

Factors influencing anaesthesiologists perceived usefulness of ACRM (Anaesthesia Crisis Resources Management) key points after a combined ACLS (AHA)-ACRM simulation training

DE BIASI FABRIZIO¹, OLIVEI MADDALENA CARLOTTA¹, VERGALLO ALESSANDRO², FIORE GILBERTO³, BALAGNA ROBERTO⁴, DONATO PAOLO⁵, CRISTOFOLI LORIS⁶, CAIRONI PIETRO¹, MARINANGELI FRANCO⁷

¹M.D., SCU Anestesia Rianimazione, AOU S. Luigi Gonzaga, Orbassano (Torino), Italy; ²M.D., SC Anestesia e Rianimazione ASTT Spedali Civili di Brescia, Brescia, Italy; ³M.D., SC Anestesia e Rianimazione Ospedale di Moncalieri e di Carmagnola (Torino), Italy; ⁴M.D., SC Anestesia e Rianimazione 2 Ospedale Molinette, Torino, Italy; ⁵M.D. SCU Anestesia e Rianimazione AOU Maggiore della Carità di Novara (Torino), ITALY; ⁶M.D., SC di Anestesia e Rianimazione AO Di Venere, Bari, Italy; ⁷M.D., SCU Anestesia Rianimazione AOU University of L'Aquila, Dipartimento di Anestesia e Rianimazione, L'Aquila, Italy.

Corresponding author: M.D. Fabrizio De Biasi, SCU Anesthesiology and Intensive Care, Hospital-University Company San Luigi Gonzaga, Gonzole Region, 10 – cap :10043 Orbassano, Turin, Italy. E-mail: fabrizio_debiasi@yahoo.it

Abstract

Background: The factors that may contribute to learners' perception about the usefulness of Anaesthesia Crisis Resource Management (ACRM) key points are little known.

Objectives: We investigated the link between demographic factors and the effect of an ACRM simulation training on anaesthesiologists' perceived value of ACRM key points.

Design: A prospective pre- and post-test survey from December 2017 to December 2019 of 111 anaesthesiologists involved into a combined ACRM-ACLS course in a simulation centre.

Methods: Before and after the course participants were asked to indicate which were, in their opinion, the 5 ACRM key points most relevant for managing an anaesthetic emergency. No taxonomy tool of the 15 ACRM key points was used for teaching purposes.

Main outcome measures: Pre-/post-course differences in participants' subjective choices were connected by logistic regression analysis with demographic factors which included age, gender, years of work as anaesthesiologist, the amount of updating exposure, and familiarity with ACRM.

Results: In median participants (47 M/64 F) had an age of 42 years (IQR 34-55 years), and 10 years working experience as anaesthesiologists (IQR 4-20 years). Around 20% of them had never heard of ACRM prior to this course. Communication was selected by up to 75% of participants without pre-/post-course differences. Although the other 4 ACRM points remained heterogeneously selected even after the course, we observed post-course vs pre-course increase in the selection rate of the ACRM points that address leadership, correct distribution of workload and utilization of all available resources. Among participants' characteristics, the lack of familiarity with ACRM was the only significant predictor of the number of pre- to post-course changes in ACRM key points selection (OR=3.03, CI 95% 1.04 -9.09; p=0.0418).

Conclusions: The familiarity with ACRM should be considered when planning ACRM training, especially in cases where the ACRM training is not yet part of a formal education in anaesthesia.

Keywords: Non-technical skills, Anaesthesia Crisis Resource Management (ACRM) key points, Anaesthesiology, Framework, Perceived usefulness.

Introduction

The effective and successful management of an anaesthetic emergency requires expertise in the integrated use of technical skills (TS) and non-technical skills (NTS). NTS training was recently

incorporated in the Advanced Cardiovascular Life Support (ACLS) course¹. The ACLS and Anaesthesia Crisis Resource Management (ACRM) combination courses are an example of integrated ACLS training with attention to both TS and NTS. Simulation is the most effective way to develop

NTS, and the ACRM is a worldwide adopted simulation-based training program that specifically addresses NTS for anaesthesia emergencies²⁻⁴. The NTS the ACRM program focuses on are summarised in the 15 ACRM key points, which are listed in Table I. Since its introduction in 1991 by Gaba and colleagues, the ACRM program has undergone different adaptations, and courses may vary in structure, assignments, and interactions between providers and instructors. Also, the 15 ACRM key points have been steadily updated and expanded over time. The perceived usefulness of ACRM key points is considered a surrogate measure of the benefits of ACRM courses in clinical practice⁵⁻⁶. Understanding factors that might influence the perceived importance of different ACRM key points is of interest as this kind of variance could influence the effectiveness of an ACRM training program. Data in literature indicate that perceptions about the relative importance of different NTS within healthcare are not homogeneous, and that demographic factors might affect how NTS are valued in anaesthesia settings⁷⁻⁸. There is evidence that the perceived usefulness of ACRM key points can differ on a country-by-country basis according to cultural and organizational characteristics⁸. So far, only a few studies have explored which demographic factors affect ACRM training outcomes related to the participants' perceived usefulness of ACRM key points. In a study-survey, female participants were more likely to rate communication as important⁹, while there were no age and years of working experience differences in the same and in another

survey^{5,9}. These surveys were both cross-sectional studies and focused on the participants' perceived usefulness of NTS after an ACRM course, without considering participants' pre-course perceptions on NTS. Moreover, they did not mention whether grouping/hierarchization systems of ACRM key points were used to organize teaching, which might have affected the results. The present survey investigates the influence of demographic factors on the learners' perception about the importance of ACRM key points, using a longitudinal study design. To this end, we asked the anaesthesiologists involved in a short combined ACLS-ACRM course to indicate which were in their opinion the 5 ACRM key points most relevant for the management of an anaesthetic emergency out of the 15 ACRM key teaching points. We looked at whether those participants' subjective choices differed before and after the training, and assessed the potential influencing effect of demographic factors, focusing on age, gender and four professional background factors, the years of work as an anaesthesiologist, level of expertise, the amount of exposure to voluntary professional update courses in the last three years, and the familiarity with ACRM before the course. In the course editions included in this survey we deliberately delivered teaching without using classification systems of the 15 ACRM key points, since these tools may have represented a potential confounder.

Table I. — List of the 15 Anaesthesia Crisis Resource Management (ACRM) key points devised by Gaba.

Anaesthesia Crisis Resource management (ACRM) Key points
1. Know the environment
2. Anticipate and plan.
3. Call for help early.
4. Exercise leadership and followership.
5. Distribute the workload.
6. Mobilize all available resources.
7. Communicate effectively.
8. Use all available information.
9. Prevent and manage fixation errors.
10. Cross (double) check.
11. Use cognitive aids.
12. Reevaluate repeatedly.
13. Use good teamwork.
14. Allocate attention wisely.
15 Set priorities dynamically.

Materials and methods

This prospective pre- and post-test survey was conducted on 111 anaesthesiologists who received one-day and a half combined ACRM-ACLS training in a permanent simulation centre between December 2017 and December 2019.

The course entailed the following: I a presentation on the theory of ACRM and ACLS, and ii 3 simulation-based practice sessions during which participants performed ACLS scenarios recommended by AHA for ACRM courses. All scenarios had a predefined sequence of when and how for the evolution of the crisis situation and were comparable in terms of complexity of TS and NTS skills. The responses to predicted therapeutic interventions were also standardized. Instructor-facilitated debriefing was performed after each scenario according to the “structured and supported method” developed by AHA.

In the teaching of the ACRM key points we deliberately avoided the use of the classification systems available in literature, which may have represented a confounding factor. In order to compensate for this potential limitation of our

course, the debriefing included the sharing of participants' individual viewpoints on the meaning of each of the 15 ACRM key points, as proposed by Gaba¹⁰.

The participants, who all had a 100% attendance rate to the scheduled activities, were asked before and after the course to select among the 15 ACRM key teaching points the 5 ACRM points that they considered most relevant for the management of anaesthesia emergencies. We did not require to build a hierarchy of these 5 ACRM key points. The list of the questions asked in pre-and post-course questionnaires is provided in Appendix 1. The first survey data set was obtained from a questionnaire that was posted together with self-study documents about ACRM, and that included demographic survey questions. The participants were asked to answer this questionnaire using only a card that listed the 15 ACRM key-points, and before reading the documentation about ACRM self-study. The second survey data set was included in the post-training satisfaction questionnaire and was filled by participants less than one hour after completing the final examination test. Participants had no possibility to gain access to any type of

reminders about the 15 ACRM key-points and were not informed of the existence of the post-course survey until just before the post-course survey was administered.

Both questionnaires identified the respondent in anonymised form. Participation to the survey was voluntary and written informed consent was obtained from each participant.

According to Italian law ethical approval is not required for non-interventional studies as the present survey study, as confirmed by our institutional ethics committee (Comitato Etico Interaziendale San Luigi Gonzaga, A.O.U. San Luigi Gonzaga, Orbassano (TO), Chairperson Prof. A. G. Piga; Protocol N. 221/2021).

Data collection survey consisted of the participants' selection of 5 out of 15 key ACRM points before and after the ACRM training, demographic data, including age, years of work as anaesthesiologist, level of expertise (based on the years of work in anaesthesia), preexisting ACRM knowledge, educational sources on ACRM prior to the course, and number of practice and theory courses in anaesthesia/critical care in the last 3 years.

Appendix 1

Appendix	
PARTICIPANTS' PRE-COURSE QUESTIONNAIRE	
We kindly ask you to fill the present form before reading the self-study course material and to return it at the course start day. All data contained in this form will be anonymized and used for an Evaluation Survey of the ACRM (Anaesthesia Crisis Resource Management) component of this course. We thank you in advance for the time you take to answer this survey!	
Age	_____
Sex	<input type="radio"/> male <input type="radio"/> female
Job position	<input type="radio"/> Anaesthesiology resident <input type="radio"/> Anaesthesiologist <input type="radio"/> Senior Anesthesiologist (>25 years of work as an anaesthesiologist)
Number of years of work as an anaesthesiologist	_____
Hospital working environment	<input type="radio"/> academic hospital <input type="radio"/> non-academic hospital
Familiarity with the ACRM principles	<input type="radio"/> yes <input type="radio"/> no
Educational sources on ACRM prior to the present course	<input type="radio"/> Ad hoc-designed simulation training <input type="radio"/> Didactic lectures <input type="radio"/> Knowledge sharing in the workplace
Number of update theory courses in anaesthesia/critical care in the last 3 years	_____
Number of update practical courses in anaesthesia/critical care in the last 3 years	_____
Course participation fee self-sponsored	<input type="radio"/> yes <input type="radio"/> no
Please select from the table below the 5 ACRM key points that you consider most important for managing anaesthetic emergency (indicate only point number, no prioritization required).	ACRM key point n° _____ ; ACRM key point n° _____ ; ACRM key point n° _____ ; ACRM key point n° _____ ; ACRM key point n° _____ ;
The 15 Anaesthesia Crisis Resource Management (ACRM) key points define the non-technical skills required for the successful running of an anaesthesia emergency and are listed in the table below.	
Anaesthesia Crisis Resource management (ACRM) Key points	
<ol style="list-style-type: none"> 1. Know the environment. 2. Anticipate and plan. 3. Call for help early. 4. Exercise leadership and followership with assertiveness. 5. Distribute the workload. 6. Mobilize all available resources. 7. Communicate effectively-speak up. 8. Use all available information. 9. Prevent and manage fixation errors. 10. Cross check and double check (never assume anything). 11. Use cognitive aids. 12. Reevaluate repeatedly. 13. Use good teamwork-coordinate with and support others. 14. Allocate attention wisely. 15 Set priorities dynamically. 	
Surname: _____	Name: _____

Statistical analysis

The open-source software package R was used for all the statistical analysis. Continuous variables were evaluated for a normal distribution using the Kolmogorov-Smirnov test. Parametric variables were expressed as mean and standard error (SE), nonparametric variables as median and interquartile range (IQR) and categorical variables as counts and percentages. The McNemar's test was used to compare the 2 proportions in which each ACRM key point was selected before and after the course respectively. Then, all continuous variables (which included the number of changes in ACRM key points selection, age, years of work in anaesthesia, ACRM knowledge prior to the course and number of practice and theory courses in anaesthesia/critical care in the last 3 years) were dichotomized around their median value. Variables explaining the number of changes in ACRM key points selection were assessed by the Fisher's exact test on univariate analysis. Thereafter, odds ratios with 95 % confidence interval were computed by binomial logistic regression. All reported P-values were two-sided and $P < 0.05$ was considered to indicate statistical significance.

Results

Participants' characteristics are listed in Table II. In median participants (47 M/64 F) had an age of 42 years (34-55 years), and 10 years of work as

an anaesthesiologist (4-20 years). Nearly 90% of participants were certified anaesthesiologists, with more than > 25 years of work as anaesthesiologist in 17% of cases. All anaesthesia residents in this survey were in their fourth year of anaesthesia residency. During the last 3 years all participants had attended at least 1 non-mandatory course both theoretical 1-4 and practical 1-3 on contents specific to anaesthesia/critical care, in addition to the continuing medical education (CME) program mandatory in Italy. However, 24 participants had never heard of ACRM prior to this training course. Figure 1 shows in what percentage the participants included each of the 15 ACRM points in their 5 points selection before and after the course. ACRM point 7 (i.e., communicate effectively) was the most frequently selected ACRM key point both before and after the course with a selection rate up to 75% of course participants. In contrast, the ACRM concerning information collection and analysis, namely points 8, 10, 11, 14 and 15, were selected by 20% or even less of course participants, and this percentage did not change after the course. The percent selection of the remaining 9 ACRM was heterogeneously distributed in the range 21-74% without significant pre-/post-course differences but for 5 ACRM key points. ACRM points 1 (knowledge of environment) and 3 (early call for help) were significantly less selected after the course while there was an increase in the choice of points 4, 5 and 6, that address role clarity, correct distribution of workload and utilization of all available resources, respectively.

Table II. — Descriptive statistics for characteristics of study participants. Values are number (proportion), median and IQR.

Variable	Total group (n=111)
Sex, n (%)	
Female	64 (58%)
Male	47 (42%)
Age, (yr) (median/IQR)	42 (34-55)
Years of work as anaesthesiologist, n (median/IQR)	10 (4-20)
Expertise level based on years of work in anaesthesia, n (%)	
Anesthesiology resident	12 (11%)
Anesthesiologist	80 (72%)
Senior anesthesiologist (>25 years of work as an anaesthesiologist)	19 (17%)
Familiarity with Anaesthesia Crisis Resource Management (ACRM), n (%)	
Yes	87 (78%)
No	24 (22%)
Prior educational sources on ACRM	
Ad hoc-designed simulation training	70 (81%)
Didactic lectures	9 (10%)
Knowledge sharing in the workplace	8 (9%)
Update courses in anaesthesia/critical care in the last 3 years, n (median/IQR)	
Theory course	2 (1-4)
Practical course	2 (1-3)

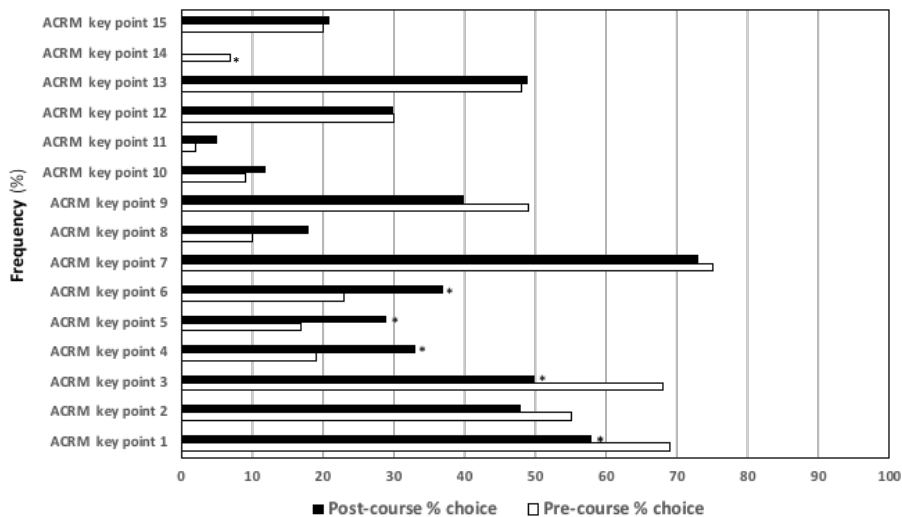


Fig. 1 — Comparison of pre- and post-course frequency by which each of the 15 Anaesthesia Crisis Resource Management (ACRM) key points was selected by the 111 course participants. (* = $p < 0.05$)

List of the 15 ACRM key points devised by Gaba: 1. Know the environment; 2. Anticipate and plan; 3. Call for help early; 4. Exercise leadership and followership; 5. Distribute the workload; 6. Mobilize all available resources; 7. Communicate effectively; 8. Use all available information; 9. Prevent and manage fixation errors; 10. Cross (double check); 11. Use cognitive aids; 12. Re-evaluate repeatedly; 13. Use good teamwork; 14. Allocate attention wisely; 15. Set priorities dynamically.

Figure 2 shows how many changes were involved from the pre-course to the post-course selection of the 5 most relevant ACRM points. In median participants changed 2 ACRM points (range 0-4).

Among the participants' characteristics listed in Table III, the lack of familiarity with ACRM was the only predictor of >2 changes in ACRM points selection on univariate analysis ($p = 0.0386$). This result was also confirmed on multivariate analysis by binary logistic regression (OR=3.03, CI 95% 1.04 -9.09; $p = 0.0418$). Therefore, the lack of knowledge of ACRM prior to the course was significantly associated with increased odds of changes from the pre-course to the post-course selection of ACRM key points.

Discussion

This survey shows an association between the familiarity with ACRM prior to taking the course and the effect of the course on the participants' perception of the usefulness of ACRM key points. In particular, course participants without pre-existing knowledge of ACRM were those more likely to modify their selection of the 5 most clinically relevant ACRM key points after the course.

This result suggests that a lack of familiarity with ACRM may have impact on the effectiveness of an ACRM teaching intervention.

Different studies have underlined the importance of differentiating the teaching of NTS for undergraduated students and for anaesthesiologists with different years of postgraduate training^{11,12}. In

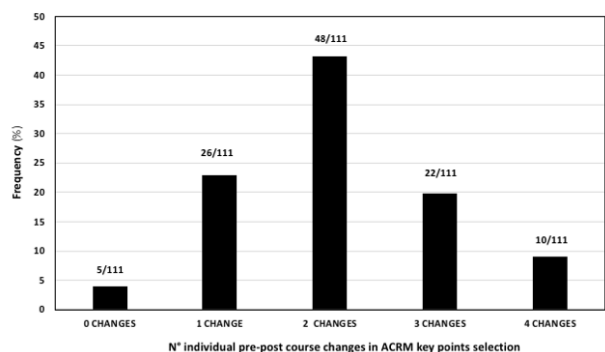


Fig. 2 — Frequency distribution of pre- to post-course number of changes in participants' selection of the 5 most relevant Anaesthesia Crisis Resource Management (ACRM) key points (ratios above each column indicate number of participants of each class on the total population).

contrast, it has not been established whether and how the degree of familiarity with ACRM principles should be taken into account in ACRM programs for certified anaesthesiologists, at least in countries as Italy where the ACRM training is still nonmandatory. About 20% of our course participants had no prior knowledge of ACRM principles, despite the fact that all of them had a working experience in anaesthesia settings of at least 4 years, a valid BLS certification, and a satisfactory exposure to non-mandatory professional updating in the last 3 years, in addition to mandatory continuous medical education. ACRM learning methods are more likely to vary when the ACRM training is not part of the formal education in anaesthesia. In our study participants' knowledge of ACRM prior to the course was obtained through simulation courses in 80% of cases, and through

Table III. — Factors affecting pre- to post-course selection of Anaesthesia Crisis Resource Management (ACRM) key points on univariate analysis. (* = $p < 0.05$).

Variable	Participants changing >2 ACRM points (n=32)	Participants changing £2 ACRM points (n=79)	p value
Age>42 years	15/32	39/79	0.4010
Female gender	21/32	43/79	0.2818
>10 Years of work in anaesthesia	16/32	42/79	0.7634
Preexisting familiarity with ACRM	21/32	66/79	0.0386*
>2 Theory courses in the last 3 years	13/32	36/79	0.6362
>2 Practice courses in the last 3 years	15/32	40/79	0.8120

potentially less effective learning methods, such as didactic lectures and informations sharing among colleagues, in the remaining 20% of cases.

A practical implication of this survey's results is that in cases where the ACRM training is not yet part of a formal education in anaesthesia, even ACRM courses directed to certified anaesthesiologists should consider the degree of familiarity with ACRM principles, and targeted ACRM teaching should be planned accordingly.

Our course increased the participants' awareness on the importance of ACRM points that address task management and teamworking, especially with respect to utilization of all available resources, role clarity and adequate distribution of workload. In contrast, the course did not affect the ACRM points with either the highest or the lowest rate of pre-course selection, namely communication (highest) and ACRM key points addressing information collection and analysis, (lowest). We speculate that participants gave least priority to information management skills since they viewed these latter as general skills relevant to most operational domains. Most of our participants, regardless of their different demographic characteristics, recognized the centrality of communication among NTS. Consistently with our findings, in two previous study-surveys, the numbers of years of working experience as anaesthesiologist did not play a significant role in influencing the perceived usefulness of communication^{5,9}. On the contrary, gender was an influencing factor in one of these two surveys⁹ but not in ours. These differences in results suggest that the influence of participants' characteristics on the perceived usefulness of ACRM key points might not be generalizable and may be population-dependent.

Based on this consideration, any training needs analysis performed prior to an ACRM teaching intervention should include data on the participants' perception about the usefulness of the ACRM key points, as this information can help instructors to make intentional adjustments to meet course objectives effectively.

The results of the present survey indirectly highlight the importance of ACRM classifications tools for the ACRM teaching. Indeed, our deliberate lack of use of ACRM classification systems might explain, at least partly, why our course reduced, but it did not eliminate the discrepancies in the participants' selection of ACRM key points, with the exception of communication. The NTS that are at the heart of ACRM training can be grouped differently, based on different goals such as teaching, evaluation, performance markers¹³. Regardless of the typology, the ACRM taxonomy tools are not intended as a simple way to ensure delivery of essential information, but rather as a way to provide a logical structure for the decision-making process during anaesthesia emergencies. The Anaesthetists' Non-Technical Skills (ANTS) systems is the most frequently classification tool used for teaching and evaluating the ACRM in the anaesthesia settings, although its role has not yet been formally recognized^{14,15}. Recent works highlight the concept that NTS frameworks should be incorporated into learning models, rather than used as separate educational tools¹⁶. Based on this notion, the SECTOR model has been recently introduced for the interdisciplinary learning of NTS in healthcare¹⁷. Although the initial results are promising, the reliability and feasibility of the SECTOR model have not been established yet, as well as when and how this tool can be integrated with the available anaesthesia frameworks of NTS.

There are design and methodological limitations to this study that are important to keep in mind.

The perceived usefulness of an ACRM intervention is generally assessed via a subjective scale, such as a Likert scale¹⁸. Instead of using this tool, we asked the participants to select the 5 ACRM key points most important for their practice both before and after the course without any type of ACRM recall. Although nonstandard, this approach has given us also some insight into which ACRM key points participants were more likely to retain. Perhaps even more importantly, regardless of the tool used to assess the participants' perceived

usefulness of ACRM, baseline and postintervention assessments should be ideally performed to obtain maximum information from this learning outcome.

Learners' perception about the usefulness of ACRM is only one of the triad of outcomes in a NTS intervention and does not predict actual learning of ACRM^{18,19}. In this survey we did not assess whether the ACRM points considered most important by participants were also those better applied during simulation training sessions, and whether the lack of use of NTS taxonomy tools impacted on actual performance.

Finally, we analyzed only a limited number of factors among those that might relate to the effect of our course on learners' perception of the ACRM key points. Among the covariates analysed in this study we did not include the participants' type of hospital (academic versus non-academic), because the surveyed participants working in an academic hospital were underrepresented (data not shown). Moreover, the lack of ACRM training in formal Italian academic curricula results in a heterogeneous offer of NTS education among Italian academic hospitals,

making it difficult to establish the potential source of bias that arises from the work environment. The need for alignment of curricula learning objectives of NTS has been highlighted by a recent review that shows the actual lack of consistent definition and operationalisation of NTS in medical education²⁰.

Also, we did not consider potential discrepancies on the perceived usefulness of NTS linked to learners' affective, cognitive and psychological dimensions. Although a study on medical students did not detect a correlation between personal motivation and performance of NTS²¹, results may differ depending on specialty degree (anesthesiology residents, anaesthesiology physicians) and on the initial motivation.

In conclusion, our surveyed population highly valued communication among ACRM key points, without pre-/post-course differences. The course increased the awareness of the importance of task management and teamwork skills, while participants' consideration of the remaining ACRM key points remained either heterogeneous or low. Lack of preexisting familiarity with ACRM was the only

Appendix 2

PARTICIPANTS' ACRM COURSE EVALUATION QUESTIONNAIRE

We kindly ask you to fill the present form. All responses will be anonymized and used for an Evaluation Survey of the Anaesthesia Crisis Resource Management (ACRM) component of this course. Thank you for your collaboration!

WE APPRECIATE YOUR HONEST RESPONSES. PLEASE **CROSS** THE RESPONSE THAT REPRESENTS YOUR OPINION.

TEACHING APPROACHES

	Excellent	Very good	Good	Fair	Poor
How effective were the instructors on this course?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
How do you rate the quality of ACRM course materials?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
How do you rate the ACRM course sessions?					
• Didactic lectures	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
• Simulation training	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
• Debriefing	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

SKILL DEVELOPMENT

How do you rate the usefulness of the nontechnical skills on your clinical daily activity?

Very High	High	Average	Low	Very Low
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Please write in extended form the 5 ACRM key points that you consider most important for managing anaesthetic emergency. No prioritization of the points is required. We ask NOT using any type of ACRM key points reminder.

Did the course improve your ability on the 5 ACRM key points that are most clinically important for you?

Completely	Partially	Not at all
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

OVERALL EXPERIENCE

Overall, how do you rate your experience in this course?

Excellent	Very good	Good	Fair	Poor
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Would you recommend this course to others?

Yes	No
<input type="radio"/>	<input type="radio"/>

Would you like to attend other ACRM courses in the future?

<input type="radio"/>	<input type="radio"/>
-----------------------	-----------------------

PARTICIPANTS' COMMENTS

What could be done to improve this course?

Surname: _____ Name: _____

significant predictor of the course induced changes on a participant's perception of the value of ACRM key points.

The results of our study suggest that the degree of familiarity with ACRM may impact on the effectiveness of an ACRM teaching intervention. This variation could be compensated by producing tailored ACRM training courses especially, when the ACRM training is not yet part of a formal education in anaesthesia. NTS frameworks may favour the building of a homogeneous perception about the importance of ACRM key points among the participants of an ACRM course.

The results of this study have not been already published, in whole or in part, elsewhere, in print or electronically. Italian law does not require ethical approval for non-interventional studies as the present survey study. We consulted our institutional ethics committee (Intercompany Ethics Committee of Hospital University Company (A.O.U.) San Luigi Gonzaga, Orbassano, Turin, Italy, Chairperson Prof. Antonio Giulio Piga) that confirmed that our survey does not fall in the interventional study category (reference n° 221/2021). Participation to this study was voluntary and written informed consent was obtained from each participant. We adhered to the General Data Protection Regulation standards to collect and to process the data properly anonymised. The survey was undertaken among 111 anaesthesiologists involved in the editions of a combined ACRM/ACLS(AHA) course that were held at the "AAROI-EMAC National Training Center AHA of Advanced Medicine and Simulation "Simulearn" of Bologna, Italy from 2017 to 2019.

Author contributions: DBF designed the study and the data collection instruments; DBF, VA, FG, BR, DP, CL, CP and MF participated in data collection and study results interpretation; OMC and DBF participated in writing the draft of the initial manuscript; MF and CP participated in reviewing the manuscript. All the authors approved the final manuscript as submitted and agreed to be accountable for all aspects of the work.

References

- Dewolf P., Clarebout G., Wauters L., Van Kerckhoven J. and Verelst S. . Effect of teaching non-technical skills in advanced life support: a systematic review. *AEM Educ and Train.* ; 2021 ; 5: 1-20. doi.org/10.1002/aet2.10522.
- Gallagher C. J. and Tan J. M., The current status of simulation in the maintenance of certification in anaesthesia. *Int Anesthesiol Clin.*; 2010;48: 83-99.
- Gaba D. M., Howard S. K., Fish K. J., Smith B. E. and Sowb Y. A. Simulation-based training in Anesthesia Crisis Resource Management (ACRM): a decade of experience. *Simulation & gaming.*; 2001;32:175-193.
- Rall M., Gaba D., Howard S. K. and Dieckmann P. . Human performance and patient safety. In *Miller's Anaesthesia 8th ed.* Philadelphia : Elsevier;2014; 120-1.
- Weller J., Wilson L. and Robinson B. Survey of change in practice following simulation-based training in crisis management. *Anaesthesia.*;2003;58:471-3.
- Blum R. H., Raemer D. B., Carroll J. S., Sunder N., Felstein D. M. and Cooper J. B. . Crisis resource management training for an anaesthesia faculty: a new approach for continuing education. *Med Educ.*; 2004; 38 45-55.
- Singer S., Lin S., Falwell A., Gaba D. and Baker L. Relationship of safety climate and safety performance in hospitals. *Health Serv Res.*;2009; 44:399-421.
- Jepsen R. M.H.G., Spanager L., Lyk-Jensen H.T., Dieckmann P. and Østergaard D. Customisation of an instrument to assess anaesthesiologists' non-technical skills. *Int J Med Educ.*;2015;6:17-25.
- Schröder T., von Heymann C. H., Ortwein H., Rau J., Wernecke K. D., Spies C. Simulation-based anaesthesia crisis resource management training. Results of a survey on learning success. *Anaesthesist.*;2009;58:992-1004.
- Rall M., Gaba D., Dieckmann P. and Eich C. B. Human performance and patient safety. In *Miller's Anaesthesia 8th ed.* Philadelphia: Elsevier;2014;179-180.
- Moll-Khosrawi P., Kamphausen A., Hampe W., Schulte-Uentrop L., Zimmermann S. and Kubitz J. C. Anaesthesiology students' non-technical skills: development and evaluation of a behavioural marker system for students (AS-NTS). *BMC Med Educ.*; 2019; 19: 205. doi.org/10.1186/s12909-2019-1609-8.
- Nicolaides M., Cardillo L., Theodoulou I., Hanrahan J., Tsoulfas G. and Athanasiou T., et al. Developing a novel framework for non-technical skills learning strategies for undergraduates: a systematic review. *Ann Med Surg.*; 2018;36:29-40.
- Boet S., Larrigan S., Martin L., Liu H., Sullivan K. J. and Etherington N. Measuring non-technical skills of anaesthesiologists in the operating room: a systematic review of assessment tools and their measurement properties. *Br J Anaesth.*;2018;121:1218-1226.
- Fletcher G., Flin R., McGeorge P., Glavin R., Maran N. and Patey R. Anaesthetists' non-technical skills (ANTS). Evaluation of a behavioural marker system. *Br J Anaesth.*; 2003; 90:580-588.
- Flin R., Patey R., Glavin R. and Maran N. Anaesthetists' non-technical skills. *Br J Anaesth.*;2010;105: 38-44.
- Gordon M., Baker P., Catchpole K., Darbyshire D. and Schocken D. Devising a consensus definition and framework for non-technical skills in healthcare to support educational design: A modified Delphi study. *Med Teach.*; 2015;37:572-577.
- Gordon M., Fell C. W. R., Box H., Farrell M. and Stewart A. Learning health safety within non-technical skills interprofessional simulation education: a qualitative study. *Med Educ Online.*; 2017; 22:1272838. doi.org/10.1080/10872981.2017.1272838.
- Boet S., Bould M.D., Fung L., Qosa H., Perrier L. and Tavares W., et al. Transfer of learning and patient outcome in simulated crisis resource management: a systematic review. *Can J Anesth.*;2014;61:571-582.
- Arora S., Miskovic D., Hull L., Moorthy K., Aggarwal R. and Johannsson H., et al. Self vs expert assessment of technical and non-technical skills in high fidelity simulation. *Am J Surg.*;2011; 202:500-506.
- Hoffmann R., Curran S. and Dickens S. Models and measures of learning outcomes for non-technical skills in simulation-based medical education: findings from an integrated scoping review of research and content analysis of curricular learning objectives. *Stud. in Educ. Eval.* ; 2021;71. 1-17. doi.org/10.1016/j.stueduc.2021.101093.
- Schulte-Uentrop L., Cronje J. S., Zöllner C., Kubitz J. C., Sehner S. and Moll-Khosrawi P. Correlation of medical students' situational motivation and performance of non-technical skills during simulation-based emergency training. *BMC Med Educ.*;2020; 20: 351. doi.org/ 10.1186/s12909-2020-02247-6.

doi.org/10.56126/73.2.09