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# The importance of assessing left ventricular longitudinal function in presence of increased afterload

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Dear Editor,

We read with interest the findings reported by *de Courson* et al.[1] regarding cardiac dysfunction in patients with good-grade subarachnoid haemorrhage (SAH), which is associated with a potentially massive surge in catecholamines. The precise prevalence of cardiac dysfunction in this population remains unclear. A recent meta-analysis[2] of 23 studies focusing on SAH patients revealed large heterogeneity in clinical outcomes and suggested that about one in five patients with SAH develops cardiac dysfunction, similar to the prevalence of cardiomyopathy observed in sepsis[3]. Such an event seemed associated with higher in-hospital mortality [odds ratio 2.69 (1.64 to 4.41);  $p < 0.001$ ;  $I^2 = 63\%$ ], though with very low certainty of evidence. Most included studies used unspecific criteria for diagnosis of cardiac dysfunction such as regional wall motion abnormality, while only three studies used left ventricular ejection fraction

(LVEF), and the other two defined cardiac dysfunction by speckle-tracking echocardiography.

Hence, *de Courson* et al.[1] should be commended for performing an advanced and detailed study using speckle-tracking echocardiography with global longitudinal strain (GLS) analysis. Importantly, the authors investigated the relationship between GLS and LVEF. We think that a couple of aspects deserve comments and more in-depth analysis.

First, the authors reported a very high prevalence of cardiac dysfunction (60.6%) when using GLS  $-20\%$  as a cut-off, but this prevalence decreased to 21.2% when using a more restrictive cut-off for cardiac dysfunction (GLS  $-17\%$ ). We believe that the latter cut-off is reasonable. For instance, a recent meta-analysis showed that longitudinal strain in septic patients averages between  $-14$  and  $-15\%$ , with a 1.45% absolute mean difference according to survival[4], similarly to findings previously published in the journal[5]. Such findings reinforce the belief that GLS cut-off used in the outpatient population may not be appropriate for critically ill patients.

Second, the authors confirmed that LVEF may not be a valuable parameter to identify early cardiac dysfunction in this population, being altered in only 1.7% and showing no correlation with GLS ( $p = 0.69$ ). This may be explained by an alteration in myocardial longitudinal deformation (GLS) at earlier stages as compared to LVEF. This is not surprising as an initial reduction in longitudinal contractility may be compensated by an increased circumferential function so that LVEF results are just marginally affected as opposed to GLS at earlier stages. Moreover, GLS is very sensitive to afterload[6–10]. For

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instance, in patients with aortic stenosis GLS is significantly more sensitive to the variation of afterload than LVEF[9, 10]. Considering the potentially massive catecholamine release in patients with SAH[11], systemic vascular resistances may increase substantially in these patients and LVEF may not be a valuable variable. In the study by *de Courson et al.*[1], both mean arterial pressure and systemic vascular resistances were high (ranges of median 100 mmHg and 1606–1866 dyn·sec·cm<sup>-5</sup>, respectively), which may have led to an alteration of GLS as a sign of subclinical LV systolic dysfunction. In this regard, the authors reported a third parameter investigating cardiac contractility, the mitral s' wave obtained with tissue Doppler imaging. This parameter investigates myocardial longitudinal function and, for this reason, may be a better surrogate of GLS as compared to LVEF. Our group performed a large study in septic showing that mitral s' and LVEF were not interchangeable, with only a moderate correlation[12]. We would ask the authors to analyse and report on the correlation and concordance of mitral s' and GLS in patients with SAH. Considering the much higher availability and greater feasibility of tissue Doppler imaging measurements as compared to the limited feasibility of obtaining strain imaging (available in only 43% of enrolled patients) in intensive care[13], it would be valuable for clinicians to understand whether mitral s' wave could be used as a surrogate of GLS.

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#### Author contributions

FS was responsible for conceptualization, writing—original draft, writing—review & editing. CS contributed to writing—review & editing. RS contributed to writing—review & editing. SD contributed to writing—review & editing. All authors conducted a literature review to identify prevalence of cardiac dysfunction as described in the manuscript. All the authors have read and approved the final manuscript.

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None.

#### References

- de Courson H, Chadeaux G, Loiseau A, Georges D, Biais M. Myocardial dysfunction assessed by speckle-tracking in good-grade subarachnoid hemorrhage patients (WFNS 1–2): a prospective observational study. *Critical care* (London, England). 2023;27(1):455.
- Messina A, Longhitano Y, Zanza C, Calabrò L, Villa F, Cammarota G, Sanfilippo F, Cecconi M, Robba C. Cardiac dysfunction in patients affected by subarachnoid haemorrhage affects in-hospital mortality: a systematic review and meta-analysis. *Eur J Anaesthesiol*. 2023;40(6):442–9.
- Hasegawa D, Ishisaka Y, Maeda T, Prasitlumkum N, Nishida K, Dugar S, Sato R. Prevalence and prognosis of sepsis-induced cardiomyopathy: a systematic review and meta-analysis. *J Intensive Care Med*. 2023;38(9):797–808.
- Pruszczuk A, Zawadka M, Andruszkiewicz P, La Via L, Herpain A, Sato R, Dugar S, Chew MS, Sanfilippo F. Mortality in patients with septic cardiomyopathy identified by longitudinal strain by speckle tracking echocardiography: an updated systematic review and meta-analysis with trial sequential analysis. *Anaesth Critic care Pain Med*. 2023. <https://doi.org/10.1016/j.accpm.2023.101339>.
- Sanfilippo F, Corredor C, Fletcher N, Tritapepe L, Arcadipane A, Vieillard-Baron A, Cecconi M. Left ventricular systolic function evaluated by strain echocardiography and relationship with mortality in patients with severe sepsis or septic shock: a systematic review and meta-analysis. *Critical care* (London, England). 2018;22(1):183.
- Rosner A, Bijmens B, Hansen M, How OJ, Aarsaether E, Muller S, Sutherland GR, Myrmet L. Left ventricular size determines tissue Doppler-derived longitudinal strain and strain rate. *Eur J Echocardiogr*. 2009;10(2):271–7.
- Aissaoui N, Guerot E, Combes A, Delouche A, Chastre J, Leprince P, Leger P, Diehl JL, Fagon JY, Diebold B. Two-dimensional strain rate and Doppler tissue myocardial velocities: analysis by echocardiography of hemodynamic and functional changes of the failed left ventricle during different degrees of extracorporeal life support. *J Am Soc Echocardiogr*. 2012;25(6):632–40.
- Park HE, Chang SA, Kim HK, Shin DH, Kim JH, Seo MK, Kim YJ, Cho GY, Sohn DW, Oh BH, et al. Impact of loading condition on the 2D speckle tracking-derived left ventricular dyssynchrony index in nonischemic dilated cardiomyopathy. *Circ Cardiovasc Imaging*. 2010;3(3):272–81.
- Carasso S, Cohen O, Mutlak D, Adler Z, Lessick J, Reisner SA, Rakowski H, Bolotin G, Agmon Y. Differential effects of afterload on left ventricular long- and short-axis function: insights from a clinical model of patients with aortic valve stenosis undergoing aortic valve replacement. *Am Heart J*. 2009;158(4):540–5.
- Miyazaki S, Daimon M, Miyazaki T, Onishi Y, Koiso Y, Nishizaki Y, Ichikawa R, Chiang SJ, Makinae H, Suzuki H, et al. Global longitudinal strain in relation to the severity of aortic stenosis: a two-dimensional speckle-tracking study. *Echocardiography* (Mount Kisco, NY). 2011;28(7):703–8.
- Salem R, Vallée F, Dépret F, Callebert J, Maurice JP, Marty P, Matéo J, Madadaki C, Houdart E, Bresson D, et al. Subarachnoid hemorrhage induces an early and reversible cardiac injury associated with catecholamine release: one-week follow-up study. *Critical care* (London, England). 2014;18(5):558.
- Chawla S, Sato R, Duggal A, Alwakeel M, Hasegawa D, Alayan D, Collier P, Sanfilippo F, Lanspa M, Dugar S. Correlation between tissue Doppler-derived left ventricular systolic velocity (S') and left ventricle ejection fraction in sepsis and septic shock: a retrospective cohort study. *J Intensive Care*. 2023;11(1):28.
- Vieillard-Baron A, Millington SJ, Sanfilippo F, Chew M, Diaz-Gomez J, McLean A, Pinsky MR, Pulido J, Mayo P, Fletcher N. A decade of progress in critical care echocardiography: a narrative review. *Intensive Care Med*. 2019;45(6):770–88.

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