ORIGINAL RESEARCH PAPER
Volume - 13 | Issue - 05 | May - 2024 | PRINT ISSN No. 2277 - 8179 | DOI : 10.36106/ijsr
INTERNATIONAL JOURNAL OF SCIENTIFIC RESEARCH

ROLE OF GCS-PUPILS AND LACTATE LEVEL TO PREDICT SHORT TERM PROGNOSIS IN TRAUMATIC BRAIN INJURY

General Surgery

Dr. Sameer Ahmed Jatoo Junior Resident, Department of General Surgery, Mahatma Gandhi Mission Medical College, Navi Mumbai,

Dr. Dikpal Jadhav Associate Professor, Department of Neurosurgery, Mahatma Gandhi Mission Medical College, Navi Mumbai.

Dr. Nandini Patel* Junior Resident, Department of General Surgery, Mahatma Gandhi Mission Medical College, Navi Mumbai. *Corresponding Author

Dr. Bhumika Padole Junior Resident, Department of General Surgery, Mahatma Gandhi Mission Medical College, Navi Mumbai.

ABSTRACT

The aim of the study is to determine whether the combination of Glasgow coma scale (GCS) and pupil responses score (GCSP) with arterial lactate level would be an index to predict short term prognosis in patients with traumatic brain injury (TBI). GCSP is used to assess 4 aspects of a patient's responsiveness, which are eye, verbal, motor responses, and pupil responses. The role of arterial lactate in TBI has gained great interest. Although higher arterial lactate may be a biomarker of poor systemic physiology, it may have neuroprotective effects on the intracranial pressure (ICP), the cerebral blood flow (CBF), and cerebral cellular metabolism. High lactate may be a protective factor for TBI patients. The interdisciplinary approach adopted in this study, encompassing neurology, critical care, and metabolic assessment, reflects the multifaceted nature of traumatic brain injuries. By combining traditional neurological assessments (GCS and pupillary response) with emerging markers of metabolic dysfunction (lactate levels), the study aims to provide a holistic and nuanced understanding of the prognostic landscape in traumatic brain injuries.

KEYWORDS

Traumatic Brain Injury, GCS, Pupil, Lactate.

INTRODUCTION:

Traumatic brain injury (TBI) stands as a pervasive global health challenge, accounting for a substantial portion of trauma-related incidents and emerging as a leading cause of both physical and cognitive disabilities. The prevalence of TBI spans across diverse populations and age groups, making it a critical public health concern. Globally, it is estimated that millions of people suffer from TBI annually, with significant variations in incidence rates observed across regions and socioeconomic strata. (1–3) The consequences of TBI are profound, often resulting in long-lasting impairments that impact not only the affected individuals but also their families and communities. Recognizing the gravity of this health issue, early identification of a patient's clinical condition becomes paramount for effective management and improved outcomes. Timely and accurate prognosis is crucial for tailoring treatment strategies, counselling families, assessing the quality of care, and allocating medical resources efficiently. (2,4,5)

At the forefront of assessing the severity of traumatic brain injuries is the Glasgow Coma Scale (GCS), a standardized tool introduced in 1974 by Graham Teasdale and Bryan J. Jennett.(6) The GCS evaluates three key components of neurological function: eye opening, verbal response, and motor response. Scores on the GCS range from 3 to 15, with lower scores indicating more severe impairment. The GCS has become a cornerstone in the initial assessment of traumatic brain injuries, offering a quick and reliable means of categorizing patients based on their level of consciousness.(6,7) Pupillary response, another crucial aspect of neurological examination, offers insights into the integrity of the brainstem and cranial nerves. Deviations from normal pupillary reactions, such as unequal or non-reactive pupils, have been consistently linked to adverse outcomes in traumatic brain injury patients. The examination of pupils not only complements the information gathered from the GCS but also provides a specific focus on brainstem function, which is vital for survival and recovery.(8,9)

In recent years, there has been a growing interest in exploring metabolic markers as prognostic indicators in traumatic brain injuries. Lactate, a byproduct of anaerobic metabolism, has emerged as a potential marker of tissue hypoxia and cellular distress. Elevated lactate levels in the context of traumatic brain injuries have been associated with poor outcomes, reflecting the systemic and metabolic consequences of severe neurological insult. As such, the inclusion of lactate assessment in the prognostic toolkit offers a more comprehensive understanding of the pathophysiological processes at play.(10–13)

The decision to undertake a study focusing on the role of GCS, pupillary response, and lactate levels in predicting short-term prognosis in traumatic brain injuries at MGM Medical College Panvel is rooted in the unique characteristics of the patient population served by the institution. MGM Medical College Panvel, being situated at the junction of two national highways, is strategically positioned to cater to a diverse demographic that is particularly prone to road traffic accidents.

The private medical college's location at the crossroads of major highways contributes to a substantial influx of trauma cases, many of which involve traumatic brain injuries. Understanding the specific challenges and patterns of injuries in this region is crucial for tailoring effective healthcare strategies. The demographics, traffic dynamics, and socioeconomic factors in and around MGM Medical College Panvel create a distinctive context that warrants a focused investigation into prognostic factors associated with traumatic brain injuries.

Moreover, the emphasis on traumatic brain injuries is imperative considering the broader societal impact. Beyond the immediate health implications for the affected individuals, traumatic brain injuries often result in long-term cognitive, emotional, and functional consequences. These, in turn, pose significant challenges for rehabilitation services, necessitating a comprehensive understanding of the factors that influence short-term prognosis.

The interdisciplinary approach adopted in this study, encompassing neurology, critical care, and metabolic assessment, reflects the multifaceted nature of traumatic brain injuries. By combining traditional neurological assessments (GCS and pupillary response) with emerging markers of metabolic dysfunction (lactate levels), the study aims to provide a holistic and nuanced understanding of the prognostic landscape in traumatic brain injuries.

MATERIALS AND METHODOLOGY:

Study Design:

This study employed a retrospective design to analyse the clinical data of traumatic brain injury (TBI) patients. The retrospective nature allowed for the examination of existing medical records, providing valuable insights into the association between Glasgow Coma Scale (GCS), pupillary response (P), lactate levels, and clinical outcomes.

Sample Size and Sampling Technique:

The study included a sample size of 100 TBI patients. The participants were selected through a complete enumeration sampling technique. All the patients admitted to the hospital with a diagnosis of TBI during the study period (April 2022- March 2023). The complete enumeration sampling method ensured the inclusion of all the which satisfied the following inclusion and exclusion criteria.

Inclusion Criteria:
Diagnosed with traumatic brain injury, Availability of complete medical records, including GCS, pupillary response, and lactate level data. Age within the specified range for the study.

Exclusion Criteria:
Patients with history of chronic kidney and liver diseases, Unstable hemodynamic parameters and Obvious signs of infection (pulmonary, intracranial infection, etc.), as these conditions can impact lactate concentration were excluded from study.

Data Collection:
After the Ethics Committee of the institution approval, ensuring adherence to ethical standards and patient confidentiality the data collection was initiated. Informed consent was not required as the study utilized retrospective data, maintaining anonymity and privacy.

- **Clinical Parameters:** GCS scores on admission, pupillary response, and S. lactate concentration (mmol/ml) were retrieved from the electronic health records and indoor papers of the patients.
- **Demographic Information:** Patient age, sex, and relevant medical history were collected.
- **Clinical Outcome Assessment:** The Glasgow Outcome Scale (GOS) was employed to assess clinical outcomes after discharge. GOS categories include 1=death, 2=vegetative, 3=severe disability, 4=moderate disability, and 5=good recovery. We considered outcomes where patients experienced good recovery or moderate disability as favorable. On the other hand, outcomes categorized as severe disability, vegetative state, and death were considered unfavorable.

Statistical Analysis:
Quantitative variables like age, GCS, GSCP, GCSPL and lactate concentration are represented with Mean SD or Median, IQR. Qualitative variables like outcome of the patients, gender, GOS at discharge, grades of GCSP scores, lactate concentration (<2, 2-5 and >5) are presented with frequency and percentage. Receiver Operating Characteristic (ROC) analysis was used to assess predictive performance. The Area Under the Curve (AUC) of the ROC was calculated to gauge the predictive accuracy of Glasgow Coma Scale (GCSP), lactate, and the combination of GCSP and lactate (GCSP-L). Statistical significance was established at a p-value less than 0.05. The statistical analyses were conducted using SPSS version 23.0 (IBM Corporation in the USA)

RESULTS:
In this STUDY involving 100 traumatic brain injury (TBI) patients, demographic distribution showed a predominance of males (79%) with an average age of 46.5 years. Glasgow Outcome Scale (GOS) outcomes indicated that 49% experienced good recovery, while 25% faced unfortunate outcomes, including death. Categorizing outcomes as favorable and unfavorable revealed that 69% of patients had favorable outcomes. The most common TBI diagnosis was subdural hematoma (33%). Lactate concentration analysis demonstrated that 54% of patients had levels below 2, 34% between 2-5, and 12% exceeding 5.

Sensitivity and specificity based on GCSP, GCSP-L and lactate
Table 3 provides a detailed overview of the Receiver Operating Characteristic (ROC) analysis, evaluating the predictive performance of Glasgow Coma Scale (GCSP), the combination of GCSP and lactate (GCSPL), and lactate concentration in traumatic brain injury (TBI) patients. The Area Under the Curve (AUC) values, a measure of the models' ability to discriminate between favorable and unfavorable outcomes, were 0.886 for GCSP, 0.807 for GCSPL, and 0.856 for lactate concentration. These values indicate substantial predictive strength, with all p-values being less than 0.001, signifying statistical significance. The corresponding sensitivities and specificities further highlight the diagnostic accuracy of these variables. GCSP exhibited a sensitivity of 81.2% and specificity of 80.6%, GCSPL demonstrated a sensitivity of 76.8% and specificity of 74.2%, while lactate concentration showed a sensitivity of 87.1% and specificity of 72.5%. The 95% confidence intervals, ranging from 0.720 to 0.893 for GCSPL, 0.779 to 0.932 for lactate concentration, and 0.823 to 0.949 for GCSP, strengthen the robustness of these predictive models.

DISCUSSION:
The findings from this study of 100 traumatic brain injury (TBI) patients provide valuable insights into the demographics, clinical outcomes, and predictive abilities of Glasgow Coma Scale (GCSP), the combination of GCSP and lactate (GCSPL), and lactate concentration. The observed male predominance (79%) aligns with existing literature on TBI demographics, highlighting the higher incidence of TBI in males.(14–16) The average age of 46.5 years is consistent with the broader age distribution reported in TBI studies. (14,17–19)

The Glasgow Outcome Scale (GOS) outcomes in our study, with 49% experiencing good recovery and 25% facing unfavorable outcomes, resonate with the complex and varied trajectories seen in TBI patients. The prevalence of subdural hematoma as the most common TBI diagnosis (33%) aligns with the literature, reflecting the diverse etiology of TBI.(14–16)

The Receiver Operating Characteristic (ROC) analysis demonstrated strong predictive capabilities for GCSP, GCSPL, and lactate concentration. The AUC values of 0.886, 0.807, and 0.856, respectively, indicate robust discriminative power in forecasting favorable and unfavorable outcomes. These findings are consistent with previous research highlighting the utility of GCSP and lactate as prognostic indicators in TBI. (16,18,20,21)

Comparing our results with similar studies, our study's sensitivities and specificities align with those reported in the literature.(21,22) The 95% confidence intervals further support the reliability of our predictive models. The observed variations in ROC curve characteristics could be attributed to differences in sample sizes, patient populations, and healthcare settings, emphasizing the need for context-specific interpretations.

While the present study contributes valuable insights, certain limitations warrant consideration. The retrospective nature may introduce biases, and the exclusion criteria might influence the generalizability of findings. Additionally, variations in clinical practices and protocols across institutions may impact the results.

CONCLUSION:
In conclusion, our study underscores the significance of GCSP, GCSPL, and lactate concentration as reliable predictors in TBI. The ROC analysis, supported by existing literature, emphasizes the potential for these variables to enhance prognostic accuracy. The discussion provides a contextual interpretation of the results, acknowledging both consistencies and variations, contributing to the broader understanding of prognostic factors in TBI.

Limitations:
Its retrospective design and reliance on medical records might have introduced potential biases and information gaps. The small sample size, complete enumeration and single-center setting might limit generalizability, and exclusion criteria could introduce selection bias. Variability in clinical practices across institutions, short follow-up, and lack of consideration for confounding factors might be deterrent for applicability in all the clinical settings outside Indian subcontinent.

Table 1:

Gender		
	Frequency	Percentage
Male	79	79.0%
Female	21	21.0%
Age (46.5± 15.2) Years		
≤50 Years	68	68.0%
>50 Years	32	32.0%
GOS Outcome		
Death	25	25.0%
Severe Disability	6	6.0%
Moderate Disability	20	20.0%
Good Recovery	49	49.0%
Total	100	100.0%

Outcome		
Unfavourable Outcome	31	31.0%
Favourable Outcome	69	69.0%
Diagnosis		
Contusion	29	29.0%
EDH	15	15.0%
IC Bleed	7	7.0%
Pneumocephalus	8	8.0%
SAH+SDH	8	8.0%
SDH	33	33.0%
Lactate Concentration		
<2	54	54.0%
2 -- 5	34	34.0%
>5	12	12.0%

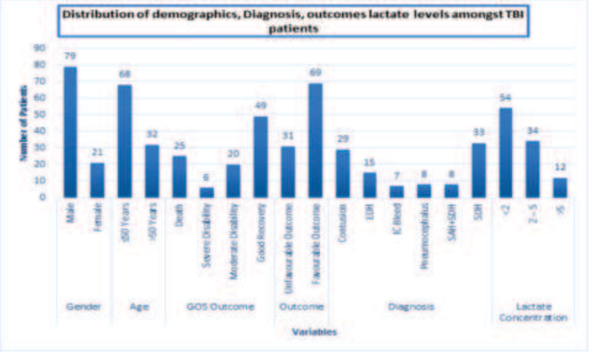


Table 2:

Table 2 Gender and agewise distribution of Diagnosis, lactate levels and grades of GCSP of TBI

		SEX		P value	Age Groups		Total	P value
		Male	Fe male		≤50 Years	>50 Years		
Diagnosis	CONTUSION	29	0	<0.001	12	17	29	<0.001
		100.0%	0.0%		41.4%	58.6 %	100.0 %	
	EDH	15	0		15	0	15	
		100.0%	0.0%		100.0 %	0.0%	100.0 %	
	IC BLEED	7	0		0	7	7	
		100.0%	0.0%		0.0%	100.0 %	100.0 %	
	PNEUMOCEPHALUS	8	0		0	8	8	
		100.0%	0.0%		0.0%	100.0 %	100.0 %	
	SAH+ SDH	8	0		8	0	8	
		100.0%	0.0%		100.0 %	0.0%	100.0 %	
	SDH	12	21		33	0	33	
		36.4%	63.6%		100.0 %	0.0%	100.0 %	
Lactate Levels	<2	43	11	0.936	32	22	54	0.116
		79.6%	20.4%		59.3%	40.7 %	100.0 %	
	2--5	27	7		26	8	34	
		79.4%	20.6%		76.5%	23.5 %	100.0 %	
	>5	9	3		10	2	12	
		75.0%	25.0%		83.3%	16.7 %	100.0 %	
GCSP	Mild (13–15)	39	12	0.474	26	25	51	0.01
		76.5%	23.5%		51.0%	49.0 %	100.0 %	
	Moderate (9–12)	36	9		39	6	45	
		80.0%	20.0%		86.7%	13.3 %	100.0 %	
	Severe (1–8)	4	0		3	1	4	
		100.0%	0.0%		75.0%	25.0 %	100.0 %	

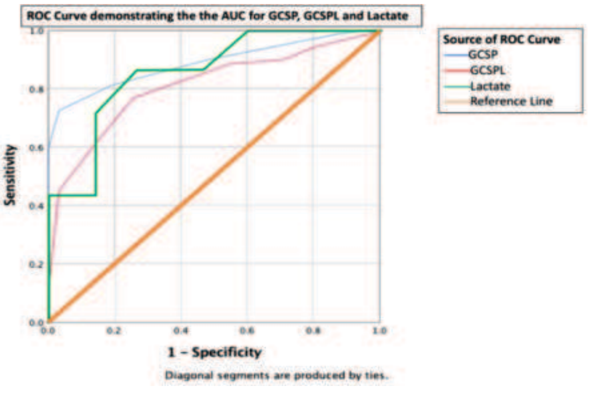
Out come	Unfavourable	24	7	0.288	27	4	31	0.247
		77.4%	22.6%		87.1%	12.9%	100.0%	
	Fav ourable	44	25		52	17	69	
		63.8%	36.2%		75.4%	24.6%	100.0%	

Table 3

Table 3 The receiver operating curves (ROC) of GCSP, lactate and GCSP-L (Area Under the Curve)

Test Result Variable(s)	Area	Std. Error	P value	95% Confidence Interval	Sensitivity	Specificity
GCSP	0.886	0.032	<0.001	(0.823-0.949)	81.2%	80.6%
GCSPL	0.807	0.044	<0.001	(0.720-0.893)	76.8%	74.2%
Lactate concentration (mmol/L)	0.856	0.039	<0.001	(0.779-0.932)	87.1%	72.5%

The test result variable(s): GCSP, GCSPL, Lactate Concentration has at least one tie between the positive actual state group and the negative actual state group. Statistics may be biased.



REFERENCES

1. Dewan MC, Rattani A, Gupta S, Baticulon RE, Hung YC, Punchak M, et al. Estimating the global incidence of traumatic brain injury. J Neurosurg [Internet]. 2018 Apr 27 [cited 2023 Dec 11];130(4):1080–97. Available from: https://thejns.org/view/journals/j-neurosurg/130/4/article-p1080.xml
2. Cole TB. Global road safety crisis remedy sought: 1.2 million killed, 50 million injured annually. JAMA [Internet]. 2004 Jun 2 [cited 2023 Dec 11];291(21):2531–2. Available from: https://pubmed.ncbi.nlm.nih.gov/15173131/
3. Maas AIR, Menon DK, David Adelson PD, Andelic N, Bell MJ, Belli A, et al. Traumatic brain injury: integrated approaches to improve prevention, clinical care, and research. Lancet Neurol [Internet]. 2017 Dec 1 [cited 2023 Dec 11];16(12):987–1048. Available from: http://www.thelancet.com/article/S147444221730371X/fulltext
4. Majdan M, Plancikova D, Maas A, Polinder S, Feigin V, Theadom A, et al. Years of life lost due to traumatic brain injury in Europe: A cross-sectional analysis of 16 countries. PLoS Med [Internet]. 2017 Jul 1 [cited 2023 Dec 11];14(7):e1002331. Available from: https://journals.plos.org/plosmedicine/article?id=10.1371/journal.pmed.1002331
5. Roozenbeek B, Maas AIR, Menon DK. Changing patterns in the epidemiology of traumatic brain injury. Nature Reviews Neurology 2013 9:4 [Internet]. 2013 Feb 26 [cited 2023 Dec 11];9(4):231–6. Available from: https://www.nature. com/articles/ nrneurol.2013.22
6. Teasdale G, Jennett B. Assessment of coma and impaired consciousness. A practical scale. Lancet [Internet]. 1974 Jul 13 [cited 2023 Dec 11];2(7872):81–4. Available from: https:// pubmed.ncbi.nlm.nih.gov/4136544/
7. Jain S, Iverson LM. Glasgow Coma Scale. StatPearls [Internet]. 2023 Jun 12 [cited 2023 Dec 11]; Available from: https://www.ncbi.nlm.nih.gov/books/NBK513298/
8. Brennan PM, Murray GD, Teasdale GM. Simplifying the use of prognostic information in traumatic brain injury. Part 1: The GCS-Pupils score: An extended index of clinical severity. J Neurosurg. 2018 Jun 1;128(6):1612–20.
9. Reith FCM, Lingsma HF, Gabbe BJ, Lecky FE, Roberts I, Maas AIR. Differential effects of the Glasgow Coma Scale Score and its Components: An analysis of 54,069 patients with traumatic brain injury. Injury [Internet]. 2017 Sep 1 [cited 2023 Dec 11]; 48(9): 1932–43. Available from: https://pubmed.ncbi.nlm.nih.gov/28602178/
10. Khalili H, Rismani M, Nematollahi MA, Masoudi MS, Asadollahi A, Taheri R, et al. Prognosis prediction in traumatic brain injury patients using machine learning algorithms. Scientific Reports 2023 13:1 [Internet]. 2023 Jan 18 [cited 2023 Dec 11];13(1):1–15. Available from: https://www.nature.com/articles/s41598-023-28188-w
11. Ghaith HS, Nawar AA, Gabra MD, Abdelrahman ME, Nafady MH, Bahbah EI, et al. A Literature Review of Traumatic Brain Injury Biomarkers. Molecular Neurobiology 2022 59:7 [Internet]. 2022 Apr 30 [cited 2023 Dec 11];59(7):4141–58. Available from: https://link.springer.com/article/10.1007/s12035-022-02822-6
12. Mondello S, Muller U, Jeromin A, Streeter J, Hayes RL, Wang KK. Blood-based diagnostics of traumatic brain injuries. Expert Rev Mol Diagn [Internet]. 2011 Jan [cited 2023 Dec 11];11(1):65. Available from: /pmc/articles/PMC3063529/
13. Helmrich IRAR, Lingsma HF, Turgeon AF, Yamal JM, Steyerberg EW. Prognostic Research in Traumatic Brain Injury: Markers, Modeling, and Methodological Principles. J Neurotrauma [Internet]. 2021 Sep 15 [cited 2023 Dec 11];38(18):2502–13. Available from: https://pubmed.ncbi.nlm.nih.gov/32316847/
14. S AS, Swamiyappan SS, Visweswaran V, Bathala RT, Krishnaswamy V, Davuluri VS, et al. Biochemical and Radiological Factors for Prognostication of Traumatic Brain Injury: An Institutional Experience. Cureus [Internet]. 2023 Jun 26 [cited 2023 Dec 12];15(6). Available from: https://www.cureus.com/articles/162444-biochemical-and-

radiological-factors-for-prognostication-of-traumatic-brain-injury-an-institutional-experience

15. Liu C, Xie J, Xiao X, Li T, Li H, Bai X, et al. Clinical predictors of prognosis in patients with traumatic brain injury combined with extracranial trauma. Int J Med Sci [Internet]. 2021 [cited 2023 Dec 12];2021(7):1639–47. Available from: http://www.medsci.org://creativecommons.org/licenses/by/4.0/
16. Wang YM, Zhu N, Zhou YM, Su R, Li HL, Zhou JX. The combination of arterial lactate level with GCS-pupils score to evaluate short term prognosis in traumatic brain injury: a retrospective study. BMC Neurol [Internet]. 2022 Dec 1 [cited 2023 Dec 12];22(1). Available from: https://pubmed.ncbi.nlm.nih.gov/36380277/
17. Reith FCM, Lingsma HF, Gabbe BJ, Lecky FE, Roberts I, Maas AIR. Differential effects of the Glasgow Coma Scale Score and its Components: An analysis of 54,069 patients with traumatic brain injury. Injury [Internet]. 2017 Sep 1 [cited 2023 Dec 12];48(9):1932–43. Available from: http://www.injuryjournal.com/article/ S0020138317303637/fulltext
18. Hoffmann M, Surgery on behalf of the TR of the GS for T, Lefering R, Surgery on behalf of the TR of the GS for T, Rueger JM, Surgery on behalf of the TR of the GS for T, et al. Pupil evaluation in addition to Glasgow Coma Scale components in prediction of traumatic brain injury and mortality. British Journal of Surgery [Internet]. 2011 Dec 22 [cited 2023 Dec 12];99(Supplement_1):122–30. Available from: https://dx.doi.org/10.1002/bjs.7707
19. Amorim RL, Oliveira LM, Malbouisson LM, Nagumo MM, Simoes M, Miranda L, et al. Prediction of Early TBI Mortality Using a Machine Learning Approach in a LMIC Population. Front Neurol. 2020 Jan 24;10:479132.
20. Régnier MA, Raux M, Le Manach Y, Asencio Y, Gaillard J, Devilliers C, et al. Prognostic Significance of Blood Lactate and Lactate Clearance in Trauma Patients. Anesthesiology [Internet]. 2012 Dec 1 [cited 2023 Dec 12];117(6):1276–88. Available from: https://dx.doi.org/10.1097/ALN.0b013e318273349d
21. Cabrero Hernández M, Iglesias Bouzas MI, Martínez de Azagra Garde A, Pérez Suárez E, Serrano González A, Jiménez García R. Early prognostic factors for morbidity and mortality in severe traumatic brain injury. Experience in a child polytrauma unit. Medicina Intensiva (English Edition). 2022 Jun 1;46(6):297–304.
22. Wang YM, Fan W, Zhang K, Zhang L, Tan Z, Ma R. Comparison of transducers with different frequencies in breast contrast-enhanced ultrasound (CEUS) using SonoVue as contrast agent. Br J Radiol [Internet]. 2016 [cited 2021 Sep 8];89(1063). Available from: /pmc/articles/PMC5257312/