

Clinical review criteria and medical emergency teams: evaluating a two-tier rapid response system

Gordon Bingham, Mariann Fossum, Macey Barratt and Tracey Bucknall

The early recognition (via abnormal vital signs) of physiological deterioration in patients, and the delivery of an appropriate response, are increasingly recognised as cornerstones in the prevention of further deterioration and adverse events.¹⁻³ The medical emergency team (MET) response to patient deterioration has evolved since its introduction in the 1990s to a widely used approach today, with a growing body of literature often referring to such approaches as rapid response systems (RRSs).⁴⁻⁶ RRSs are typically structured with an “afferent” (sensing) limb, including track-and-trigger protocols for staff to identify deteriorating patients and guide escalation. The “efferent” (treating) limb typically uses an MET response with doctors and/or nursing staff with skills in critical care.⁶

Although MET systems are increasingly being adopted, the overall RRS structures remain subject to ongoing debate about efficacy and design.^{5,7,8} In Australia, afferent limb activation by staff occurs typically when a single-parameter physiological variable reaches a predetermined value.^{3,9} Studies of MET call activation have revealed poor compliance with the frequency of observation taking, recognition of parameter breaches and RRS activation.¹⁰⁻¹² Patients who receive an MET call or who fulfil MET criteria have an inhospital mortality rate of about 25%, with low MET activation rates recognised as being associated with poorer patient outcomes.^{10,13-15} The need to balance local ward responses and hospital responses has also been highlighted.^{15,16} Thus, in some hospitals, the single response by the MET team has been further extended. A two-tier response to values marginally wider than typical MET activation criteria (often termed clinical review criteria [CRC]), and incorporating an initial response by senior nursing staff and/or the patient’s admitting medical team, is now in place in some areas (Table 1).¹⁷⁻¹⁹

To date, the use and performance of CRC or a two-tier RRS has received limited attention in the literature.¹⁵⁻²¹ In our study, we assessed the prevalence of patients fulfilling CRC, the CRC activation rates when the criteria were met, and the patient outcomes associated with CRC. Baseline characteristics and outcomes of patients fulfilling CRC were compared with those of patients who did not meet CRC, and documented nursing actions in response to altered CRC values were reviewed.

ABSTRACT

Objectives: To assess the prevalence of patients fulfilling clinical review criteria (CRC), to determine activation rates for CRC assessments, to compare baseline characteristics and outcomes of patients who fulfilled CRC with patients who did not, and to identify the documented nursing actions in response to CRC values.

Design, setting and participants: A cross-sectional study using a retrospective medical record audit, in a university-affiliated, tertiary referral hospital with a two-tier rapid response system in Melbourne, Australia. We used a convenience sample of hospital inpatients on general medical, surgical and specialist service wards admitted during a 24-hour period in 2013.

Main outcome measures: Medical emergency team (MET) or code blue activation, unplanned intensive care unit admissions, hospital length of stay and inhospital mortality. For patients who fulfilled CRC or MET criteria during the 24-hour period, the specific criteria fulfilled, escalation treatments and outcomes were collected.

Results: Of the sample ($N = 422$), 81 patients (19%) fulfilled CRC on 109 occasions. From 109 CRC events, 66 patients (81%) had at least one observation fulfilling CRC, and 15 patients (18%) met CRC on multiple occasions. The documented escalation rate was 58 of 109 events (53%). The number of patients who fulfilled CRC and subsequent MET call activation criteria within 24 hours was significantly greater than the number who did not meet CRC ($P < 0.001$).

Conclusions: About one in five patients reached CRC during the study period; these patients were about four times more likely to also fulfil MET call criteria. Contrary to hospital policy, escalation was not documented for about half the patients meeting CRC values. Despite the clarity of escalation procedures on the graphic observation chart, escalation remains an ongoing problem. Further research is needed on the impact on patient outcomes over time and to understand factors influencing staff response.

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Methods

After ethics approval (ID: 583/13) was obtained, a retrospective chart audit was conducted on all inpatient wards

Table 1. Clinical review team and medical emergency team call criteria

Criterion	Clinical review team	Medical emergency team
Airway	–	Airway threatened
Respiratory rate	7–10 or 25–35 breaths/min	≤ 6 or ≥ 36 breaths/min
O ₂ saturation	91%–93% (room air or O ₂)	≤ 90% (room air or O ₂)
O ₂ flow rate	≥ 6 L/min	–
	Increased by ≥ 4 L/min	–
Systolic BP (mmHg)	91–100 or 180–199	≤ 90 or ≥ 200
Heart rate	41–50 or 120–139 beats/min	≤ 40 or ≥ 140 beats/min
Temperature	< 36.0°C or > 38.0°C	–
Conscious state	Previously alert patient now only responsive to verbal stimuli	Any unexpected decrease in level of consciousness; GCS score decreased by > 2 points; seizures
Other	Worried about patient but does not fit criteria	Serious concern, uncontrolled pain

BP = blood pressure. GCS = Glasgow coma scale.

for 1 day in September 2013. Data were collected using a standardised case report form (CRF). The patient's vital signs from the graphic observation chart (GOC) were reviewed to determine if they fulfilled CRC during the 24-hour period. Medical record progress notes were reviewed to determine if there was any documentation of escalation, patient outcomes or any nursing actions in addition to actions recorded on the GOC.

Setting

Our study was conducted in a major tertiary referral hospital which provides a comprehensive range of specialist acute health and mental health services in Melbourne, Australia. An MET was established in the health service in 2000, with a current median daily MET call rate of 17 calls (range, 5–38 calls) using a single parameter trigger for activation of the RRS.

In November 2012, the hospital implemented a revised GOC based on a standardised chart produced by the Australian Commission on Safety and Quality in Health Care (ACSQHC).²² The new chart incorporated the two graded-response CRC and MET call criteria categories. Both response systems require only a single parameter to meet the activation criteria. The GOC incorporates the human factor principles recommended by the ACSQHC, with different colours in the chart reflecting levels of physiological abnormality linked to specific triggers in the escalation protocol.²²

Table 2. Patient clinical outcomes (N = 422)

Outcome	Data
CRC met*	81 (19%)
MET call criteria met*	13 (3%)
MET call activated*	9 (2%)
Code blue [†] activated*	2 (0.5%)
Transferred to ICU*	8 (2% %)
Inhospital mortality*	9 (2%)
Hospital length of stay (days) [‡]	11 (5–24)

CRC = clinical review criteria. MET = medical emergency team. * n (%). † Respiratory arrest and/or cardiac arrest. ‡ Median (interquartile range).

The escalation protocol is activated depending on the level of physiological abnormality. When observations reach the yellow zone, a clinical review is indicated, and in the purple zone an MET call is indicated. The GOC provides the facility for staff to document their response to the abnormal observation below each set of observations, ie, A = nurse in charge (NIC) informed, B = NIC reviewed patient, C = escalation to medical officer. According to the hospital policy, when a patient fulfils CRC on the GOC, the nurse caring for the patient should escalate the review to the NIC to assess the patient and intervene as required within their scope of practice, eg, pain relief, repositioning the patient or administration of medications.

If the nursing interventions are unsuccessful or not appropriate, the next step is to notify the treating medical team for review. In the 6 months before implementation of the revised GOC, an extensive education program was delivered to all medical units and included in ongoing hospital orientation sessions for all staff. For nursing staff, a blended learning and training program was developed. This involved online, low-fidelity simulation and ward-based sessions in how to document and activate escalation for both CRC and MET call criteria. The program was delivered to over 1000 nursing staff involved in patient care.

Participants

Adult patients were included in the study if they were hospitalised in the 24-hour study period in wards that were using the GOC. Patients were excluded if they were in the intensive care unit or the emergency and trauma centre, as these areas do not use the GOC.

Data collection

Data were collected by one investigator who accessed the scanned medical records and CRF of the patients. Patient characteristics, including demographic and outcome information, were recorded for every included patient. A second

Table 3. Characteristics and clinical outcomes of patients who met CRC and patients who did not meet CRC

Characteristics and clinical outcomes	CRC met (n = 81)	CRC not met (n = 341)	P
Mean age (years)	61	58	0.199*
Male, n (%)	46 (57%)	223 (65%)	0.095*
Median hospital length of stay, days (IQR)	12 (7–22)	11 (5–25)	0.507 [†]
MET call criteria met, n (%)	10 (12%)	3 (1%)	<0.001*
Code blue, [‡] n (%)	1 (1%)	1 (1%)	0.347 [§]
Unplanned ICU admission, n (%)	1 (1%)	7 (2%)	0.999 [§]
Inhospital mortality, n (%)	2 (2%)	7 (2%)	0.685 [§]

CRC = clinical review criteria. IQR = interquartile range.
 MET=medical emergency team. ICU = intensive care unit.
 * Independent t test. † Mann–Whitney U test. ‡ Respiratory arrest and/or cardiac arrest. § Fisher exact test.

investigator achieved 100% agreement using the CRF independently in more than 10% of patient records reviewed.

Outcome measures

Outcome measures were MET or code blue activation, unplanned ICU admissions, hospital length of stay and in-hospital mortality. The GOC and medical record notes were reviewed to determine the specific criteria fulfilled, escalation treatments, outcomes, time and reason for meeting criteria, if the escalation process had been documented and the nature of any interventions.

Data analysis

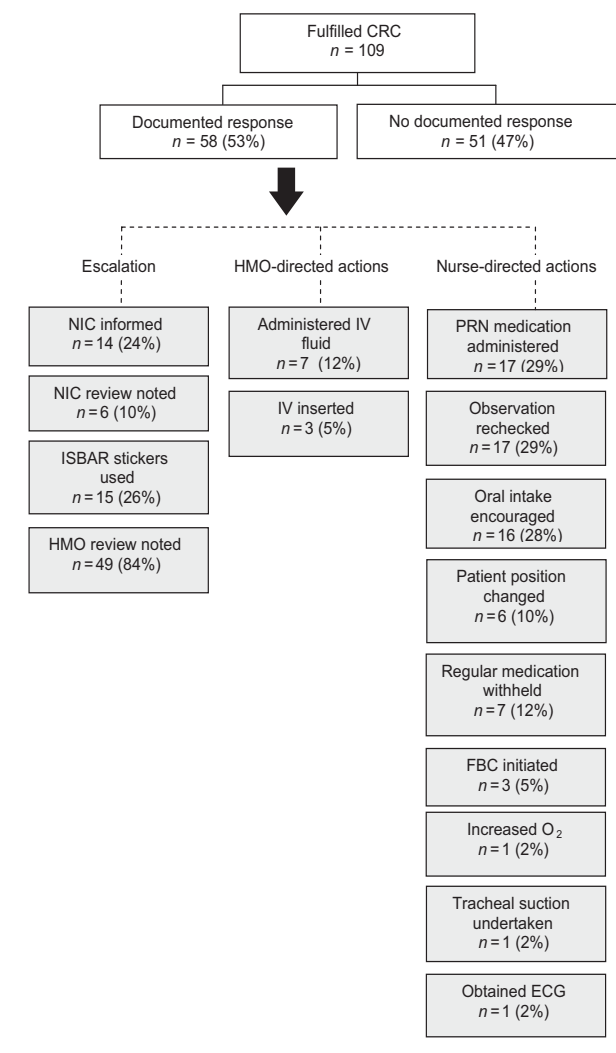
The differences in baseline characteristics (sex and age) and outcomes (MET or code blue call activation, unplanned ICU admission, length of stay and in-hospital mortality) for patients who fulfilled CRC were compared with patients who did not. Descriptive statistics (mean, median and standard deviation) were applied. The χ^2 test or Fisher exact test were used for categorical data. The student t test or non-parametric equivalent test were used for continuous data. All data were analysed using SPSS, version 22 (SPSS Inc). A P of ≤ 0.05 was considered statistically significant.

Results

Patient characteristics and prevalence of CRC fulfilled

During the study period, a total of 422 patients fulfilled the inclusion criteria and had a review of their GOCs and medical records. The mean age was 57 years (range, 37–77 years) and 263 patients (64%) were men.

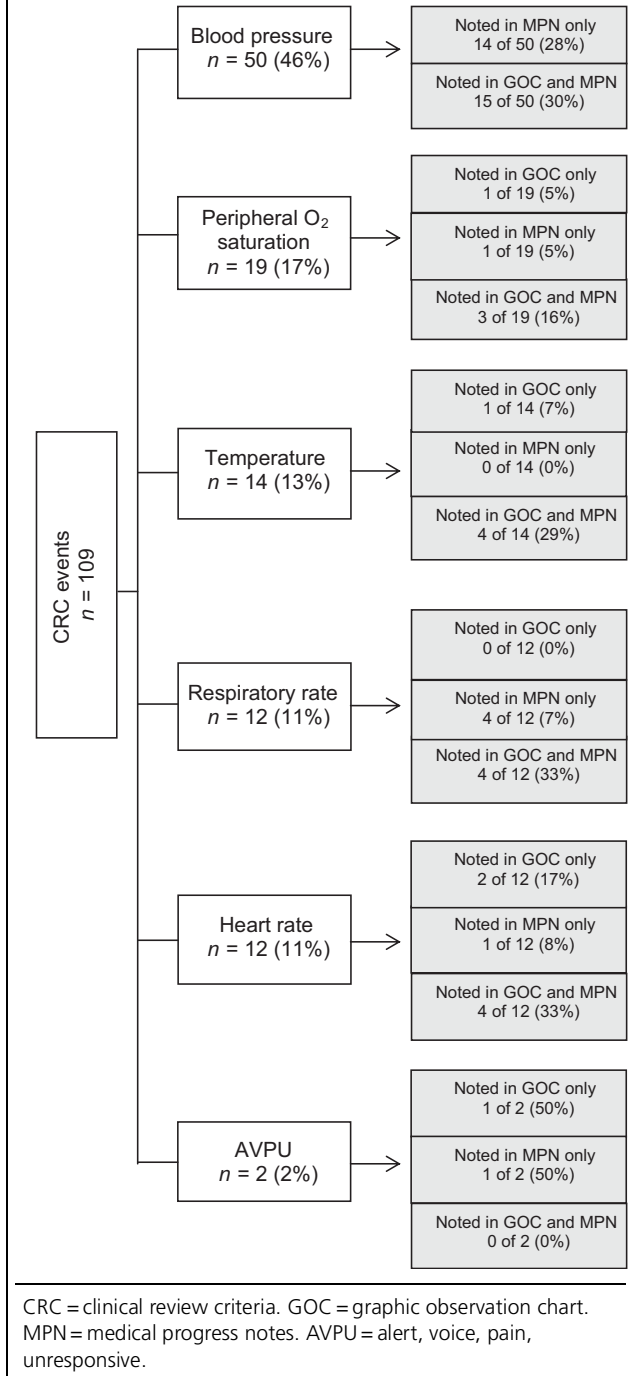
Figure 1. Documentation and responses to aberrant vital signs (N = 109)



CRC = clinical review criteria. NIC = nurse in charge. IV = intravenous. PRN = pro re nata (as needed). ISBAR = identify, situation, background, assessment, recommendation. HMO = hospital medical officer. FBC = full blood count. ECG = electrocardiogram.

Eighty-one patients of the total sample (19%) had one or more vital signs which fulfilled CRC; 66 of these patients (81%) did so for one criterion and 15 patients (19%) fulfilled CRC on multiple occasions and/or fulfilled more than one criterion, for a total of 109 events documented. Of the 422 patients, 13 (3%) had a physiological derangement which fulfilled MET call criteria. Of these 13 patients, nine had an MET call activated, resulting in a missed MET rate of four patients (30%). During the study period, two patients of the included 422 (0.5%) had a code blue activated for cardiac arrest. A summary of the patient outcomes is shown in Table 2.

Figure 2. Summary of vital signs meeting clinical review criteria, and documentation of interventions in graphic observation chart or in medical progress notes (N = 109)



Comparison between patients fulfilling CRC and patients who did not

We compared age, sex, hospital length of stay, MET call criteria fulfilled, code blue activations, rates of unplanned

ICU admissions and in-hospital mortality for patients who achieved vital signs documented as fulfilling CRC, with patients who did not achieve them. Comparisons of clinical outcome variables between the two groups are shown in Table 3. The only outcome variable to achieve statistical significance was fulfilment of CRC and progression to fulfilling MET activation criteria within 24 hours ($P < 0.001$; relative risk, 3.9; 95% CI, 2.1–5.3).

CRC documentation and escalation

An audit of the GOC and medical records showed 58 of the 109 CRC events (53%) had the clinical deterioration status documented and escalated, as in the hospital policy. The NIC was documented as being informed in only 14 of the 58 documented responses (24%). Recording of the escalation information on a preprepared “identify, situation, background, assessment, recommendation” (ISBAR) sticker occurred in only 15 of the 58 escalation events (26%). Medical response to the escalation occurred in 49 of the 58 events (84%) (Figure 1). Figure 2 shows a summary of the vital signs which fulfilled CRC and documentation details of these patients.

Nursing intervention after CRC escalation

Documented nursing actions in response to CRC varied depending on the nature of the physiological variable in question. For alterations in blood pressure, which was the largest single cause of CRC escalations, this included rechecking of values with a second piece of equipment (typically a manual sphygmomanometer), administration or withholding of pro re nata (PRN) (as needed) medications likely to exert a hypertensive or hypotensive effect, encouragement of oral fluid intake and administration of ordered intravenous fluid. The GOC and medical record audit of documented nursing actions after CRC escalation are shown in Figure 1.

Discussion

Major findings

We conducted a retrospective observational study to determine the prevalence and outcomes of patients who fulfilled CRC during a 24-hour period of their hospital admission. We found that 19% of the patients had vital signs that fulfilled one or more CRC, reaching the first-tier response for deterioration, and 3% of those patients also fulfilled MET call criteria. The escalation process, which is intended to be activated to prevent further deterioration when CRC are fulfilled, was only documented as occurring about half the time. Significantly, patients who fulfilled CRC were about four times more likely to progress to fulfilling MET criteria.

Comparison with previous studies

Previous work describes the incidence of and associations between abnormal observations and selected patient outcomes, such as mortality and unplanned ICU admissions.^{15,16,19} An early, tiered response to balance effectiveness and limited resources is advocated.^{15,16} Local ward responses, if activated early, can prevent serious adverse events and potentially lower hospital mortality rates associated with clinical deterioration.

Other authors have described the introduction of two-tiered RRSs using an ICU outreach nursing model and clinical reviews by the treating team.¹⁷⁻¹⁹ Their findings showed improved patient outcomes, such as reduced unplanned readmissions to ICU and unexpected hospital deaths, increased monitoring of vital signs and increased staff satisfaction with the two-tier system.

To our knowledge, our study is the first to report on nursing interventions in a two-tier system in relation to patients meeting CRC. We describe nurses' attempts, within their scope of practice, to mitigate changes in the condition of their patients through further observation, consideration of medication administration, encouragement of fluid intake and initiation of additional documentation.

It has been reported that, as the use of RRSs matures over time, higher activation rates result.²³ However, embedding a pre-MET clinical review process, such as the use of CRC, may in fact reduce the number of MET calls.^{15,16,19,20} As such an early stage of the two-tier RRS implementation, it is yet to be determined if this will occur. Future studies will be required to determine if this is the case at the study centre.

There is evidence that a "dose-response" relationship exists, with increasing numbers of MET calls reducing adverse patient outcomes such as mortality, cardiac arrests and unplanned ICU admissions.^{5,19,24,25} It is further suggested that a dose-response relationship may explain the improved outcomes after a multifaceted intervention to improve detection of deteriorating patients.¹⁹ A range of values for rapid response calls between 20 and 40 calls per 1000 admissions has been suggested as being required for an effective system, although these values refer to an MET call response, not CRC activations.²⁵ Current evidence is yet to suggest an optimal number of CRC activations to achieve a reduction in adverse events.

The rate of documented escalation was disappointingly low. Compliance with organisational-specific escalation protocols is recognised as problematic internationally, and the rate we report is similar to the partial adherence to established protocols reported elsewhere.^{10,11,26} However, it is still possible that escalation or treatment did occur in the clinical setting in some form but that it was not documented in the GOC or the medical record.

Implications

There are several implications arising from the description of the prevalence, outcomes and documentation of escalation related to the recently introduced CRC in the Australian context. First, RRS activation rates, such as MET call rates, have been documented as occurring at between 3% and 27%.^{10,15,23,27,28} Our study presents new prevalence data after significant educational initiatives within the organisation and national policy changes aimed at increasing the recognition and response to deteriorating patients in hospitals. Activation rates for local review have been infrequently reported,^{15,19} which inhibits our understanding of the true prevalence of patients at risk and underlying actions of non-critical care staff to prevent adverse outcomes. Our study provides a basis from which ongoing audits of activation rates and outcomes can be monitored. It will be of interest to observe the epidemiological changes, given reports that RRSs mature over time.⁸

Second, the rationale behind the introduction of a pre-MET review was getting the right people with the right skills to the patient earlier. This should potentially improve patient outcomes and reduce adverse events,^{20,23,26} however, we found no association between the outcome measures other than an increased likelihood of progressing to MET call activation if CRC values had been met. There are several possible reasons for the relationship between CRC values and MET criteria in our study. It may be possible that the patients meeting CRC were more likely to fulfill MET criteria due to the severity of their illness, and that any escalation or intervention would not prevent this.

Our study did not determine the timing or delay of interventions during escalation. It is possible that when a patient met CRC, the two-tier escalation system may have delayed interventions for patients requiring critical care-type review and interventions, thus the right people were not matched with the right skills and knowledge.²⁹ It may also be argued that the escalation rate of 53% will not result in enough effect on physiology to cause a reduction in progression to MET call criteria similar to the dose-response relationship described for MET call activations elsewhere.^{24,25} The rates of failure to escalate review in response to fulfilling MET call criteria are reported to be 16%–96%, with lower rates attributed to more mature and embedded systems.^{10,12,30} It may be possible that the documented rates of CRC escalation are a reflection of the relative immaturity of a new system.

There is little research examining the sensitivity, specificity and predictive validity of the early signs of deterioration which have been used to develop the CRC values. The increasing move to continuous electronic monitoring and data linkage to patient outcomes may provide further knowledge on which organisations can base CRC values.

Lack of accuracy in documentation is recognised as a factor in failure to activate the escalation procedure and has been reported in other organisations which have a single-parameter RRS.^{24,30} Further audit and feedback to clinical areas will be required to promote compliance and escalation rates over time. The importance of nurses recognising clinical deterioration and escalating patient care early is becoming increasingly recognised as having an impact on patient outcomes. Despite this, escalation remains variable across organisations.^{10,11,24,27,30}

Further research

As a recently introduced component of RRSs, the use of CRC as a two-tier pre-MET system will benefit from further research. Comparison of patient outcomes, between patients who met CRC and were escalated and patients who were not escalated, would reveal greater understanding of the effect of the escalation process. Further studies are needed in organisations which introduce this process, to compare rates of meeting CRC before and after introduction of the procedure, and any subsequent impact on MET or code blue events. It may be that a similar dose–response relationship, such as exists for MET calls, will become apparent. It is recognised that although MET criteria have a high specificity for identifying adverse events (94%), they also account for a high rate of false positive calls, with reported sensitivity of 50%.¹² It would therefore be of benefit for future work to report on the causes of CRC calls to determine if the activation values are appropriate. In particular, attention should also be paid to the timing and rates of deterioration, to help direct physiological monitoring protocols and potential applications in electronic automated response systems.

Strengths and limitations

To our knowledge, ours is the first study which reviews the prevalence and outcomes of patients fulfilling CRC and the associated nursing response in an Australian context. The 13 patients who fulfilled MET criteria were typical of our organisation's average daily MET rate, thus providing a representative sample. Because our audit was retrospective, nurses were unaware of the review, so there was no effect on their decisionmaking or documentation practices.

A further limitation was that this was a single-centre study, reliant on documentation and undertaken on one day that may not reflect the same results if repeated or undertaken elsewhere.

Conclusions

One in five patients is likely to require urgent clinical review or the first level of an RRS during their hospital admission.

Patients who fulfil CRC are about four times more likely to fulfil MET call criteria. Despite this, review escalation for patients fulfilling CRC occurred in about half the cases. Poor compliance with an established escalation policy is likely to have an impact on patient outcomes. Further focus on the behaviour of clinicians to implement RRS policies is required if we are to maximise the potential of such a system.

Competing interests

None declared.

Author details

Gordon Bingham, ICU Liaison Nurse¹

Mariann Fossum, Research Fellow²

Macey Barratt, Registered Nurse²

Tracey K Bucknall, Director of Nursing Research,¹ and Professor of Nursing²

¹ Nursing Services, Alfred Health, Melbourne, VIC, Australia.

² School of Nursing and Midwifery, Deakin University, Burwood, VIC, Australia.

Correspondence: g.bingham@deakin.edu.au

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