

Development and Validation of a Tool to Assess Emergency Physicians' Nontechnical Skills

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Study objective: Nontechnical skills are “the cognitive, social and personal resource skills that complement technical skills, and contribute to safe and efficient task performance.” Our research team developed and evaluated the task of developing and validating a behavioral marker system for the observational assessment of emergency physicians' nontechnical skills.

Methods: The development of the tool was divided into 3 phases and used triangulation of data from a number of sources. During phase 1, a provisional assessment tool was developed according to published literature and curricula. Phase 2 used analysis of staff interviews and field observations to determine whether the skill list contained any significant omissions. These studies were also used to identify behavioral markers linked to nontechnical skills in the context of the emergency department (ED) and establish whether skills included in the tool were observable. Phase 3 involved evaluating the content validity index of exemplar behaviors, using a survey of experts.

Results: A behavioral marker system was developed that comprised 12 emergency medicine–specific nontechnical skills, grouped into 4 categories. Content validity was assessed with a survey of 148 emergency medicine staff, and 75% of items achieved the recommended content validity index greater than 0.75. Data from the survey enabled further refinement of the behavioral markers to produce a final version of the tool.

Conclusion: Although further evaluative studies are needed, this behavioral marker system provides a structured approach to the assessment and training of nontechnical skills in the ED. [Ann Emerg Med. 2012;59:376-385.]

Please see page 377 for the Editor's Capsule Summary of this article.

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INTRODUCTION

Background and Importance

There is increasing awareness that health care workers should not only possess excellent clinical skills but also be competent in an array of nontechnical skills, which are “the cognitive, social and personal resource skills that complement technical skills, and contribute to safe and efficient task performance.”¹ Examples include communication and decisionmaking. Several studies have demonstrated an association between nontechnical skills and patient safety in the emergency department (ED).²⁻⁴ Effective leadership in particular has been identified as one of the main factors associated with high clinical performance.⁵ Although most emergency physicians accept that teamwork is important, it is not entirely clear which nontechnical skills are most relevant in the ED or what constituent behaviors represent these skills in practice. Identifying and describing the key nontechnical skills for emergency physicians is an essential prerequisite to focus improvement strategies through training and assessment.

Many graduate and undergraduate curricula refer to the importance of interpersonal skills and professionalism, but structured assessment of related competencies is often lacking. Assessment of nontechnical skills is necessary to provide structured and specific feedback to trainees and prioritize training needs for an individual or group.¹ Furthermore, measuring the progressive development of an individual or group is necessary to evaluate the effect of any training program.⁶ It is therefore crucial to have a robust method of assessing nontechnical skills that is specific to the ED. A number of tools have been developed for assessing nontechnical skills in the resuscitation room or simulator environment.^{7,8} However, these tools focus entirely on the management of a single critically ill patient, which constitutes only a portion of an emergency physician's daily activities. It is important to ensure that assessment and feedback of nontechnical skills covers the full spectrum of activities that an emergency physician performs.⁹

The main approaches to assessing nontechnical skills involve either peer review, such as multisource feedback, or observation of an individual. Behavioral marker systems have been used to

Editor's Capsule Summary

What is already known on this topic

Nontechnical (cognitive, social, and interpersonal) skills contribute to effective performance in emergency care, but methods for assessing them have been limited either to teamwork skills or to the resuscitation setting.

What question this study addressed

This article reports the development and content validation of a tool using observable behavioral markers for assessing nontechnical skills related to safe performance in the emergency department (ED). The tool was developed in 2 EDs in the United Kingdom, using interviews and direct observations, and triangulated against existing literature and a survey.

What this study adds to our knowledge

The study provides a behaviorally based assessment tool for general, ED-specific, nontechnical skills for physicians.

How this is relevant to clinical practice

These results might be useful in assessment and training on further validation.

structure observation and assessment of nontechnical skills in other areas of health care, such as anesthetics and surgery.^{10,11} These systems are composed of a number of nontechnical skills, grouped into categories, and each skill is linked to explicit behavioral markers that illustrate good and poor practice; for example, "encourages team members' input in decisionmaking." This is combined with a rating scale to enable assessors to rate skills according to observable behaviors.

Goal of This Investigation

Our research team undertook the task of developing a behavioral marker system that encompassed all nontechnical skills required by emergency physicians. This included the skills required during resuscitation, as well as those necessary during routine work and the management of multiple patients. In view of the vital contribution clinical leadership makes to safety in the ED, the assessment tool also needed to reflect the role of the shift lead physician, a rotating senior physician who, in addition to meeting the clinical needs of patients, takes responsibility for overseeing and coordinating staff and patients on the "shop floor" at any given time. A series of studies was carried out with the aim of developing and validating a behavioral marker system for the observational assessment of emergency physicians' nontechnical skills in the workplace.

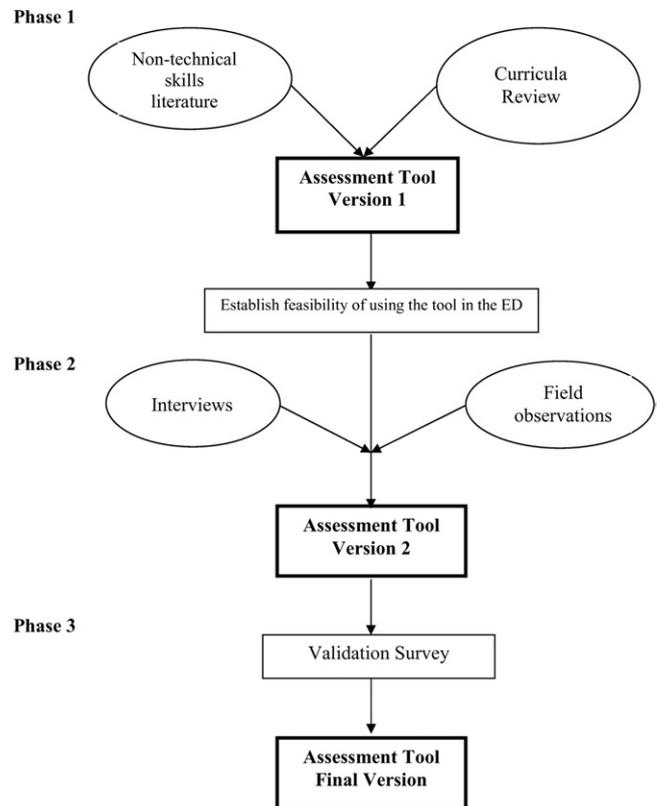


Figure 1. Phases of development of the assessment tool.

MATERIALS AND METHODS

The development of the tool was divided into 3 phases and is illustrated in Figure 1. Each phase had specific aims:

1. Review of published literature and curricula: To produce a provisional assessment tool using the best available evidence.
2. Interviews and field observations: To determine whether, in practice, the skill list contained any significant omissions and whether skills were observable. These studies were also used to identify behavioral markers linked to nontechnical skills in the context of the ED.
3. Staff survey: To evaluate the content validity of the behavioral markers by using expert opinion and to further examine whether the tool contained any significant omissions.

Evidence from a number of sources was triangulated to develop this assessment tool, which helped to counteract some of the limitations of each research method alone. For example, interviews measure peoples' attitudes and self-reported behavior, which may be different from their actual behavior. Observational studies examine behavior in a real-life setting, but single observations may be unrepresentative of a participant's usual behavior.

During Phase I, a review of the literature was undertaken to identify the nontechnical skills associated with safety and error specifically in the ED.¹² Analysis was guided by codes derived from the data rather than using a predefined coding framework.

1. Maintaining standards
2. Decisionmaking
3. Managing workload
4. Communicating
5. Resolving conflict
6. Team building
7. Leadership
8. Supporting others
9. Teaching and providing feedback
10. Using authority and assertiveness
11. Situational awareness
12. Coordinating team members
13. Supervising/assessing capabilities

Figure 2. Potentially relevant nontechnical skills.

The results of the review were combined with analysis of other observational tools used to assess nontechnical skills in health care.^{7,10,13-23} Observable behaviors and skills mentioned in the literature were grouped together to produce a list of 13 potentially relevant nontechnical skills, shown in Figure 2.

Training syllabi and curricula from regulatory bodies are important sources for identifying relevant nontechnical skills.¹ The College of Emergency Medicine Generic Skills Curriculum²⁴ and the Academy of Royal Medical Colleges Medical Leadership Curriculum²⁵ are the 2 main curricula that describe nonclinical skills and competencies for emergency medicine trainees in the United Kingdom. The lead researcher (L.F.) examined these curricula to ensure that the assessment tool reflected the skills described. These curricula also state existing methods of assessment for each competency, so this was reviewed to ensure that the tool complements and enhances what is already in place.

Data from all resources were synthesized, and each skill from the list was considered for inclusion and discussed within the research team, comprising 3 emergency physicians and 2 human factors experts. Once a provisional tool was established, the feasibility of undertaking assessment in the ED was briefly assessed. The process involved following the lead emergency physician for a series of hour-long observations and using the tool to document and rate the observed nontechnical skills. The trial helped determine whether staff found the process acceptable and to check whether a sufficient variety of skills would be observable in a reasonable period.

Phase 2 comprised 2 separate studies, interviews with ED staff, and a series of observations in the ED. Ethical approval was granted by the National Research Ethics Service (UK). Semistructured interviews were conducted with ED medical and nursing staff of various grades as part of a wider study exploring how staff work under pressure.²⁶ A purposive sampling method was used to recruit staff from a single London teaching hospital. Participants were asked to describe positive and negative teamwork behaviors and any effect this had on the team. Staff were also asked to describe an error and make suggestions about

how the team could work together more effectively.

Audiorecorded interviews were anonymized and responses were transcribed verbatim. The transcripts were analyzed to extract quotes that related to nontechnical skills, and these were categorized and coded with the list of 13 nontechnical skills identified in phase 1 (Figure 2). Transcript data were also reviewed to determine whether any additional skills were mentioned by participants that were not included in the coding framework. The coded material was subject to member check to reduce investigator bias, which involved showing participants a summary of how their responses had been coded to ensure that the true meaning was retained.²⁷

A series of field observations, each lasting approximately 1 hour, was undertaken in 2 London EDs. These were both teaching hospitals with annual ED attendances of 70,000 and 98,000. Observations involved a single observer recording extensive, handwritten field notes as she followed the lead physician going about clinical duties. During these observations, only registrars were observed. However, it is logical to expect that a consultant fulfilling this role would require similar skills. In addition to supervisory duties, these physicians also clerked patients and performed the standard clinical tasks of junior emergency physicians. The notes provided details of observed behavior and communication events and documented any perceived errors or examples of substandard practice. The field notes were then typed and analyzed with the same coding method used for the interview study.

With the data gathered from the 2 studies, in addition to evidence from published literature, each skill was again discussed within the research team and reconsidered for inclusion. Factors taken into consideration included the weight of empirical evidence available linking the skill to safety in general and specifically emergency medicine, whether the skill is adequately assessed with existing methods of assessment, and how observable the skill is (both frequency of observation and the degree hidden cognitive processes are involved). If the observer believed a skill should have been observed but was not, eg, a missed teaching opportunity or failure to anticipate a problem, this was documented. Subsequently, if the opportunity to observe a skill occurred in less than 50% of observations, this was deemed insufficient to be included as a separate element in the tool.^{28,29}

Coded interview transcripts and field notes were reviewed by the lead researcher (L.F.) to extract examples of behavioral markers linked to each skill. The research team then met to discuss which markers gave the clearest and broadest description of each skill, and a consensus was reached. This produced a revised version of the assessment tool (version 2).

During Phase 3, content validity of the tool was evaluated. Content validity is the degree to which elements of an assessment instrument are relevant to and representative of the targeted construct for a particular assessment purpose.³⁰ A survey design, in the form of a questionnaire, was chosen because this enables collection of data from a large,

geographically dispersed sample of the target population. A purposive sampling method was used to survey a minimum of 100 emergency staff in the United Kingdom. Though there is no agreed number of participants needed to establish content validity,³¹ a larger sample reduces the effect of agreement caused by chance and ensures that a wide cross-section of staff is included. The survey was distributed to emergency physicians and nurses at various national and regional ED study days and academic meetings after a short presentation focusing on nontechnical skills and safety issues. This provided participants with a conceptual basis for the instrument, which is essential for accurate content review.³²

Participants were asked to read the skill descriptions and behavioral marker statements on the questionnaire and rate each behavior according to how important it is for an emergency physician on a scale of 1 to 5. Thirty-six exemplar behaviors were used in the questionnaire (examples of poor behavior were not included). Respondents were given approximately 15 minutes to complete the questionnaire anonymously, and these were collected as participants left the auditorium. Participants were also encouraged to annotate the list of skills and behaviors with comments, such as ambiguous or unsuitable wording, to help determine item content and style.³² The second part of the questionnaire assessed item comprehensiveness by inviting respondents to make suggestions for skills or behaviors that they believe are important and had not been listed.

Content validity was measured by calculating the content validity index for each item on the questionnaire.³¹ This is the number of participants giving a rating of 4 or 5 ("very important" or "essential") divided by the total number of participants, ie, the proportion in agreement about relevance.³³ There is no consensus about what content validity index value is acceptable for establishing the validity of an item, and it depends on the size of the sample (a smaller sample requires a higher content validity index value). However, Lynn's³⁴ widely cited guidelines state that a content validity index of 0.75 would be considered "excellent," so this was chosen as the cutoff for the purpose of this study. The free-text questions were coded according to themes that emerged from the data rather than a predetermined coding framework. Calculations of content validity index and coding were completed by lead researcher (L.F.), and then the research team reviewed the results to determine how problem items should be revised.

RESULTS

A summary of the main literature search and extraction of data is given in Table E1 (available online at <http://www.annemergmed.com>). A separate review and analysis of existing assessment tools highlighted the complexity of skills such as decisionmaking and situational awareness. In 2 behavioral marker systems,^{10,11} these skills were each divided into 3 or 4 subcomponents, which were assessed separately. The research team agreed that dividing decisionmaking and situational awareness into subskills was also appropriate for emergency medicine. For example, effective decisionmaking in

Table 1. Extracts from the interview study and observational field notes, with corresponding nontechnical skills.

Extract From Interview Study	Coded Nontechnical Skill
"You can admit to your juniors, actually I don't know. What are your thoughts?" Registrar 1	Decisionmaking
"There's one person I've not felt able to approach [to ask questions]. . .because they have a tendency to be quite abrupt in their responses." Junior physician 4	Using authority and assertiveness
"The reg was seeing two patients in resus and he said, 'This patient needs Tazocin [antibiotic].' So that patient got Tazocin, the one he was talking to. Unfortunately he meant the other patient." Nurse 1	Communicating and maintaining standards
Extract from Observational Study	Coded Nontechnical Skill
Checks junior physician is confident aspirating a knee joint	Supervising/assessing capabilities
Overhears paramedic telling nurse in charge about a sick patient they have just brought in and makes inquiries	Situational awareness
Writes illegible drug order so that nurse has to clarify dose	Maintaining standards

the ED requires gathering information, communicating decisions, and reviewing the effect of decisions. Clearly, a physician could be competent in making decisions but fail to adequately communicate this or review the outcome.

The provisional tool comprised 13 skills. This was briefly trialed, and a minimum of 11 of the 13 skills were observed during each 45- to 60-minute assessment period. Staff found the experience acceptable and commented that they thought it was a good idea to get feedback on these types of skills.

Twenty-two interviews were completed, each lasting between 40 and 80 minutes. The sample comprised 4 consultants, 7 registrars, 5 lower-grade physicians, and 6 nurses. Examples of quotes from the interview study and corresponding nontechnical skills are shown in Table 1. The frequency with which interviewees mentioned skills and behaviors related to safety or team functioning are summarized in Table 2. This helped to determine the relative importance of the skills.

A total of 20 observations were carried out and 13 registrars were observed. Extracts from the field notes and coded skills are shown in Table 1. Frequency of observation of skills was not recorded because some skills, eg, communication and decisionmaking, are virtually continuous processes and frequency is not necessarily proportional to importance. Instead,

Table 2. Frequency with which skills are mentioned by interviewees.

Skill	No. of Participants Who Mentioned Skill	Interviews Support Inclusion	Weak Evidence to Support Inclusion
Maintaining standards	11	●	
Decisionmaking	20	●	
Managing workload	23	●	
Communicating	18	●	
Resolving conflict	12	●	
Team building	22	●	
Supporting others	2		●
Teaching and providing feedback	8		●
Using authority and assertiveness	17	●	
Situational awareness	21	●	
Coordinating team members	15	●	
Assessing capabilities/supervising	2		●

field notes were reviewed to extract examples of behavior that either had the potential to or appeared to contribute to errors, safety, or team function.

During the observational study, it became clear that leadership was difficult to isolate as a separate skill. Salas et al³⁵ specified important aspects of leadership, including directing and coordinating the activities of others, assessing team performance, assigning tasks, motivating team members, and organizing and executing management plans. Therefore, good leadership incorporates a number of nontechnical skills such as situational awareness, managing workload, teaching/providing feedback, team building, and decisionmaking. Consequently, leadership was not coded as a separate skill and instead elements of leadership were included in the definitions and behavioral markers for each skill. A summary of the evidence used to determine the skills included in the observational tool is given in Table 3.

Reasons for excluding skills were as follows: (1) the behaviors observed or mentioned in the interviews already fell within the definition of another skill group (for example, evidence of “coordinating the team” involved behaviors that were coded in “managing workload”), or (2) opportunities to display the skill were scarce and there was no strong evidence for inclusion from other sources, ie, literature or interview study (for example, there was insufficient evidence for “resolving conflict” as an independent skill, so it was included in the definition of “using authority and assertiveness”).

Three further skills were considered for exclusion after analysis of the results from the observational study: team building, teaching and providing feedback, and supervising/assessing capabilities. Team building was often not observed as a specific set of behaviors but rather the overall approach of the physician during interactions with the team. Although brief

episodes of teaching were observed, feedback to team members relating to performance was rarely observed. The literature describes the vital importance of debriefing and feedback for calibrating individuals' performance,³⁶⁻³⁹ and the distinct lack of this observed behavior may actually suggest the need for its inclusion. Furthermore, the importance of “shop floor” apprenticeship teaching has been well established,⁴⁰⁻⁴⁴ and this is not currently assessed. Supervision and assessing capabilities involves predominantly cognitive processes, so this skill was difficult to observe. However, there is a strong association between failed supervision and error in the ED, so these skills were merged into a single element, supervising and providing feedback, and teaching was encompassed within the skill definition.

Skills were organized into 4 categories to aid ease of use of the tool, as shown in Figure 3. Although some skills within categories were clearly interrelated, such as the decisionmaking category, other skills were grouped together for pragmatic reasons.

One hundred forty-eight questionnaires were completed at 6 meetings by 65 emergency medicine consultants, 53 trainee registrars, 7 nontraining middle-grade physicians, and 23 senior ED nurses.

Of the 36 behaviors included in the survey, 9 items failed to achieve a content validity index greater than or equal to 0.75 and were therefore revised. In addition, 2 behaviors had more than 4 missing responses, so these statements were also reviewed.

Participants' annotations to the questionnaire were used to help revise problem items with low content validity index or sizeable missing data. For example, 2 participants commented that the term *reprimand* (“Reprimands doctor for illegible notes. . .”) was too severe and this was one of the lowest-scoring behaviors. One participant remarked that it is not always appropriate to disagree with senior colleagues (“States differing opinion to senior colleague regarding patient management plan”), although it may be essential if patient safety is at risk. This potential contradiction may have explained the low response rate on this item. Other comments related to the widespread use of alcohol gel (“Washes hands between patients”) and the view that many of the “anticipating” behaviors seemed to reflect a nurse's role rather than a physician's. A list of original exemplar behaviors and corresponding revised statements is available in Table E2 (available online at <http://www.annemergmed.com>).

Respondents gave 101 suggestions for nontechnical skills or behaviors not listed in the questionnaire. These were analyzed for repetition or grouping and subsequently condensed into 53 potentially relevant behaviors or skills. The research team concluded that all the relevant statements could be categorized into the existing 12 nontechnical skills and there was no major omission in the tool. For example, 7 participants mentioned the importance of trainees taking breaks, and this was incorporated

Table 3. Summary of evidence used to support inclusion in assessment tool

Nontechnical Skill	Literary Search	CEM Curriculum	ARMC Curriculum	Interviews	Observations
Maintaining standards*	●	●	●	●	●
Decisionmaking*	●	●	●	●	●
Managing workload*	●	●	●	●	●
Communicating*	●	●	●	●	●
Resolving conflict		●	●	●	○
Team building*		●	●	●	
Leadership	●	●	●	●	N/A
Supporting others		●	●		
Teaching and providing feedback*	●	●	●		○
Using authority and assertiveness*	●		●	●	●
Situational awareness*	●			●	●
Coordinating team members				●	
Supervising/assessing capabilities	●				○

ARMC, Academy of Royal Medical Colleges; CEM, College of Emergency Medicine.

○ Skills borderline for inclusion.

*Skills included in version 2 of assessment tool.

into the skill “managing workload” and did not reflect the omission of a major skill.

Participant suggestions were used to improve or replace low-scoring behavioral statements. These included comments on clear handover (documented by 2 participants, $n=2$), team leadership in resuscitations ($n=3$), handling interruptions ($n=2$), being aware of their own limitations or admitting they do not know ($n=2$), ensuring that prescribed treatment is administered in an appropriate timeframe ($n=1$), communicating with situation, background, assessment, recommendation (SBAR),⁴⁵ ($n=1$), and identifying a junior physician in difficulty ($n=1$).

Other comments reflected good practice but were not considered nontechnical skills. For example, 7 participants mentioned empathy and 4 wrote compassion. Some comments were disregarded because they were too vague; for example, “promotes team work” or “risk management.” Others were discounted because they are not readily observable, such as skills that rely on cognitive processes (eg, “ability to reflect on own practice”). Remaining comments related to activities already listed in the exemplar behaviors (eg, “maturity in taking advice from nursing staff” is similar to “listens to team members’ input”) or were already included in skill definitions (eg, conflict resolution and prioritizing).

A review of published literature and relevant curricula, interviews, field observations, and a survey of ED staff were used to produce a final version of the behavioral marker system, which is shown in Figure 3.

A 9-point rating scale was chosen for the assessment tool. This was divided into unacceptable (1 to 3), acceptable (3 to 6), and exemplary (7 to 9), as shown in Figure 3. There is a theoretic argument that course scales with fewer points may be less reliable than fine scales, and this has been demonstrated experimentally.⁴⁶ A study comparing mini-clinical evaluation exercise assessments with a 5- and 9-point scale found similar interrater reliability results for the 2 scales.⁴⁷ However, the 9-

point scale appeared to provide more accurate scores for identifying unsatisfactory, satisfactory, and superior scripted levels of competence. Discussion within the research team also highlighted the advantage of using a scale that allowed discrimination between trainees who had marginally poor performance and those who required more serious remedial action.

LIMITATIONS

The initial studies used to inform the development of the assessment tool were based in 2 London teaching hospitals, and it could be argued that this may not be representative of other EDs. However, the validation survey included participants from around the United Kingdom and the literature review included predominantly non-UK studies. Although only 20 hours of observation were undertaken, this was sufficient to detect the key nontechnical skills. A multicenter validation study has been developed to collect more extensive observational data involving both lead and nonlead emergency physicians. Behavioral markers related to poor practice were not included in the validation questionnaire for the sake of brevity. This was the tradeoff for choosing to sample a large number of ED staff rather than a smaller group who were assembled specifically for this purpose. Furthermore, many poor behaviors are simply the absence or opposite of good behavior and, indeed, some observational tools only give exemplar behaviors.^{15,29} However, future studies will validate the tool in its entirety, including newly revised and added markers. There may have been some bias introduced by the sampling method used for the validation study. The participants were largely a self-selected group who attended meetings related to academic emergency medicine and patient safety and may not represent the views of the wider emergency medicine community. However, for validation purposes, the participants are expected to be “subject matter experts,” and this cohort is more likely to have background knowledge of the issues related to assessment of nontechnical

Assessment of EM physicians' non-technical skills			Assessor	Trainee	Date
	Element		Rating	Observations	
Management & Supervision	Maintaining Standards	Subscribes to clinical and safety standards as well as considering performance targets. Monitors compliance.			
	Managing Workload	Manages own and others' workload to avoid both under and over-activity. Includes prioritising, delegating, asking for help and offering assistance.			
	Supervising and Providing Feedback	Assesses capabilities and identifies knowledge gaps. Provides opportunities for teaching and constructive feedback.			
Teamwork & Cooperation	Team Building	Provides motivation and support for the team. Appears friendly and approachable.			
	Communicating Effectively	Gives verbal and written information concisely and effectively. Listens, acknowledges receipt of information and clarifies when necessary.			
	Authority & Assertiveness	Behaves in an appropriately forceful manner and speaks up when necessary. Resolves conflict effectively and remains calm when under pressure.			
Decision-Making	Generating Options	Uses all resources (written and verbal) to gather information and generate appropriate options for a given problem or task. Involves team members in the decision making process.			
	Selecting & Communicating Options	Considers risks of various options and discusses this with the team. Involves clearly stating decisions and explaining reasons, if necessary.			
	Reviewing Outcomes	Once a decision has been made, reviews suitability in light of new information or change in circumstances and considers new options. Confirms tasks have been done.			
Situational Awareness	Gathering Information	Surveys the environment to pick up cues that may need action as well as requesting reports from others.			
	Anticipating	Anticipates potential issues such as staffing or cubicle availability in the department and discusses contingencies.			
	Updating the Team	Cross-checks information to ensure it is reliable. Communicates situation to keep team 'in the picture' rather than just expecting action.			

Unacceptable Standard			Acceptable Standard			Exemplary Standard		
Several examples of poor behaviour or behaviour that directly compromises patient safety			Performance was of a satisfactory standard with mostly good behaviour observed. Standard expected of a competent trainee.			Performance was of a consistently high standard. A model for other team members.		
1	2	3	4	5	6	7	8	9

		Examples of good behaviour	Example of poor behaviour
Management & Supervision	Maintaining Standards	<ul style="list-style-type: none"> Notifies doctor's illegible notes and explains the value of good note keeping Explains importance of ensuring sick patient is stable prior to transfer Ensures clinical guidelines are followed and appropriate pro forma is complete 	<ul style="list-style-type: none"> Fails to write contemporaneous notes Does not wash hands (or use alcohol gel) after reviewing patient Fails to adhere to clinical safety procedures
	Managing Workload	<ul style="list-style-type: none"> Sees a doctor has spent a long time with a patient and ascertains the reason Ensures both themselves and other team members take appropriate breaks Deals with interruptions effectively 	<ul style="list-style-type: none"> Fails to act when a junior is overloaded and patient care is compromised Focuses on one particular patient and loses control of the department Fails to escalate appropriately when overloaded
	Supervision & Feedback	<ul style="list-style-type: none"> Gives constructive criticism to team member Takes the opportunity to teach whilst reviewing patient with junior doctor Gives positive feedback to junior doctor who has made a difficult diagnosis 	<ul style="list-style-type: none"> Criticises a colleague in front of the team Does not adequately supervise junior doctor with a sick patient Fails to ask if junior doctor is confident doing a practical procedure unsupervised
Teamwork & Cooperation	Team Building	<ul style="list-style-type: none"> Even when busy, reacts positively to a junior doctor asking for help Says thank you at end of a difficult shift Motivates team, especially during stressful periods 	<ul style="list-style-type: none"> Harasses team members rather than giving assistance or advice Speaks abruptly to colleague who asks for help Impolite when speaking to nursing staff
	Quality of Communication	<ul style="list-style-type: none"> Gives an accurate and succinct handover of the department Ensures important message is heard correctly Gives clear referral to specialty doctor with reason for admission (e.g. SBAR) 	<ul style="list-style-type: none"> Uses unfamiliar abbreviations that require clarification Repeatedly interrupts doctor who is presenting a patient's history Gives ambiguous instructions
	Authority & Assertiveness	<ul style="list-style-type: none"> Uses appropriate degree of assertiveness when inpatient doctor refuses referral Willing to speak up to senior staff when concerned Remains calm under pressure 	<ul style="list-style-type: none"> Fails to persevere when inpatient doctor refuses appropriate referral Shouts instructions to staff members when under pressure Appears panicked and stressed
Decision making	Option Generation	<ul style="list-style-type: none"> Seeks help when unsure Goes to see patient to get more information when junior is unclear about history Encourages team members' input 	<ul style="list-style-type: none"> Does not look at previous ED notes/ old ECGs when necessary Fails to listen to team members input for patient management Fails to ensure all relevant information is available when advising referral
	Selecting & Communicating Options	<ul style="list-style-type: none"> Verbalises consideration of risk when sending home patient Discusses the contribution of false positive and false negative test results Decisive when giving advice to junior doctors 	<ul style="list-style-type: none"> Uses CDU to avoid making treatment decisions Alters junior doctor's treatment plan without explanation Forgets to notify nurse-in-charge of admission
	Outcome Review	<ul style="list-style-type: none"> Reviews impact of treatment given to acutely sick patient Follows up with doctor to see if provisional plan needs revising Ensures priority treatment has been given to patient 	<ul style="list-style-type: none"> Fails to establish referral outcome of complicated patient Sticks rigidly to plan despite availability of new information Fails to check that delegated task has been done
Situational Awareness	Gathering Information	<ul style="list-style-type: none"> Uses Patient Tracking System appropriately to monitor state of the department 'Eyeballs' patients during long wait times to identify anyone who looks unwell Notifies doctor has not turned up for shift 	<ul style="list-style-type: none"> Fails to notice that patient is about to breach and no plan has been made Ignores patient alarm alerting deterioration of vital signs Fails to notice that CDU is full when arranging new transfers
	Anticipating	<ul style="list-style-type: none"> Identifies busy triage area and anticipates increased demand Discusses contingencies with nurse-in-charge during periods of overcrowding Prepares trauma team for arrival of emergency patient 	<ul style="list-style-type: none"> Fails to anticipate and prepare for difficulties or complications during a practical procedure Fails to ensure that breaks are planned to maintain safe staffing levels Fails to anticipate and plan for clinical deterioration during patient transfer
	Updating the Team	<ul style="list-style-type: none"> Updates team about new issues such as bed availability or staff shortages Keeps nurse-in-charge up to date with plans for patients Communicates a change in patient status to relevant inpatient team 	<ul style="list-style-type: none"> Notifies the long wait but fails to check the rest of the team is aware Fails to inform team members when going on a break

Figure 3. A tool for the assessment of emergency physicians' nontechnical skills. SBAR, Situation, background, assessment, recommendation.

skills. Despite these limitations, this study achieved the Grant and Davis³² recommendations for establishing content validity by assessing item content, item style, and comprehensiveness.

DISCUSSION

To the best of our knowledge, this is the first time a behavioral marker system has been developed that comprehensively assesses the nontechnical skills required by emergency physicians. More thorough investigation involving different contexts and roles is needed, as well as consideration of how this may translate internationally, before widespread implementation is possible. However, this provides a vital starting point to take assessment of nontechnical skills out of the simulator and into the wider ED setting.

Historically, training in nontechnical skills has been informal and haphazard, and many experienced ED staff have acquired these skills through trial and error. Identification of the core emergency medicine nontechnical skills will facilitate a more structured approach to training and assessment. This tool has been designed for use in formative assessment: to promote reflection, guide future learning, and monitor progress.⁴⁸ Encouraging staff to pause and reflect on their performance of nontechnical skills is particularly important in the fast-paced ED. Formal assessment is also important because there is evidence that physicians have limited ability to self-assess competence,⁴⁹ and this is likely to be exaggerated for interpersonal skills such as team building and communication. Formative assessment is integral to medical education because it reinforces the motivation to learn and can encourage professional development.⁵⁰ Unlike other behavioral marker systems that have primarily been tested for use in the simulator,^{8,10} this tool is designed for use as a workplace-based assessment, which is beneficial because assessments of actual practice are considered a much better reflection of routine performance than those performed under artificial test conditions.⁵¹

The practical applications of this assessment tool are wide and varied. The tool was originally designed for direct observation and assessment of a trainee's nontechnical skills in the workplace during a 1-hour period. Like other workplace-based assessments, multiple assessments undertaken by a variety of assessors are likely to be necessary to obtain adequate levels of reliability^{52,53} and to fully capture all skills. This supposition will be fully investigated in subsequent studies. Ideally, assessments should be completed before and after training to chart an individual's progress and to indicate the effectiveness of a training program.

It is essential that every assessment be followed by a thorough debriefing session, which not only enables assessors to provide valuable feedback but also encourages individuals being assessed to reflect on performance and discuss the reasoning behind observed behaviors. Although the observational study used to develop the tool focused on emergency medicine registrars, the skills described would be

applicable to both registrar and consultant physicians and are likely to cover the skills needed by junior medical staff. Currently within the United Kingdom, only trainees undertake workplace-based assessment, but with the introduction of revalidation, all qualified physicians will soon be required to seek feedback from colleagues about performance. Peer assessment of nontechnical skills at both a registrar and consultant level may be a possibility.

The tool could also be used to observe a trainee for a shorter period by targeting specific events such as a senior physician reviewing a junior physician's patient management plan. The tool could be used during teaching sessions to structure discussion around actual or hypothetical clinical scenarios and clinical incidents. Additional research is needed to evaluate the tool in the simulator environment; however, it appears to have good face validity for this use. Although further evaluative studies will determine acceptability and reliability, development of this behavioral marker system provides an important step toward improving nontechnical skills and safety in the ED.

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Table E1. Data extracted from the literature review.

Non-technical skills identified in the ED literature												
Ref.	Study design	Country	Sample	Communicating	Managing Workload	Anticipating	Situational Awareness	Supervising & Providing Feedback	Leadership	Maintaining Standards	Using Assertiveness	Decisionmaking
Andersen (2010)	Critical Incident Analysis	Denmark	122 critical incidents	Communication			Patient monitoring/ observation		Leadership			
Andersen (2010)	Interview	Denmark	11 ATLS instructors	Closed-loop communication	Avoid task overload				Identifiable leader Hand-off	Maintaining standards & guidelines	Assertion	Team decision-making
Apker (2007)	Interviews	USA	12 interviews	Handover/ expectations								
Beach (2003)	Case study	USA	N/A	Team transitions			Team situational awareness					Diagnostic error/ cognitive bias
Boreham (2000)	Observation & critical incident analysis	UK	30 months								Authority gradients	Cognitive errors
Brodie (2009)	Failure modes and effects analysis	UK	16 multi-disciplinary interviews						Identifiable leader			
Campbell (2007)	Case study	USA	N/A	Team transition							Authority gradients	Cognitive error
Cosby (2008)	Critical incident analysis	USA	636 cases	Communication Shift handover				Failure to supervise			Authority gradients	Medical reasoning
Eisenberg (2005)	Observation	USA	1 year	Handover/team transition							Hierarchy	
Elshove-Bolk (2004)	Claims analysis	Netherlands	256 claims					Supervision				Diagnostic error Cognitive error
Famularo (2000)	Critical incident analysis	Italy	4 cases									
Fernandez (2008)	Focus group	USA	ED staff	Closed-loop communication	Back-up behavior Coordinating activities	Planning	Patient monitoring System monitoring Team cognition	Debrief	Leadership			
Fordyce (2003)	Observational & interview	USA	7 days 346 errors	Communication								Diagnostic error
Hamman (2010)	Scenario Simulation	USA	1 simulation	Handover								
Henneman (2006)	Focus groups	USA	20 ED nurses									
Hicks (2008)	Survey	Canada	84 ED doctors & nurses	Communication	Prioritizing Coordinating team actions							
Hoff (2008)	Observations & Interviews	USA	ITU, surgical & EM teams		Workload Interruptions							
Horwitz (2009)	Survey	USA	139 respondents 40 errors	Handover	Workload						Professional conflict	Diagnostic error Incomplete info
Kachalia (2007)	Claims review	USA	122 claims	Handover	Workload			Supervision				Cognitive errors
Kennedy (2009)	Observations & interviews	Canada	88 EM & internal medicine trainees		Workload							Asking for help
Kaissi (2003)	Survey	USA	261 ED, ICU and OR nurses	Communication					Debrief		Identifiable leader	Assertiveness Conflict resolution
Kilroy (2006)	Critical Incident Analysis	UK	18 EM consultants & trainees						Supervision			Team input in decision-making
Laxmisan (2007)	Observation & interviews	USA	3 months			Interruptions Multi-tasking						Cognitive error
Lubbert (2009)	Observation	Holland	387 trauma videos				Patient supervision		Identifiable leader	Following protocol		
Magid (2009)	Survey	USA	3562 ED doctors & nurses	Shift handover	Dealing with interruptions							
Redfern (2009)	Failure modes and effects analysis	UK	N/A	Shift handover/ team transition								

Table E1. Continued

Non-technical skills identified in the ED literature

Ref.	Study design	Country	Sample	Communicating	Managing Workload	Anticipating	Situational Awareness	Supervising & Providing Feedback	Leadership	Maintaining Standards	Using Assertiveness	Decisionmaking
Risser (1999)	Critical incident analysis	USA	54 critical incidents	Communicate plans Check back communication	Cross-monitor actions of team Prioritize Assign roles		Monitor execution of plan (maintain S.A)				Assert a position Apply 2 challenge rule	Offer/seek info. for decision-making Develop/execute a plan
Schenkel (2003)	Critical Incident interviews	USA	16 medicine, surgical & obstetric trainees					Supervision Feedback				Diagnostic error
Simmons (2010)	Focus group	USA	19 NICU and ED nurses	Communication	Back up behavior		Shared mental models		Leadership		Conflict resolution	
Stella (1996)	Critical incident analysis	Australia	112 incidents	Communication				Supervision				Diagnostic error
Wears (2002)	Case report	USA	Single case report		Interruptions	Anticipation	Situational awareness	Supervision				
White (2004)	Review of claims	USA	74 claims	Communication				Supervision		Documentation Failure to follow procedures		Diagnostic error

Data extracted from 32 papers

Table E2. Original and revised behavioral marker statements.

Skill	Original Behavior Statement *Low response rate (>4 missing values) <0.75		CVI	Revised Behavior Statement
	CVI ≥0.75	CVI		
Maintaining Standards	● Reprimands doctor for illegible notes and explains value of good note keeping		0.61	● Notices doctor's illegible notes and explains the value of good note-keeping
	● Explains importance of ensuring sick patient is stable rather than moving patient for sake for organisational reasons		0.98	
	● Washes hands between patients		0.86	
Managing Workload	● Identifies that SHO has spent a long time on a patient and ascertains the reason		0.79	● Ensures both themselves and other team members take appropriate breaks
	● Practices back-up behaviour (eg, does a set of observations) when nurse is busy		0.55	
Supervising & Providing Feedback	● Escalates to consultant when overloaded		0.88	● Deals with interruptions efficiently
	● Gives constructive criticism to team member		0.82	
	● Takes opportunity to teach whilst reviewing patient with junior		0.76	
	● Gives positive feedback to junior who has made a difficult diagnosis		0.88	
Team Building	● Reacts in a friendly way to SHO asking for help even though they are busy		0.93	● Motivates team, especially during stressful periods
	● Says thank you at end of shift		0.78	
	● Motivates team to work faster during periods of high workload		0.70	
Communicating Effectively	● Gives succinct clinical history when requesting radiological investigation		0.74	● Gives and accurate and succinct handover of the department
	● Acknowledges and repeats message to ensure understanding		0.75	
	● Gives clear referral to speciality doctor with reason for admission*		0.86	
Using Authority & Assertiveness	● Uses appropriate degree of assertiveness when speciality refuses referral		0.88	● Ensures important message is heard correctly
	● States differing opinion to senior colleague regarding patient management*		0.79	
Generating Options	● Remains calm under pressure		0.98	● Gives clear referral to speciality doctor with reason for admission (eg, situation, background, assessment, recommendation)
	● Checks that the patient's carer has been involved when discussing discharge plan		0.69	
	● Goes to see patient to get more information when doctor is unclear about history		0.93	
Selecting & Communicating Options	● Listens to team member's input		0.93	● Motivates team, especially during stressful periods
	● Verbalizes consideration of risk when suggesting sending home elderly patient		0.81	
	● Decisive when giving advice to juniors		0.84	
	● Discusses plan for patient with SHO and explains reasons for change in management plan		0.91	

Table E2. Continued.

Skill	Original Behavior Statement *Low response rate (>4 missing values) <0.75 CVI ≥0.75 CVI	CVI	Revised Behavior Statement
Reviewing Outcomes	● Seeks out doctor after seeing patient to see if provisional plan needs revising	0.75	● Ensures priority treatment is given to patient
	● Assesses outcome of moving doctor from majors to minors to relieve waiting time	0.68	
	● Reviews impact of treatment on acutely sick patient	0.95	
Gathering Information	● Checks team members all turn up for shift at correct times	0.79	● Uses Patient Tracking System to monitor the state of the department
	● Eyeballs patients in cubicles when long wait to check for anyone who looks unwell	0.86	
	● Calls mini-board round to get update on patients when department busy	0.73	
Anticipating	● Identifies that there are lots of patients with injuries waiting to be triaged and allocates extra doctor to minors	0.75	● Identifies busy triage area and anticipates increased demand
	● Recognises that Majors is almost full and discusses plan with NIC to clear cubicles	0.90	● Discusses contingencies with nurse-in-charge during periods of crowding
	● Asks for side room early for patient who may be admitted with infective diarrhoea	0.72	● Prepares trauma team for arrival of emergency patient
Updating the Team	● Updates team about waiting time	0.52	● Communicates a change in patient status to relevant speciality doctors
	● Keeps nurse-in-charge up to date with plan for patients	0.91	
	● Communicates to team any new issue such as a doctor calling in sick	0.83	

CVI, Consensus validity index.