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BRIEF REPORTS

CODE BLUE! Does how we feel predict how we do? A quantitative observational study of in-situ, near-peer simulations among internal medicine residents using self-reports and expert ratings

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Abstract

Background: Understanding the impact of residents' emotions during simulation training may improve preparation for managing Code Blue scenarios. The optimal use of in-situ simulations for deliberate practice of previously learned skills is a growing field. This study applied Pekrun's Control Value Theory to examine if internal medicine residents' achievement emotions, driven by appraisals of control and value, influenced their performance following in-situ, near-peer Code Blue simulations facilitated by fellow residents.

Methods: This quantitative, cross-sectional observational study involved 74 internal medicine residents (25 leaders, 49 team members) participating in monthly in-situ Code Blue simulations at a Canadian academic hospital. Immediately following each simulation, residents completed self-reports of their emotions and performance. Concurrently, a medical expert used the Ottawa Global Rating Scale to rate code leaders' performances. Linear regressions were used to assess the predictive relationships between participants' appraisals of their degree of control over and value for the simulation, their emotions and performance outcomes.

Results: Residents primarily reported positive-activating emotions. Among leaders, higher perceived control predicted positive-activating emotions, which in turn predicted better self-reported performance and higher expert ratings.

Conclusions: In the context of this voluntary, near-peer, in-situ series of booster simulations aimed at providing learners with deliberate practice of highly valued previously learned skills, learners reported mainly positive activating emotions, which in turn predicted better performance. This study highlights the utility of formative in-situ simulations for enhancing residents' Code Blue team leadership skills.

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CODE BLEU ! Nos émotions influencent-elles nos performances ? Une étude observationnelle quantitative portant sur des simulations in situ entre pairs chez des internes en médecine interne, à partir d'auto-évaluations et d'évaluations d'experts

Résumé

Contexte : Comprendre l'impact des émotions des résidents pendant la formation par simulation pourrait améliorer leur préparation à la gestion des scénarios de « Code Bleu ». L'utilisation optimale des simulations in situ pour la pratique ciblée de compétences acquises précédemment est un domaine en plein essor. Cette étude a appliqué la théorie de la valeur du contrôle de Pekrun afin d'examiner si les émotions liées à la réussite des résidents en médecine interne, motivées par leur évaluation du contrôle et de la valeur, influençaient leurs performances lors de simulations de « Code Bleu » in situ menées par des pairs et animées par d'autres résidents.

Méthodes : Cette étude observationnelle quantitative et transversale a porté sur 74 résidents en médecine interne (25 leaders, 49 membres d'équipe) participant à des simulations mensuelles de « Code Bleu » in situ dans un hôpital universitaire canadien. Immédiatement après chaque simulation, les résidents ont rempli des questionnaires d'auto-évaluation concernant leurs émotions et leurs performances. Parallèlement, un expert médical a utilisé l'échelle d'évaluation globale d'Ottawa pour noter les performances des leaders. Des régressions linéaires ont été utilisées pour évaluer les relations prédictives entre l'évaluation par les participants de leur degré de contrôle sur la simulation et de la valeur qu'ils lui accordaient, leurs émotions et leurs résultats en termes de performances.

Résultats : Les résidents ont principalement fait état d'émotions positives et stimulantes. Chez les leaders, un contrôle perçu plus élevé prédisait des émotions positives et stimulantes, qui à leur tour prédisaient de meilleures performances auto-évaluées et des notes plus élevées attribuées par l'expert.

Conclusions : Dans le cadre de cette série de simulations de rappel volontaires, réalisées in situ entre pairs de niveau de formation similaire et visant à offrir aux apprenants une pratique délibérée d'habiletés acquises antérieurement auxquelles ils accordaient une grande valeur, les apprenants ont principalement rapporté des émotions positives et stimulantes, qui prédisaient à leur tour de meilleures performances. Cette étude souligne l'utilité des simulations formatives in situ pour améliorer les compétences de leadership des résidents à diriger une équipes d'intervention lors d'un « Code Bleu ».

Introduction

Code Blue and simulation training

Within hospitals, a Code Blue is called to initiate emergency resuscitative measures for patients who are in cardiac arrest or at risk of imminent death. Despite universal training in Advanced Cardiac Life Support (ACLS), 49% of residents feel inadequately prepared to lead such teams.[1] Ineffective Code Blue leadership during in-hospital cardiac arrest is linked to poorer patient survival.[2,3]

In-situ simulations are widely used to build resuscitation and team leadership skills, with evidence linking them to improved patient outcomes.[4] In our single Canadian academic hospital context, monthly voluntary, near-peer led, formative, in-situ Code Blue simulations are organized by internal medicine residents to provide their co-residents with opportunities for deliberate practice and feedback on previously learned ACLS and team leadership skills.

It is unclear how residents' emotions influence their learning or expert-rated performance during simulated scenarios.[5] Reviews of the topic have found that negative or deactivating emotions such as anxiety and relief can impair simulation performance, attention to feedback and motivation.[6,7] Yet in another study, adding emotional stressors to ACLS simulations was associated with improved performance and retention.[8]

Given that leadership-dependent process failures are associated with lower in-hospital cardiac arrest survival, and that team performance in these events may be affected by emotional factors, understanding how emotions influence performance during Code Blue simulations is critical.

Control Value Theory of achievement emotions

Pekrun's Control Value Theory (CVT) explains the relationship between a learner's achievement emotions, their antecedents, and performance outcomes.[9] CVT categorizes achievement emotions into four quadrants: positive-activating, positive-deactivating, negative-activating, and negative-deactivating. According to CVT, the types of achievement emotions experienced by a learner are determined by the perceived control the learner has within an activity and the perceived value attributed to the activity by the learner. These appraisals of control and value predict achievement emotions, which in turn modify performance outcomes. Positive emotions are thought to help with flexible thinking and deep processing, while negative emotions are believed to generally lead to more rigid, surface-level processing. Activating emotions are posited to impact the learner's arousal and motivation.[10]

Environmental antecedents play an important role in influencing achievement emotions due to their effect on control and value appraisals. The purpose of this study was to identify what emotions residents reported after formative, near-peer facilitated, in-situ Code Blue simulations (the environment), how appraisals of control and value (proximal antecedents) are associated with these emotions and the subsequent associations between emotions and performance.

Research questions

1. What emotions did (a) leaders; and (b) team members' self-report after a formative, near-peer led, in-situ Code Blue simulation?
2. Did leaders and team members' self-reported appraisals of control and/or value predict their self-reported emotions?
3. Did leaders and team members' self-reported emotions predict their (a) self-reported performance and (b) expert observer-rated performance during a Code Blue simulation?

Methods

Prior to commencing this study, ethical approval was granted by the university's Institutional Review Board. All participants were informed of the purpose and design of this study, as well as their right to freely consent to data collection and withdraw consent at any time. Participation in the research study was voluntary and did not affect the residents' ability to participate in the simulation. Simulations were explicitly framed as formative learning experiences in both pre-briefs and debriefs. The study was designed to preserve the established

structure and delivery of these longstanding, widely appreciated, simulation sessions.

Participants

Participants were internal medicine residents working on the clinical teaching unit of a Canadian hospital. Of the seventy-four (n = 74) participants, twenty-five (n = 25) were 'leaders' and forty-nine (n = 49) were 'team members'. All trainees had comparable levels of training. The choice of team leader was decided by the participating residents, as was the established practice for these simulations, in order to minimize disruption to the educational environment.

Design

This was a cross-sectional study involving a simulation where trainees were asked to assess a "deteriorating patient" (a high-fidelity manikin), eventually requiring the trainees to manage a Code Blue. Simulations lasted 10-15 minutes and were followed by a debriefing. Simulations and debriefs were facilitated by other residents (near-peer), with an internal medicine staff physician observing and providing expert feedback. Prior to beginning the simula--ion, study forms were distributed and explained to participants. Data collection occurred from June 2020 to May 2022, with residents participating once each. All forms were anonymized and linked using a randomly generated identification number.

Measures

Medical Emotions Scale (MES). Emotions were assessed using a shortened 10-item version of the Medical Emotion Scale (MES), an instrument adapted from Pekrun's Achievement Emotions Questionnaire (AEQ) which has validity evidence for medical simulation contexts.[11] The 10 emotions were selected to ensure representation across the four CVT quadrants, while minimizing respondent burden in the immediate post-simulation environment. Immediately following the simulation, participants were asked to rate each emotion (Bored, Proud, Anxious, Happy, Frustrated, Enjoyment, Curious, Disappointed, Relieved, Relaxed) on a scale of 1-5, to "indicate how you currently feel now that the activity is completed". A score of 1 indicated that an emotion was felt "not at all," while 5 meant "very strong."

Cronbach's Alpha values were calculated for the self-reported emotions of leaders and team members based on the CVT quadrants of emotions. For both leaders and team members, there was acceptable reliability in the emotion groupings, except for team members' negative-deactivating emotions (α = .23; see Table 1). This low alpha value is likely because there were only two items which is often insufficient for a strong score, and the simulations rarely elicited boredom.[12]

Resident questionnaire. Following the adapted MES, residents completed a three-item Likert-scale questionnaire assessing residents' self-reported (1) own performance, (2) how highly they valued the learning experience and (3) their perceived control over their performance in the simulation (for items, see Appendix A). In the absence of a pre-existing instrument validated for in-situ resuscitation simulations, the first author and primary investigator (senior author) developed these items. Control and value items were mapped directly onto the constructs as defined by Pekrun.[13] The brief format was prioritized to minimize respondent burden in the post-simulation environment.

Ottawa Crisis Resource Management Global Ratings Scale (Ottawa GRS). Leaders were assessed by the observing experts using the Ottawa GRS[14] and rated from 1 (implying a 'novice' level rating) to 7 (implying an 'expert' level rating). There was a positive correlation between leaders' self-rated performance and Ottawa GRS ratings, $r(24) = .50$, $p = .05$, contributing to the convergent validity of these two measures.

Power analysis

Using *GPower 3.1*, a post-hoc power analysis based on a sample of 74 participants and a medium effect size of .40, indicated that a nominal power of .90 was achieved for 'team members' and nominal power of .76 was achieved for 'leaders.' The sample was sufficiently powered to detect differences within the sample groups.

Table 1. Descriptions and correlations for team members and leaders

Descriptives and Chronbach's Alphas for Self-Rated Emotions and Performance								
	M	*SD*	*N*	Items	Alpha			
Team Members Self-Rated Emotions (Scale from 1-5)								
Positive-Activating	3.12	0.76	49	4	0.72			
Positive-Deactivating	2.98	0.84	49	2	0.67			
Negative-Activating	2.07	0.65	49	2	0.72			
Negative-Deactivating	1.5	0.57	49	2	0.23			
Leaders Self-Rated Emotions (Scale from 1-5)								
Positive-Activating	3.07	0.72	24	4	0.8			
Positive-Deactivating	3.04	0.5	24	2	0.6			
Negative-Deactivating	1.6	0.69	24	2	0.64			
Negative-Activating	2.41	0.73	24	2	0.8			
Self-Rated Control and Performance Values								
Perceived Control Over Performance (Scale from 1-5)	3.60	0.65						
Ottawa GRS rating (Scale from 1-7)	4.75	0.94						
Self-rated performance (Scale from 1-10)	5.16	1.49						
Perceived value of the learning experience (Scale from 1-5)	4.73	0.14						
Correlations for Team Members' Emotions								
	1	2	3	4				
1. Positive-activating	1							
2. Positive-deactivating	0.43**	1						
3. Negative-deactivating	-0.20	-0.38*	1					
4. Negative-activating	0.58	-0.26	0.31*	1				
Correlations for all of the Leaders' Study Variables								
	1	2	3	4	5	6	7	8
1. Positive-activating	1							
2. Positive-deactivating	0.44*	1						
3. Negative-deactivating	-0.61**	-0.29	1					
4. Negative-activating	-0.12	-0.20	0.68**	1				
5. Self-rated performance	0.60**	0.27	-0.58**	-0.23	1			
6. Perceived control over performance	0.42*	0.24	-0.14	0.06	0.37	1		
7. Ottawa GRS rating	0.13	0.45	-0.18	-0.10	0.39	0.50*	1	
8. Perceived value of the learning experience	0.11	0.23	-0.21	0.15	0.16	0.12	0.1	1
*Significant at 0.05, **significant at 0.001								

Statistical methods

All statistical tests were conducted using IBM *SPSS 28*. Using the approach outlined by Harley et al.,[15] a series of linear regressions were used to determine that team leaders' self-rated control predicted self-reported positive activating emotions (RQ2), and self-reported emotions predicted better self-rated performance and Ottawa GRS ratings (RQ3).

Results

RQ1: Regarding emotions self-reported by participants, our results revealed a predominantly positive emotional environment. Positive-activating emotions were reported most frequently by both leaders (M = 3.12) and team members (M = 3.07). Descriptive statistics and correlations between variables are reported in Table 1.

RQ2: Concerning the relationship between self-reported appraisals of control and emotions (see Table 2), linear regressions for leaders supported the CVT model. High perceived control statistically significantly predicted leaders' positive-activating emotions (p = .04). Task value was nearly universally high (M = 4.73), creating a ceiling effect that precluded its use as a regression predictor.

Table 2. Regression analysis for leaders' emotions and testing variables

	Standardized Coefficient	R2	Adjusted R2	*P*
	Perceived control over performance			
Multiple Regression Results for Leaders' Emotions on Perceived Control				
Positive-Activating	0.03*	0.2	0.03	0.04*
Positive-Deactivating	0.10	0.12	0.30	0.69
Negative-Activating	0.15	0.14	0.39	0.72
Negative-Deactivating	0.03	0.03	0.30	0.92
Multiple Regression Results for Leaders' Emotions on Perceived Performance				
Positive-Activating	0.03*	0.2	0.03	0.00**
Positive-Deactivating	0.02	0.43	0.31	0.92
Negative-Activating	-0.46	0.43	0.02	0.20
Negative-Deactivating	0.04*	0.36	0.33	0.00**
Multiple Regression Results for Leaders' Emotions on Ottawa GRS Rating				
Positive-Activating	0.03*	0.05	-0.15	0.04*
Positive-Deactivating	0.14	0.16	0.12	0.60
Negative-Activating	-0.24	-0.18	-0.12	0.60
Negative-Deactivating	0.08	-0.10	0.05	0.83

**Significant at 0.05, **significant at 0.001*

RQ3: Regarding whether self-reported emotions predicted performance (see Table 2), positive activating emotions reported by team leaders statistically significantly predicted better self-rated performance ($p < .001$) and higher expert-rated Ottawa GRS scores ($p = .04$). No statistically significant predictive relationships were found for team members.

Discussion

In this study, medical residents participating in near-peer, in-situ voluntary booster Code Blue simulations experienced predominantly positive-activating emotions, and these emotions were associated with better resident performance. These find--ngs contrast with prior work in medical simulation, where negative-activating emotions such as anxiety and frustration have often been reported, particularly among novices.[11,15] The difference in our study likely reflects the low-stakes, formative, peer-led nature of the simulations, as well as our subjects' appreciation of the importance of Code Blue practice. These conditions may have enhanced residents' sense of control, while maintaining task value.[16] Our findings regarding leaders' self-reported emotions and Ottawa GRS results align with CVT, which posits that higher perceived control and value promote positive-activating emotions, leading to more adaptive learning and better performance outcomes.

Positive emotions have been shown to be associated with greater intrinsic motivation in a task and improved cognitive flexibility.[13] These associations are desirable when learning to manage a Code Blue and may help explain the relationship between positive emotions and performance in our study results. The extent to which one can use learners' achievement emotions to inform the design or conduct of effective simulation-based educational activities remains an important area for future study.[17] In addition, further work is needed to explore the impact of these emotional effects over time.

This study was limited by its reliance on emotions being self-reported after the simulation. The study designers wanted to minimize interference within this important educational activity by introducing educationally extraneous items only after the conclusion of the simulation and by keeping forms brief. The use of self-appraisal measures in this exploratory study is consistent with prior work examining emotions in medical education,[18,19,20] though this highlights the need for future research to develop and validate more robust instruments.

Conclusion

This study uses Control-Value Theory to help illustrate the critical relationship between residents' appraisals of their control, emotions, and performances during simulated resuscitation. Our find--ngs suggest that the nature of formative, near-peer, in-situ simulations may foster a unique educational climate defined by high perceived control, value and positive-activating emotions where "how we feel" is

linked to "how we do." This study advocates for the strategic use of near-peer, in-situ booster simulations as a powerful educational tool to cultivate the psychological and clinical readiness essential for Code Blue leadership.

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Conflict of Interest:

This study did not receive external or internal funding and no such monies were exchanged from any third-party to conduct this study. Our institution did not receive, at any time, additional payments, or support in kind for any aspect of the submitted work. No author has a financial relationship (regardless of the amount of compensation) with entities surrounding this submitted work. All authors were affiliated with McGill University at the time of data collection, and the study participants were internal medicine residents from the same university. The primary investigator (an internal medicine staff phy-ician) and first author (a critical care resident at the time of data collection) may have had prior educational interactions with participants in the context of their usual teaching and supervisory roles. To minimize potential bias, participation in the research study was voluntary, responses were anonymized and linked only by randomly generated identifiers, and study data were not used for any formative or summative evaluation of residents. The authors believe these measures mitigated risks of personal conflict of interest.

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Appendix A.

Resident Questionnaire

Does how we feel affect how we do?

Understanding medical residents'

emotions during Code Blue simulations:

1. What is your level of training (ex: PGY-2)?:

2. What role did you play during this simulation?

3. Please rate your performance during this simulation:

1	2	3	4	5	6	7	8	9	10
Poor				Fair					Excellent
○	○	○	○	○	○	○	○	○	○

4. During this Code Blue simulation, I felt that I had **control** over my performance:

1	2	3	4
Strongly Disagree	Disagree	Neutral	Agree
○	○	○	○

5. This simulation provided me with a **valuable** learning experience:

1	2	3	4
Strongly Disagree	Disagree	Neutral	Agree
○	○	○	○