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# The performance of a rapid response team in the management of code yellow events at a university hospital

*Atuação do time de resposta rápida em hospital universitário no atendimento de código amarelo*

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## ABSTRACT

**Objective:** To describe the epidemiological data of the clinical instability events in patients attended to by the rapid response team and to identify prognostic factors.

**Methods:** This was a longitudinal study, performed from January to July 2010, with an adult inpatient population in a hospital environment. The data collected regarding the code yellow service included the criteria of the clinical instability, the drug and non-drug therapies administered and the activities and procedures performed. The outcomes evaluated were the need for intensive care unit admission and the hospital mortality rates. A level of  $p=0.05$  was considered to be significant.

**Results:** A total of 150 code yellow events that occurred in 104 patients were evaluated. The most common causes were related to acute respiratory insufficiency with hypoxia or a change in the respiratory rate and a concern of the team about the patient's clinical

condition. It was necessary to request a transfer to the intensive care unit in 80 of the 150 cases (53.3%). It was necessary to perform 42 procedures. The most frequent procedures were orotracheal intubation and the insertion of a central venous catheter. The patients who were in critical condition and had to wait for an intensive care unit bed had a higher risk of death compared to the other patients (hazard ratio: 3.12; 95% CI: 1.80-5.40;  $p<0.001$ ).

**Conclusions:** There are patients in critical condition that require expert intensive care in the regular ward unit hospital beds. The events that most frequently led to the code yellow activation were related to hemodynamic and respiratory support. The interventions performed indicate the need for a physician on the team. The situation of pent-up demand is associated with a higher mortality rate.

**Keywords:** Hospital rapid response team; Emergency treatment; Patient safety; Inpatients

This study was conducted at the Hospital Universitário, Universidade Estadual de Londrina - HU/UEL - Londrina (PR), Brazil.

**Conflicts of interest:** None.

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## INTRODUCTION

Hospitalized patients may present conditions of clinical deterioration in hospital units in which the team is not prepared to manage emergencies. Unexpected cardiac arrest in hospitalized patients is frequently preceded by signs of clinical deterioration.<sup>(1,2)</sup> In situations of clinical instability such as these, early detection and intervention provide opportunities to prevent cardiac arrest and increase safety for inpatients. Such clinical signs are also known as “code yellow” and activate an urgent management call

by professionals who work in the urgent care and emergency units. Studies in pioneering countries that can count on rapid response teams (RRTs), such as England and Australia, have shown that the early identification of the signs of clinical instability and the work of RRTs in the management of unstable patients may lead to a decreased number of both cardiac arrests and unanticipated transfers to intensive care units (ICUs), thereby decreasing inpatient mortality.<sup>(3-5)</sup>

RRTs are typically multidisciplinary and consist of medical, nursing and physical therapy professionals. They are responsible for the timely evaluation, screening and treatment of patients with signs of clinical deterioration outside the ICU environment. RRT members have autonomy, independent of the assistant physician responsible for patient hospitalization, to request urgent investigative diagnostic tests, prescribe drug and non-drug treatments, recommend intensive care and discuss palliative care.<sup>(6,7)</sup>

RRT development has grown along with the increased interest in improving the quality of care and safety for inpatients.<sup>(8)</sup> To improve the quality of hospitalization systems, a review of the safety mechanisms is essential to identifying opportunities for preventing potentially fatal events and for improving the response to critical situations. The system as a whole requires epidemiological evaluation and administrative management to oversee and support the urgent care and emergency management systems.

The objective of this study was to describe the epidemiological data from clinical instability events (code yellows) in the adult inpatient units at a university hospital and to identify prognostic factors.

## METHODS

This was an observational, longitudinal and prospective study performed at the *Hospital Universitário da Universidade Estadual de Londrina* (HU/UEL), Brazil. The data were collected from January to June 2010. This study was approved by the local Ethics Committee (opinion letter # 208/08) with a waiver for the Free and Informed Consent process. The HU/UEL is a supplementary unit and is a large-sized public university hospital with 333 beds, which serves the city of Londrina and the

neighboring region. The studied population consisted of adult patients admitted to the inpatient units (female and male units) at the HU/UEL who had a clinical instability condition (code yellow). We used convenience sampling, which consisted of all of the adult patients with a clinical instability condition who were attended to by the HU/UEL RRT during the study. The patients who had incomplete data were not included and were deemed as data losses.

The HU/UEL RRT consists of one intensive care physician and one physical therapist who answer code yellow or code blue events (cardiac arrest management) in the adult ward unit. The HU/UEL RRT activities began in March 2009 and, due to a restriction in human resources, the team works 12 hours a day (from 7 am to 7 pm), 7 days a week. During the nighttime, the staff on duty at the hospital emergency unit manages code events.

The general data collected were gender, age, the date of hospital admission, the type of admission, the hospitalization unit, the date of discharge and the outcome at discharge. The data collected regarding the clinical instability event (code yellow) were the heart and respiratory rates, body temperature, blood pressure, the peripheral oxygen saturation, the need for oxygen therapy, capillary blood glucose and a neurological assessment according to the level of consciousness or Glasgow coma scale. The data collected regarding the clinical instability (code yellow) management were the specific clinical instability criteria, the drug and non-drug therapies administered, the activities of personnel and the procedures performed, the immediate clinical development and the need for admission to an ICU. The data regarding the time of service were recorded during a code yellow event. The time of the code yellow activation was considered to be the period between the onset of the clinical instability signs and symptoms and the call for the code event. The time of arrival for attending to the code event was considered to be the time between the call of the code and the arrival of the team to begin management of the event. The time of service was the time between the arrival of the team and the conclusion of the code service.

The sources of the data collection were patient records and the hospital electronic database. The patients were followed up until a final outcome of either hospital discharge or death.

## Statistical analysis

Continuous variables were presented as the mean and standard deviation (in the case of a Gaussian distribution) or as the median and interquartile ranges (for a non-Gaussian distribution). Categorical variables were presented as proportions. Descriptive statistics were used to present all of the relevant variables. The data were presented in charts and tables. A *Student's t* test or, when the distribution was not Gaussian, a non-parametric equivalent (Mann-Whitney) was used to compare continuous variables. The categorical variables were compared with Pearson's chi-square test with Yates' continuity correction. The survival analysis was performed with Kaplan-Meier curves and the comparison of two curves by the log-rank test. The level of significance was 5%, and the analyses were performed using the software Epi-Info 3.3.2. (CDC, USA) and MedCalc for Windows, version 9.3.2.0 (MedCalc Software, Mariakerke, Belgium).

## RESULTS

During the study, 150 code yellow events that occurred with 104 patients were evaluated. Seventy-six patients required a single code yellow management; 18 patients had 2 events, and 10 patients had 3 or more code yellow events. The patients were  $61.2 \pm 18.6$  years old, on average, and 52 (50%) were male.

The diagnoses that led to hospital admission among the patients who had code yellow events were various, and the most frequent were sepsis (20.6%), cancer (13.7%), cerebral vascular accident (9.9%), trauma (9.2%), chronic peripheral artery disease (7.6%), amyotrophic lateral sclerosis (3.8%), cirrhosis (3.1%), chronic obstructive pulmonary disease (3.1%), congestive heart failure (3.1%) and other (25.9%).

Considering the 150 events during the study, the time for the code yellow activation after the onset of clinical instability was an average of  $3.8 \pm 5.4$  minutes. The average time for the RRT arrival after the call was  $2.2 \pm 1.8$  minutes, with a minimum of 1 minute and a maximum of 10 minutes. The average time of the code yellow service by the RRT was  $43.4 \pm 48.0$  minutes, with a minimum of 1 minute and a maximum of 282 minutes. The months that had the higher number of code yellow events during the study were January and

March (with 22% and 20.7%, respectively), and April had the lowest number of calls (8.7%). The causes for the code yellow activation were evaluated, and the most frequent causes were related to acute respiratory insufficiency with hypoxia or a change in respiratory rate, in addition to a concern of the team about the patient's clinical condition (Table 1).

**Table 1** - Causes that led to code yellow activation

N	Cause	%
1	Increased concern for the patient's overall condition	38
2	Acute decrease of O <sub>2</sub> saturation to <90%	28.7
3	Decrease of systolic blood pressure to <90 mm Hg	23.3
4	Change in respiratory rate to <10 rpm or >30 rpm	22.7
5	Decrease in consciousness level	20
6	Change in heart rate to <45 bpm or >125 bpm	18
7	Convulsion	8
8	Increase in systolic blood pressure to >180 mm Hg	4.7

The activities performed by the RRT professionals during the code yellow events were separated into activities, procedures and therapy. The most frequent activities during the events were diagnostic investigation (55.6%), respiratory support or the adjustment of mechanical ventilation by respiratory physical therapists (14.5%), hemodynamic monitoring (6.0%) and the request for a specialist consult (5.1%), among others. During the 150 code yellow events, it was necessary to perform 42 procedures. The most frequent procedures were orotracheal intubation (17 of 42), central venous catheter insertion (15 of 42) and tracheal aspiration (7 of 42), in addition to a paracentesis, a vesical probe insertion and a nasogastric tube. The most frequent therapies used during the code yellow event management were vasoactive drugs, antimicrobials, a crystalloid solution for volume replacement, analgesic drugs, oxygen therapy, sedatives and others (Table 2).

From the 150 events, 80 (53.3%) patients required transfer to ICU-monitored beds. From the 104 patients seen during the study, the RRT was called to attend to 9 patients with non-resuscitation instructions and the recommendation for palliative care. Of these 9 patients, 8 died during hospitalization and 1 was discharged with home palliative care.

**Table 2** - Most frequently used medications during code yellow management

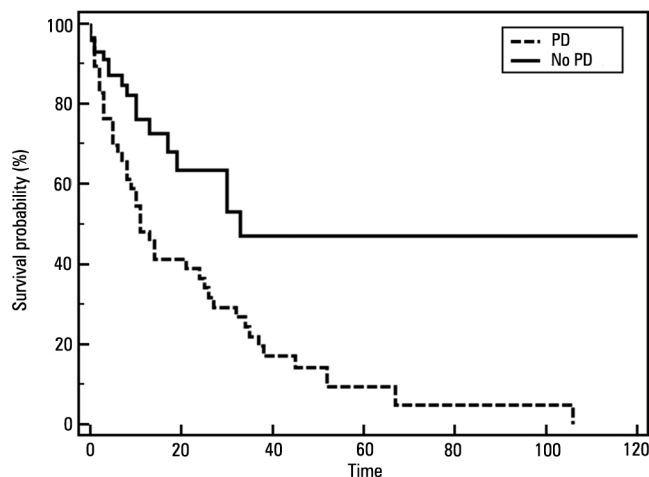
Medication	Frequency	%
Vasoactive drugs	29	19.2
Antimicrobials	27	17.9
Crystalloid solution	23	15.3
Analgesia	13	8.6
Oxygen therapy	11	7.3
Sedation	10	6.6
Bronchodilators	9	6.0
Diuretic drugs	7	4.7
Anticonvulsants	6	4.0
Antiarrhythmics	5	3.3
Hypertonic glucose	5	3.3
Anti-hypertensive drugs	2	1.3
Antiplatelet drugs	2	1.3
Insulin	1	0.6
Mucolytic drugs	1	0.6
Total	151	100.0

The hospital mortality rate of patients who had code yellow events during hospitalization was 59 out of 104 (56.7%). However, after excluding the patients who underwent palliative care, the hospital mortality rate after a code yellow event was 51 out of 95 (53.7%). The overall hospital mortality rate was 4.3% during the same period, and the rate of ICU bed occupation was 97.9%.

When the 95 patients attended to by the RRT were analyzed, excluding the patients in palliative care, 45 (47.4%) required transfers to the ICU with a monitored bed and waited for its availability in a situation of pent-up demand at some point during hospitalization. The patients who needed transfers to the ICU and were on pent-up demand had a higher chance of death when compared to the other code yellow patients [hazard ratio: 3.12; 95% Confidence Interval (CI): 1.80-5.40;  $p < 0.001$ ] (Figure 1). Among the 45 patients on pent-up demand, the ones who were later transferred to the ICU (85.7%) had the same mortality rate as those who needed an ICU transfer but had no access to it (87.5%;  $p = 0.59$ ).

## DISCUSSION

This study demonstrated that the activation of code yellow was frequent in the institution. Most



**Figure 1** - Survival analysis comparing code yellow patients in a scenario of pent-up demand with other patients. PD - pent-up demand; log-rank test:  $p < 0.001$ .

of the patients attended to by the RRT were at a risk of death. These patients required specialized therapeutic interventions and had high mortality rates. These findings may have great potential in the strategic planning and risk management of an institution regarding the safety and the quality of care of inpatients.

The RRT performed well regarding the time goals. In a prospective study describing an RRT that attended to surgical inpatients, Bellomo et al.<sup>(9)</sup> reported an average time for the RRT arrival of  $1.7 \pm 2.6$  minutes and an average time of service duration of  $40 \pm 39$  minutes. The findings of the present study are consistent with the reported data, but the great variation in the time of service in the present study reflects the delay in transferring the patients to a monitored ICU bed.

Respiratory insufficiency and hemodynamic instability, in addition to the team's concern for the patient's overall condition, were the reasons for most of the code yellow activations. The criteria adopted for code yellow calls in the present study are similar to those recommended to prevent cardiac arrests in other regular units of the hospital.<sup>(4,10,11)</sup>

The causes of the code yellow calls identified patients in critical conditions who had several physiological abnormalities. In many cases, these patients were already being attended to in hospital ward units with intensive monitoring, which indicates that the outpatient unit teams already recognized the patient



as critically ill. After the code yellow management, if there was a recommendation for an ICU transfer, the transfer was immediately requested. In some cases, the ICU transfer had already been requested by the primary or substitute physician outside of the RRT working hours (i.e., during the nighttime), thus the patient was in a situation of pent-up demand during the initial code yellow event managed by the RRT.

The ICU beds were frequently full during the study, and many patients were treated in the adult wards while waiting for an ICU bed. These patients were routinely reassessed by the RRT team (at least twice a day) and could be seen again at any time with a code yellow in the case of new clinical instability.

The therapeutic actions and procedures performed by the RRT can be considered as specialized and are similar to those reported by other authors.<sup>(12)</sup> The activities performed by the RRT were compatible with the reasons that led to the activation of the RRT. Decreases in O<sub>2</sub> saturation and changes in the respiratory rate were frequent, indicating that acute respiratory insufficiency was a common cause for the RRT activation. The management of these patients included a prescription for oxygen therapy, orotracheal intubation, respiratory physical therapy, tracheal aspiration or the adjustment of mechanical ventilation in the patients who were already undergoing this treatment when the code yellow was activated. Hemodynamic instability was also a common cause for the RRT activation, and the management of hemodynamic instability included volume replacement and the use of vasoactive drugs, in addition to the insertion of a central venous catheter for the infusion of drugs and monitoring.

Several interventions performed by the RRT and described in the present study are considered "physician activities", which justifies the inclusion of a medical doctor as the professional leading the rapid response team at the study's institution. Many authors describe RRTs with different compositions, which may or may not include physicians in the team, depending on the legal ramifications and on each institution.<sup>(13-15)</sup>

Sepsis was the admission diagnosis of the patients who originated most of the code events. Sepsis may be defined as an exaggerated response of the body to an infection with the excessive activation of inflammatory cells that leads to the involvement of multiple organs.<sup>(16,17)</sup>

It is a disease with a high mortality and morbidity rate that is associated with many body impairments, and the treatment of sepsis must be implemented as early as possible to reduce mortality.<sup>(18)</sup> Therefore, sepsis increases the workload of the team responsible for the patient and may cause the patient to present many events of clinical instability and signs of deterioration, which can be identified and treated by the RRT.

The ICU at HU/UEL has 17 hospital beds, which is not enough for the immediate admission of all of the patients who need intensive care. The mortality rate of the ICU inpatients during the study was 35%, while the mortality rate of the patients seen by the RRT during the same period was 56.7%. This mortality rate indicates that the patients attended to by the RRT may be considered as critical patients, and because they are not in the ICU, these critical patients require a multidisciplinary team of experts who are aware of clinical instability signs and are capable of managing and reverting critical cases in a rapid manner.

The mortality rate found in the present study is high compared to others reported in the literature.<sup>(8,9,19)</sup> Konrad et al. reported that the mortality rate of patients attended to by a team of medical emergency personnel was 15.8%.<sup>(8)</sup> Buist et al. reported 40 deaths in 124 patients seen under code yellow conditions.<sup>(19)</sup> Bellomo et al. reported a mortality rate of 10.6% in patients seen by a team of medical emergency personnel, excluding the patients under palliative care.<sup>(9)</sup> The implementation of an RRT has been described as an experience that results in the decrease of cardiac arrests and hospital mortality.<sup>(20,21)</sup>

Several patients in the present study were in pent-up demand, waiting for an ICU bed. Waiting for an ICU admission was considered to increase the probability of death, even when the patient is finally admitted.<sup>(22)</sup> It is possible that, with the restriction of access to ICU beds as in this scenario, the implementation of an alert system based on the combined signs of clinical instability, such as the Modified Early Warning System (MEWS),<sup>(23)</sup> may help to identify earlier the code yellow situations and reduce mortality.

The difference in the mortality rates between the critical patients waiting for an ICU bed in pent-up demand and the other patients seen under code yellow conditions reflects a reality and is of great concern. Although the RRT provides care to critical patients

outside of the ICU and potentially increases inpatient safety, it is possible to infer that a rapid response system is only completely effective if there is a specialized intensive care bed available for the immediate transfer of such patients.<sup>(24)</sup>

There are limitations in the present study that should be taken into account. This study was carried out in one site only, a public teaching hospital that had no beds available in the intermediate care unit, which restricts a patient's access to specialized intensive care, the results of the present study are not applicable to institutions with different infrastructures and organizational characteristics. Moreover, the small number of events analyzed and the peculiar fact that the institution's RRT does not work fulltime may have influenced the results.

## CONCLUSIONS

This study revealed that there are critical patients who need intensive specialized care in regular ward unit hospital beds. Many of these patients were previously identified by the assistance team as critical patients who may benefit from the services of a specialized team.

Clinical instability that was associated with the need for a rapid response team activation was a common event in the inpatient units of the studied hospital. The events that most frequently led to the code yellow activation were related to respiratory and hemodynamic support. The interventions performed demonstrate the need for a physician in the team. The pent-up demand scenario is associated with a higher mortality rate among patients under code yellow conditions.

## RESUMO

**Objetivo:** Descrever dados epidemiológicos de eventos de instabilidade clínica em pacientes atendidos pelo time de resposta rápida e identificar fatores prognósticos.

**Métodos:** Estudo longitudinal, realizado de janeiro a junho de 2010, com população adulta internada em ambiente hospitalar. Os dados coletados sobre o atendimento do código amarelo foram critérios de instabilidade clínica, terapia medicamentosa e não medicamentosa, orientações e procedimentos. Os desfechos avaliados foram necessidade de admissão em unidade de terapia intensiva e mortalidade hospitalar. O nível de significância utilizado foi de  $p=0,05$ .

**Resultados:** Foram avaliados 150 códigos amarelos que ocorreram com 104 pacientes. Os motivos mais frequentes estiveram relacionados à insuficiência respiratória aguda, apresentando hipóxia ou alteração da frequência respiratória, e preocupação da equipe com o estado clínico do paciente. Houve necessidade de

solicitação de transferência para unidade de terapia intensiva em 80/150 (53,3%) ocasiões. Foi necessária a realização de 42 procedimentos, sendo os mais frequentes a intubação orotraqueal e a inserção de cateter venoso central. Os pacientes graves que aguardavam leito de unidade de terapia intensiva apresentaram maior chance de morte, comparados aos demais pacientes (*hazard ratio*: 3,12; IC95%: 1,80-5,40;  $p<0,001$ ).

**Conclusão:** Existem pacientes graves que necessitam de tratamento intensivo especializado nos leitos comuns de enfermarias dos hospitais. Os eventos que mais levaram ao acionamento do código amarelo estiveram relacionados a suporte respiratório e hemodinâmico. As intervenções realizadas caracterizam a necessidade do médico na equipe. A situação de demanda reprimida está associada à maior mortalidade.

**Descritores:** Equipe de respostas rápidas de hospitais; Tratamento de emergência; Segurança do paciente; Pacientes internados

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