Clinical Significance of Heart Rate in Acute Cardiovascular Diseases — Simple But Meaningful —

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As a vital sign, heart rate (HR) is a simple and important cardiovascular index. The regulation of HR is controlled not only by the autonomic nervous system (i.e., the sympathetic and parasympathetic nervous systems), but also by other hormone systems and channels of the cardiac conduction system. Furthermore, it is important to remember that the response of each of the intrinsic systems involved in the adjustment of HR depends on the time after the onset of acute cardiovascular diseases (Figure). Rapid adjustments in HR by reflex systems, such as baroreflex and chemoreceptor activation, occur within seconds, whereas HR responses to changes in vascular

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tone and body fluid volume occur minutes after the rapid adjustments by reflex systems. Several hormonal mechanisms, including HR regulation by the renin-angiotensin-aldosterone system, are activated over the next hour or days. Blood pressure and HR are affected by these intrinsic factors.¹ Thus, the clinical significance of HR should be considered bearing in mind the time from onset of cardiovascular diseases. In acute heart failure, the relationship between HR and outcome remains controversial. Several

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studies have shown that high HR at admission is related to poor outcome;^{2,3} in contrast, other studies have demonstrated that the higher the HR at admission, the better the outcome.^{4,5} In the case of the former, the proposed rationale is that both higher HR due to a more activated sympathetic nervous system with acute decompensation of heart failure (HF) and cardiac remodeling caused by sustained high HR must be related to poor outcome. It is known that high HR is related to poor outcome in chronic HF states.⁶ In the case of higher HR at admission being associated with better outcome, the proposed rationale is chronotropic incompetence. Low HR after onset of acute cardiovascular diseases must be caused by impaired cardiac reflexes, which is reportedly associated with the severity and outcomes of HF.⁷

In this issue of the Journal, Matsumoto et al demonstrated that the higher the post-resuscitation HR in patients who were rescued from out-of-hospital cardiac arrest due to acute coronary syndrome and survived, the worse the prognosis.⁸ The relationship between HR after resuscitation and outcome has not been clarified previously. The study of Matsumoto et al demonstrated that HR after resuscitation can be used to predict the prognosis of patients with acute coronary syndrome with out-of-hospital cardiac arrest.⁸ There are points to note in interpreting the results of that study. First, HR must be changed by time-dependent effects of intrinsic factors, including reflexes, neurohormonal systems, and cardiac conducting systems, as mentioned above (**Figure**). Second, early management affects HR after resuscitation. In particular, the type and dose of drugs administered, including vasoactive agents, inotropes, and vasodilators, can affect HR. The results of the study of Matsumoto et al showed that there was no relationship between the dose of epinephrine administered and HR, indicating that patients with high HR, with or without epinephrine, had a poor prognosis.⁸ However, it should be noted that drugs other than epinephrine, such as dopamine, norepinephrine, dobutamine, and amiodarone, can affect HR, although there was no difference in the proportion of the use of these drugs between the 2 groups. An interesting study was recently reported.⁹ That study was a double-blind multicenter randomized trial comparing the efficacy and safety of epinephrine and norepinephrine in patients with cardiogenic shock following acute myocardial infarction that found that both drugs were equivalent in terms of changes in blood pressure and cardiac index, but that epinephrine significantly increased HR in the early stage of administration compared with norepinephrine and significantly increased double products and lactic acidosis.⁹ Furthermore, the use of epinephrine was associated with a higher incidence of refractory shock. The findings of that study suggest that norepinephrine may be better than

epinephrine in supporting arterial pressure in patients with acute myocardial infarction with cardiogenic shock who undergo successful primary coronary intervention.⁹ Together, the observations indicate that it is important to consider which drug to administer in early management in terms of changes in HR to improve outcome.

Non-pharmacological interventions, such as coronary interventions and mechanical circulatory support devices, as well as pharmacological interventions also affect HR (**Figure**). The relationship between such extrinsic factors (except drugs) related to changes in HR changes and outcome has not been investigated, and should be clarified in the future. Finally, another important point in considering the clinical significance of HR is rhythm. The effects of sinus rhythm and atrial fibrillation on hemodynamics and outcome must be different. The HR adjustment in atrial fibrillation and sinus rhythm in the acute phase needs to be discussed separately.

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