performance but also their non-technical skills, such as decision-making or team work.

Development of the ANTS system

In 1999, Flin and Glavin obtained funding from the Scottish Council for Postgraduate Medical and Dental Education, later subsumed into NHS Education Scotland, to develop a taxonomy of non-technical skills, which could be rated from behavioural observations of individual anaesthetists working in an operating theatre. A team of anaesthetists and psychologists was assembled to design an anaesthetists' non-technical skills (ANTS) system using methods of task analysis similar to those for the NOTECBS system for pilots.⁵ The skill set for ANTS content was derived from a series of task analyses based on a literature review, observations, interviews, surveys, and incident analysis^{6–8} and the rating tool was formulated to meet a set of design criteria, such as suitability for practical use in theatre or a simulation setting. For detailed reports and the resulting papers, see the ANTS website (www.abdn.ac.uk/iprc/ants).

The ANTS skills framework (Fig. 1) has four categories: Situation awareness, Decision-making, Task management, and Teamworking with component elements and examples of good and poor behaviour for each element. Managing stress and coping with fatigue are not explicit categories, as they can be difficult to detect unless when extreme; moreover, they influence other behaviours that can be rated. Leadership is incorporated into the Teamworking category, as there are times where the anaesthetist may lead the theatre team.

In addition to the ANTS framework, a behaviour rating scale was designed which is printed on a single page for ease of use. It has a set of 4-point rating scales for rating observed behaviours in relation to the elements and categories and space also to write brief comments (Fig. 2). It should be noted that the descriptors for the points on the rating scale emphasize not only performance levels, but also their relevance for patient safety. The ANTS ratings are made where anaesthesia is being delivered, normally in the theatre or anaesthetic room setting (or in simulator facilities). The tool is designed to be used by experienced anaesthetists to rate the non-technical skills of another anaesthetist who has achieved basic technical competence.

An evaluation of the ANTS behaviour rating method was undertaken with 50 consultant anaesthetists who were given 4 h of training on the system and then rated the non-technical skills of consultant anaesthetists in eight videotaped scenarios. The levels of rater accuracy were acceptable and inter-rater reliability approached an acceptable level.⁹ Given that the raters had no previous experience of behaviour rating and minimal training in the ANTS system, it was concluded that these findings were sufficient to move on

to usability trials. The first measures of usability and acceptability from consultants and trainees were promising¹⁰ and so the system was released in 2004 and made available free of charge to anaesthetists for non-commercial use.

The subsequent sections describe consultant anaesthetists' experiences of introducing ANTS into an anaesthetic department and to a clinical simulation centre.

Using ANTS in a Department of Anaesthesia

We now present an example of introducing ANTS into one department of anaesthesia in a Scottish hospital. Following the publication of the ANTS system, a sizeable minority of consultant training staff in one large teaching hospital anaesthetic department underwent ANTS training similar to that provided in the pilot cascade training approach (described later in this article) of the Royal College of Anaesthetists (RCA). It proved difficult for staff in this department, as it did for those who took part in the RCA pilot, to routinely use ANTS to discuss and assess the use of non-technical skills in their daily practice. All trainees from this department attend the Scottish Clinical Simulation Centre at various times during their training and learn about human factors issues as part of this experience. However, the education team felt that for this learning to transfer to the work place, it was important for there to be regular discussion of the best use of non-technical skills throughout the training period and for trainees to be given feedback on their performance of non-technical skills. There was strong support and a willingness for further initiatives which would help

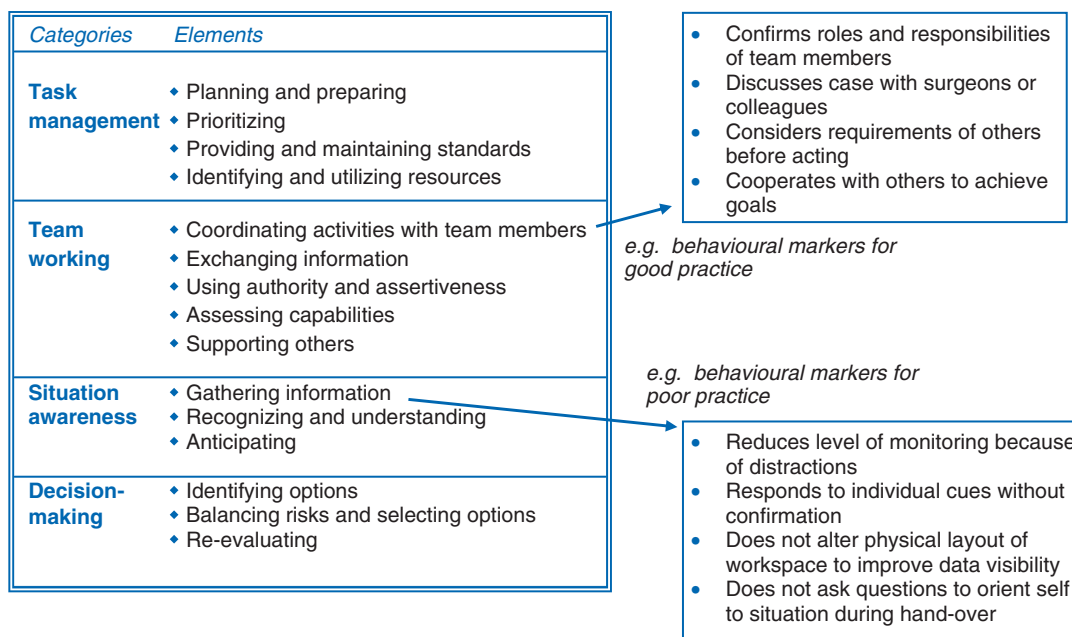


Fig 1 The ANTS system—prototype.

Element ratings	1 – Poor	2 – Marginal	3 – Acceptable	4 – Good	Not observed	Comments on behaviour observed
Planning and preparing				✓		Discussed positioning of patient with surgeon, explain all the intricacies of plan to assistant and trainee
Prioritizing			✓			Sent trainee to answer phone query so could concentrate on patient
Providing and maintaining standards			✓			Cross-checked drugs with assistant, re-check connections after moving patient

Fig 2 Example of ANTS system rating form.

make non-technical skills part of the language of the department in order to achieve this.

A training day was run in 2007 to familiarize the key training consultants in the department with ANTS and to explore the options for including this system into the core training provided by the department. Arising from this day, a number of initiatives have taken place. First, in contrast to the common morbidity and mortality meeting where adverse events are explored, an analysis of a critical incident where an adverse event was avoided was analysed using the ANTS framework. The incident involved an airway emergency where a wide multidisciplinary team successfully formed and worked together, where there was limited time to gain control. After presentation of the case from the perspective of the different disciplines involved, the audience was invited to consider the non-technical skills that had been used during the crisis. Evaluation of this method of incident analysis was very positive and although this approach to M&M meetings has not been sustained, the discussion on key non-technical skills areas has increased.

For 3 years now, all new starts to anaesthesia, and any trainees joining the department at a later stage in their training, have attended a half-day workshop to introduce the ANTS system. After a short introduction outlining the importance of non-technical skills, participants consider their own and others' use of non-technical skills during exercises designed to help familiarize them with the system. The workshop is generally held around 4 months after starting anaesthesia, when the novices have developed their basic anaesthetic knowledge and technical skills and are undergoing the initial tests of competence. As homework, the trainees are required to use ANTS to detail the non-technical behaviours that could be observed during a gold standard rapid sequence induction. *Ad hoc* training days continue to be held for the trainers within the department with discussion on ways to incorporate non-technical skills into training and conversations around ANTS with trainees are encouraged. It is emphasized that the incorporation

of ANTS into training is not primarily about dealing with trainees with difficulties but rather improving the quality and safety of anaesthesia provided by all.

The latest initiative in the department is to incorporate a training tool known as tactical decision games (TDGs) into the core programme provided for the new starts to anaesthesia. The TDGs are a low-fidelity simulation, developed by the US Marines and subsequently used in other industries requiring decision-making during emergencies, designed to help novices progress their decision-making ability during time-pressured, stressful emergency situations.¹¹ Although TDGs had been used intermittently by R.P. in ANTS and other training sessions, the tool had not been formally evaluated. During the discussion of each game, trainees consider the use of non-technical skills in general and their influence in decision-making during emergencies. A pilot evaluation of a programme of TDGs suitable for novice anaesthetists has just been completed and plans are being made for further evaluation across a number of schools of anaesthesia.

Using ANTS in a Clinical Simulation Centre

Anaesthetic simulators have been widely used to deliver crew resource management type courses for anaesthesia for many years.^{4 12} However, as mentioned above, the lack of validated instruments with which to measure the behavioural aspects of anaesthetic performance during and after simulation training¹³ was one of the initial drivers to the inception of the ANTS system. At the Scottish Clinical Simulation Centre, the development of a skills system grounded in anaesthesia has allowed us to develop courses that focus on the development of the non-technical skills, which are directly relevant to anaesthetic practice. The CARMA (Crisis Avoidance and Resource Management for Anaesthetists) course, developed at the Centre, utilizes the ANTS system as the basis for the introduction and enhancement of non-technical skills.¹⁴ The emphasis is on the use of non-

technical skills in routine practice to avoid errors and adverse events but the courses also illustrate the importance of such skills in the management of emergency situations.

Knowledge of the basic psychological vocabulary (e.g. situation awareness) and underlying theory is still unfamiliar to most anaesthetists. The course therefore starts with theoretical introduction to human error and human performance limitation and then introduces the four key skills categories of the ANTS taxonomy, namely:

- Situation awareness
- Decision-making
- Teamworking and leadership
- and Task management (including stress and fatigue)

All theoretical components of the course use presentations and small group work exploring the skills with the aid of clinical patients. Simulated scenarios involving management of patients both within and outside the operating theatre then allow the participants to put their non-technical skills into practice. Course participants alternate taking part in scenarios with observing. Observers use the ANTS framework taxonomy to identify their colleagues' non-technical skills and provide feedback on the behavioural aspects of performance. Video replay is a particularly powerful way of allowing scenario participants to reflect on their actions and facilitation also allows further exploration of the cognitive processes. The advantage of using a skills framework is that, by identifying specific behavioural examples during performances with illustration of the positive and negative impacts of these actions, course participants rapidly build their understanding.

By the end of the 2-day course, all participants report confidence with and demonstrate their ability to accurately identify specific non-technical skills using the ANTS framework. The opportunity for personal reflection on action in the simulator with video debriefing is consistently the most positively evaluated part of the course. Post-course evaluation demonstrates that most participants continue to use the ANTS taxonomy for personal reflection and many describe the usefulness of the tool to analyse aspects of performance of the consultants who they see as role models in clinical practice. Although many course participants return to the simulation centre to attend further courses and therefore have the opportunity to reflect further on their own non-technical skills, the effect of this simulator training on non-technical skills development has not to date been formally evaluated in Scotland. However in Canada, Yee and colleagues¹⁵ have demonstrated an improvement in non-technical skills with repeated exposure to simulator-based training and debriefing using the ANTS system.

One of the major challenges to the effective spread of the use of the ANTS taxonomy beyond the simulation centre is the relative lack of clinicians who are familiar with its use and therefore able to give recurrent feedback in the clinical domain. As shown in the section above, there are areas of Scotland where this issue has been addressed.

ANTS in the UK

The ANTS system was presented to a meeting of the Educational Strategy Group of the Royal College of Anaesthetists (RCA) in 2003. The members of the group exhibited a positive response to the system and agreed that the next stage would be to apply the system to a whole School of Anaesthesia. A small school (East of Scotland—Dundee and Perth) and a large school (Manchester and North West) were selected for this phase of the study. R.G. was invited to deliver presentations to representatives of the consultant body in both schools. East of Scotland declined to proceed any further at that stage but representatives from Manchester attended a training day delivered by R.G. using study materials. The method chosen by the RCA was a cascade method. In this approach, those who were given instruction would use the system themselves and when they were confident in its use, they would teach other consultants in their hospital departments. Six months after the initial training very few had put the system into practice. There were several reasons given, but probably one of the most important was the then unfamiliarity of anaesthetists with assessment tools to assess trainees in the workplace. The combination of a relatively unfamiliar set of behaviours (the markers underpinning the ANTS system) and the formal use of workplace-based assessment tools was probably a step too far. Other schools underwent a similar form of cascade teaching by R.P., but in each case no formal teaching of other consultants took place beyond the initial setting. Cascade teaching was not an appropriate method to further ANTS training at that time. This was not the only RCA-supported activity in which familiarization of ANTS occurred.

The anaesthetist as educator course

This course began life as a series of one-day courses intended to improve the teaching skills of anaesthetists run by the RCA in 1999. In 2002, a 2-day course initially known as 'Teaching Methods' workshop was introduced. One of the components of this course was a formal session on ANTS: an initial presentation was followed by small group exercises in which participants on the course applied the ANTS rating tool to two of the study videos. This course has undergone many modifications and is now just one of several courses falling under the umbrella of 'Anaesthetists as Educators'. This course, now referred to as 'Teaching in the Workplace' continues to have a session on ANTS. This session has proved problematic to deliver because not all of the faculty members on the course feel sufficiently confident in their own understanding of non-technical skills. The session duration is insufficient to deliver formal instruction in the use of the ANTS system but it links the role of non-technical skills with other attributes of anaesthetists that are seen in the workplace and are necessary for the anaesthetist to achieve effective care.

Workplace-based assessment tools

The formal use of tools to 'assess' trainees in the workplace was introduced as part of the Foundation Training Curriculum

in the UK in August 2005. In August 2007, the specialist component of *Modernizing Medical Careers*¹⁶ was introduced and this brought significant changes to postgraduate medical education in the UK, many of which are still ongoing. The Northern Ireland School of Anaesthesia piloted a set of workplace-based assessment tools. These were based on the Foundation Programme assessment tools but although they did not contain ANTS, it was interesting to note that the Mini Clinical Examination (MiniCEX) contained an element-labelled situation awareness. Personal communication with the Regional Adviser for the Northern Ireland School of Anaesthesia suggested that this was understood to varying extents by the consultants applying the system.

RG modified the MiniCEX and case-based discussion tools then in use by the RCA to incorporate some of the ANTS categories and elements. This was done with the intention of raising familiarity with these particular components and helping to link them to the more conventional clinical areas to be assessed. The term assessed is probably inaccurate as subsequent reports from the Academy of Medical Royal Colleges and the Postgraduate Medical Education and Training Board have placed the emphasis on the use of these tools to form the basis of a dialogue of a primarily formative nature rather than have a primarily summative assessment role. As implied above, the nature and use of these tools continues to be modified by both the RCA and the UK regulator (PMETB at time of writing but about to change to become part of the General Medical Council). The skills matrix in the Training e-Portfolio project (March 2010) states that it is 'based on Aberdeen ANTS', but while it uses the ANTS structure and appears to incorporate some of the ANTS categories and elements, it is not clear on what basis this matrix was developed or tested. While there is increasing awareness in the UK in the use of non-technical skills for anaesthetic training and evaluation, it appears that the Royal College of Anaesthetists has not yet found an established role for the ANTS system.

ANTS beyond the UK

There has been considerable interest in the use of ANTS by anaesthetists in other countries, including India¹⁷ and the USA.¹⁸ We have given permission for ANTS to be translated into German and Hebrew and are aware of its use in anaesthetic simulator training in Canada, Spain, Sweden, the Netherlands, Australia, and Denmark. It has also been adapted by Italians for use in non-technical skills assessment in the intensive care unit,¹⁹ although we would advise that proper task analyses are used for developing taxonomies for specific domains, as were undertaken for the non-technical skills for surgeons tool (NOTSS).²⁰ Rall and Gaba²¹ in reviewing behavioural assessment methods in 'Miller's Anaesthesia' concluded, 'On the whole, the ANTS system appears to be a useful tool to further enhance assessment of nontechnical skills in anaesthesia, and its careful derivation from a current system of nontechnical assessment in aviation (NOTECHS) may allow for some interdomain comparisons'.

They also discussed issues inherent in both technical and non-technical performance assessment, including criterion thresholds, rating fluctuating performance, and inter-rater reliability. These concerns have been echoed in early trials, where the raters have been inexperienced in behavioural assessment and often have not had basic non-technical skills training.

A number of simulation studies in Canada have used the ANTS tool to examine the effects of simulation training.^{15 22} For example, Bould and colleagues,²³ used an ANTS assessment as part of an investigation into a cognitive aid for neonatal resuscitation, while Bruppacher and colleagues²⁴ used ANTS to evaluate anaesthesiologists' non-technical skills before and after simulation-based training for cardiopulmonary bypass weaning. A German study used ANTS to test the efficiency of simulator-based training on anaesthesia crisis management.²⁵ While we are heartened to see ANTS being adopted in this way, the issues of adequacy of NTS training for the ANTS assessors may need to be taken into account, as a recent Australian study has shown.

The Australian and New Zealand College of Anaesthetists sponsored an evaluation study of ANTS training. Graham and colleagues^{26 27} gave 26 anaesthetists a morning of training on ANTS and asked them in the afternoon to rate five videotapes showing the behaviour of anaesthetists during operations. While their trainees were positive about the content validity, and the internal reliability (Cronbach's alpha) scores of the categories were acceptable, they found low inter-rater reliability at the element level. At the category level, which would be the more typical level for formal assessment, the inter-rater reliability scores were not reported. This level of reliability at the element level across 26 raters is hardly surprising, as none of the anaesthetists had any previous training in non-technical skills or in behavioural rating.

A group of New Zealand anaesthetists described the modification and initial use of a mini-CEX tool incorporating some non-technical skill components. This group also identified the difficulties associated with inter-rater reliability if the tool is used in a summative manner.²⁸

As we have already advised,⁹ a half-day training session is not an adequate time period to teach the underlying psychology and anaesthetic consequences for four non-technical skills categories, the principles of using behavioural rating scales, and then to explain and train the use of the ANTS system. A minimum of 2 days is recommended²⁹ and this is for raters who already understand non-technical skills concepts. It is unlikely that anaesthetists would show very high inter-rater reliability if asked to use an unfamiliar rating system to rate observations of technical skills with 4 h of training. Moreover, the training should be conducted in small groups to maximize time for class discussion and individual feedback from the trainers. The Australian study^{26 27} is timely and is an important contribution to our understanding of the application of ANTS in practice. They have also demonstrated another issue which we have witnessed in our own ANTS training sessions. That is that anaesthetists, even

from the same unit, do not always agree on what is safe anaesthetic practice. This does present a considerable problem for professional assessment of technical, and non-technical skills.

Emerging issues

The process of introducing the ANTS system in the UK has revealed the difficulties of bringing a novel type of assessment system to a profession with no formal evaluation of competence post-qualification. Not only is the notion of workplace assessment new (apart from assessing trainees), it became apparent in our early ANTS training courses that the basic psychological language was unfamiliar to most anaesthetists. (For example, the term situation awareness was not known, although there was good conceptual understanding of the need to maintain attention and vigilance). In aviation, pilots are taught and examined in the psychological and physiological factors influencing task performance from the start of their basic training (Human Performance Limitations courses). They then undertake Crew Resource Management training on a regular basis. This suggests that there is a need for basic awareness training courses in non-technical skills in undergraduate medicine³⁰ to introduce the concept of non-technical skills and explain their importance for patient safety, before specialist training in non-technical skills such as ANTS can be effectively introduced at the postgraduate stage. This has already been acknowledged by a recent Parliamentary Report into Patient Safety, July 2009. 'Lack of non-technical skills can have lethal consequences for patients. However, the NHS lags unacceptably behind other safety-critical industries, such as aviation, in this respect. Human Factors training must be fully integrated into undergraduate and postgraduate education'.³¹ Emerging programmes of non-technical skills training for medical undergraduates, for example at Aberdeen University, suggest that there may soon be a foundation for a more structured introduction of non-technical skills to the medical profession.

At the postgraduate level and beyond, there appears to be a new level of interest in non-technical skills training for anaesthetists, given recent references to ANTS in relation to the promotion of excellence in anaesthesia,³² and the number of requests we are receiving for training courses. There appears to be a need to introduce a systematic programme of non-technical skills training at three different levels. First at the postgraduate stage, starting practitioners require training in order to acquire familiarity with anaesthetists' non-technical skills (e.g. the ANTS taxonomy) to use in their own practice and to appreciate their importance for patient safety. At a second level, more experienced anaesthetists who would be tasked with delivering this training or in giving trainees feedback on their non-technical skills, need to have a more detailed knowledge of the ANTS taxonomy and rating system and how to use it in theatre or the simulator.³³ These ANTS trainers and raters should understand the psychological constructs underpinning the skill

set and how they relate to factors influencing human error in relation to patient safety.¹ They also need to be trained in debriefing skills. Some of these training components could be supported by web-based delivery mechanisms or other forms of e-learning.

Anaesthetists engaged in formal assessment of non-technical skills for licensing or revalidation would require additional training at a more advanced level. In order to achieve consistency across raters for the core categories of ANTS (or any other behavioural marker system), the raters must be trained and calibrated. This requires a significant level of guided practice. They would also need to know how to deal with professional issues, such as consequences of failure or provision for remedial training. The new UK Civil Aviation Authority standards for training and examining pilots' non-technical skills offer valuable guidance for professional development and qualification at this level.³⁴ As an aviation expert advises, 'Any airline that chooses to introduce CRM [NTS] assessment without first training its cadre of line training captains or simulator instructors is simply ensuring that the process will be conducted in a haphazard and unreliable fashion'.³⁵

Conclusion

In the last 10 years we have noticed a growing interest from anaesthetists, in the UK and beyond, in the concept of non-technical skills. This has probably been driven by rising concern about patient safety, coupled with national initiatives on competence assurance for healthcare professionals. We produced the first taxonomy of non-technical skills for anaesthetists and designed a behavioural rating system (ANTS) for anaesthetists to rate these skills from workplace observations. In general, the system has been well received by anaesthetists and the early reports of ANTS in practice have shown that the basic content and design of the tool seem to be acceptable, although inter-rater reliability is predictably low when raters have minimal training and experience with ANTS.

So there is a need for us to heed our own warning: 'The danger is that behaviour rating systems look deceptively simple. Considerable skill is required to make observations and ratings, and to give constructive feedback to those being rated'.¹ We had designed a behaviour rating system for professionals who had no training in non-technical skills concepts, or the psychology of human error or workplace assessment. In a sense, we produced 'the cart before the horse', in which basic training in non-technical skills, then specialized training in the use of the ANTS system, are required before this type of tool can be used reliably for professional development and assessment.

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Conflict of interest

None declared.

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