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REVIEW ARTICLE

Surgical Apgar Score in Hepatobiliopancreatic Surgery and Liver Transplantation — An Integrative Review

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ABSTRACT

The Apgar score was created to assess newborns' risk of death and complications. The surgical Apgar score (SAS) was created to adapt this index to determine mortality and postsurgical morbidity. This scale ranges from 0 to 10, with the highest value corresponding to the patient with the lowest risk. Its use may be more widely disseminated to avoid and evaluate possible postoperative complications in specific surgeries. **Objectives:** This study aims to investigate the effectiveness of the SAS and its implication in postsurgical risk assessment in patients undergoing hepatobiliopancreatic surgery and hepatic transplantation. **Methods:** Integrative literature review developed through searches in the PubMed database. To compose this review, six articles were selected after analyzing and applying the criteria defined by the authors. **Results:** The use of the SAS has good statistical evidence as a scale for assessing the risk of complications and death in the postoperative period of hepatobiliopancreatic surgeries and hepatic transplantation. In addition to proving valuable and efficient in pancreatic surgeries, the SAS was also considered helpful in indicating complications after hepatic surgery and hepatic transplantation. **Conclusion:** The SAS can be clinically useful to guide decisions on rapid post-transplant and perioperative risk screening for general surgeries or the allocation of intensive care, given that it proves to be efficient as a strategy that can predict the chance of morbidity and mortality of a particular patient who underwent surgery.

Descriptors: Prognosis; Liver Transplantation; Pancreas; Bile Ducts.

Índice de Apgar Cirúrgico Na Cirurgia Hepatobiliopancreática e no Transplante Hepático – Uma Revisão Integrativa

RESUMO

O índice de Apgar foi criado com o objetivo de avaliar o risco de morte e de complicações em recém-nascidos. Para adaptar esse índice à avaliação de mortalidade e morbidade pós-cirúrgicas, foi criado o índice de Apgar cirúrgico (IAC). Essa escala varia de 0 a 10, sendo o maior valor correspondente ao paciente com menor risco, e sua utilização pode ser mais amplamente difundida para evitar e avaliar possíveis complicações pós-operatórias em cirurgias específicas. **Objetivos:** Este estudo visa investigar a efetividade do IAC e sua implicação na avaliação de riscos pós-cirúrgicos em pacientes submetidos à cirurgia hepatobiliopancreática e a transplante hepático. **Métodos:** Revisão integrativa da literatura desenvolvida por meio de buscas na base de dados PubMed. Para compor esta revisão, após análise e aplicação dos critérios definidos pelos autores, foram selecionados seis artigos. **Resultados:** O uso do IAC apresenta bons indícios estatísticos como escala para avaliação de risco de complicações e morte no pós-operatório de cirurgias hepatobiliopancreáticas e transplante hepático. Além de se mostrar útil e eficiente em cirurgias pancreáticas, o IAC foi considerado útil para indicar complicações após a cirurgia hepática e a transplante hepático. **Conclusão:** O IAC pode ser de utilidade clínica para orientar as decisões sobre o rastreamento rápido de risco pós-transplante – e perioperatório de cirurgias em geral – ou para atribuir cuidados intensivos, visto que se mostra uma estratégia eficiente que pode predizer morbidade e mortalidade de determinado paciente submetido à cirurgia.

Descritores: Prognóstico; Transplante de Fígado; Pâncreas; Ductos Biliares.

INTRODUCTION

The creation of the Apgar score by Virgínia Apgar[1] in 1953 was an important milestone for neonatal assessment. This 10-point scale became essential in assessing the risk of death and complications in newborns.

Based on the index created by Virgínia Apgar and the idea of transforming subjective impressions into a numbered risk scale, a group of researchers implemented the Apgar score to evaluate major postoperative complications and mortality in patients undergoing vascular and general surgery[2].

The description of the surgical Apgar score (SAS) was pioneered in the An Apgar Score for Surgery study[2], published by the American College of Surgeons. The study used three cohorts evaluated over 30 days after vascular surgeries, mainly colonic resections. The scale was created to be a predictive score for postoperative mortality and morbidity and includes only three intraoperative variables in the calculation: estimated blood loss in mL, lower mean arterial pressure in mmHg, and lower heart rate in beats per minute (bpm). Adding the scores attributed to these three variables, we obtain a risk value of 0 to 10 for the patient (Table 1), with 0 being the worst postoperative risk prognosis and 10 being the best prognosis[2].

Table 1. Original SAS – 10-point score for surgical outcomes.

	0 point	1 point	2 points	3 points	4 points
Estimated blood loss (mL)	> 1.000	601-1.000	101-600	≤ 100	-
Lower mean blood pressure (mmHg)	< 40	40-54	55-69	≥ 70	-
Lower heart rate (bpm)	> 85	76-85	66-75	56-65	≤ 55*

Source: Gawande et al.[2] Sum of points for each category throughout the procedure. *Occurrence of pathological bradyarrhythmia, including sinus arrest, atrioventricular block or dissociation, junctional or ventricular escape rhythms, and asystole also receives 0 points for the lowest heart rate.

As a result of this initial study validated by Gawande et al.[2], the significance of the score as a predictor of significant complications or death was well-known and proven. Such outcomes were significantly associated with a reduced surgical score. Differences in outcomes between patients with different scores were also statistically significant. Among 29 patients with a surgical score ≤ 4 after general or vascular surgery, 17 patients suffered substantial complications or death within 30 days, in contrast to the 220 patients with a score of 9 or 10, of whom only eight (3.6%) presented complications or death within 30 days.[2] Contudo, nesse estudo, um dos critérios de exclusão utilizados foi em relação a pacientes submetidos a transplante, casos de interesse para a revisão em questão.

SAS in liver transplantation

Liver transplantation is the only option for curing and improving the quality of life of patients with chronic liver disease. Patients undergoing this procedure, which is high-risk and one of the most complex in modern surgery, are constantly monitored post-operatively in transplant-specific intensive care units (ICU).

The indication for liver transplantation is based on the Model for End-Stage Liver Disease (MELD) scale. Although this scoring system effectively assesses pre-transplant mortality, it is not a great predictor of postoperative complications and outcomes[3].

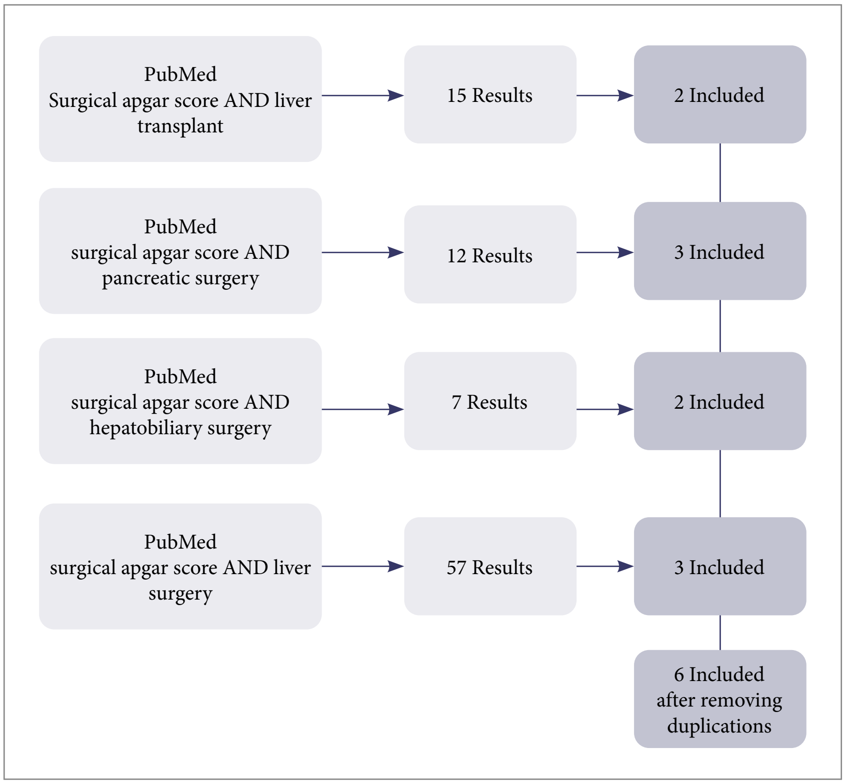
SAS in liver transplants can be used, as described by Gawande et al.[2], based on a 10-point scale with three criteria restricted to intraoperative variables. However, liver transplantation was considered an exclusion criterion in this study. In 2017, a retrospective study carried out in the United States of America suggested modifying the SAS variables to improve the achievement of significant postoperative results, specifically in liver transplants[4].

METHODS

The method chosen for this study was the integrative review (IR). The work was conducted based on the elaboration of a guiding question, search in the literature of primary studies, evaluation of the studies included in the review, analysis and synthesis of results and presentation of the IR[5].

The guiding question of the IR was based on the PICO strategy, an acronym for Patient (patients undergoing hepatobiliopancreatic surgery and liver transplant), Intervention (use of SAS), Context (mortality and postsurgical morbidity) and Outcome, resulting in the following question: "Is the use of SAS efficient and objective to predict the risks of postsurgical morbidity and mortality in patients undergoing hepatobiliopancreatic surgery and liver transplantation?"

For the bibliographic survey, a search was carried out in the PubMed database. The following descriptors and their combinations in English were used to search for articles in the literature: "Surgical Apgar Score," "Liver Transplant," "Hepatobiliary Surgery," and "Pancreatic Surgery" (Fig. 1).

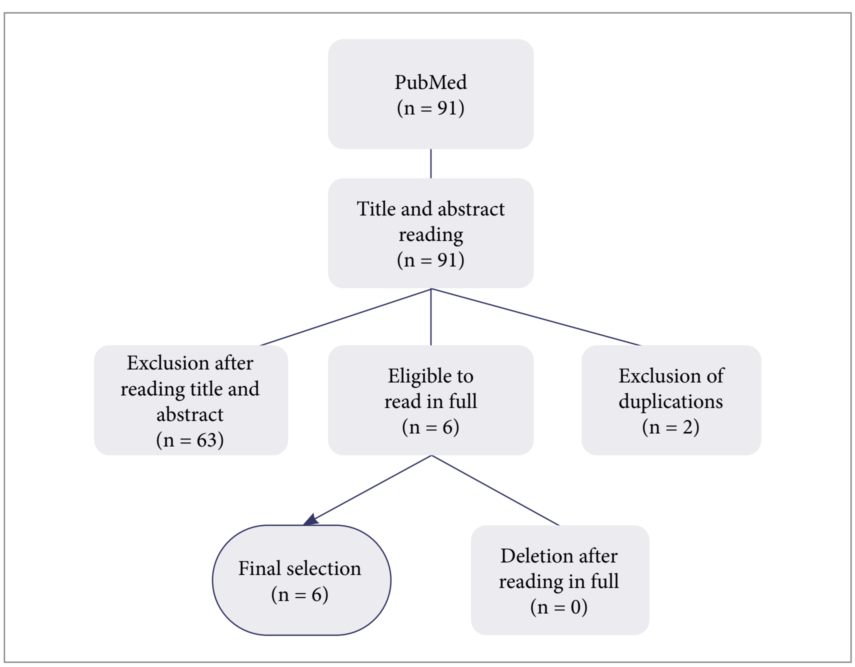


Source: Elaborated by the authors.

Figure 1. Articles included in this study.

The inclusion criteria for selecting articles were articles published in Portuguese or English, full articles on the subject of IR and articles published and indexed in these databases without limitation on publication date.

The initial selection occurred by reading the title and abstract. Subsequently, the articles were read in total, and those that met the inclusion criteria were attached to the IR sample (Fig. 2).



Source: Elaborated by the authors

Figure 2. Flowchart for identification, selection and inclusion of studies in the IR.

A script was used to extract the data, and a table was created with the data from each selected study, including information identifying the article, as well as its location and methodological characteristics (Table 2).

Table 2. Characteristics of primary studies according to authors, study location, design and authorship.

Study	Authors	Location	Design	Authorship
E1	Assifi et al.[6]	Philadelphia, EUA	Retrospective review	Medical
E2	Aoyama et al.[7]	Yokohama, Japan	Retrospective study	Medical
E3	La Torre et al.[8]	Roma, Italy	Retrospective cohort	Medical
E4	Pearson et al.[4]	Mayo and Rochester, USA	Retrospective cohort	Medical
E5	Mitsiev et al.[9]	International	Retrospective cohort	Medical
E6	Tomimaru et al.[10]	Toyonaka, Japan	Retrospective cohort	Medical

Source: Elaborated by the authors.

The terminology used by the research authors themselves was adopted to identify the design of the primary studies. When the type of study was not identified, the design analysis was based on concepts from specialized literature.

Data analysis and synthesis were carried out descriptively, allowing the reader to summarize each study included in the IR. In this way, new studies on SAS in different types of surgery were identified, seeking to answer questions that are still unknown.

RESULTS

The use of SAS presents good statistical evidence as a scale for assessing the risk of complications and death in the postoperative period of hepatobiliopancreatic surgeries and liver transplantation. Concerning liver transplantation, creating a Pearson et al.[4]-modified SAS promoted a simple and specific way to calculate post-transplant risks[4].

The most significant limitation of this review was the small number of published studies reporting the use of SAS in specific surgical procedures. However, despite this restriction, support for using the index in medical practice to predict and treat possible complications in patients previously categorized by the score was notable. In all six studies analyzed (Table 3), SAS was reduced in patients with complications compared to those without complications.

Table 3. Summary of primary studies according to authors, objective, method and main results.

Study	Authors	Objectives	Methods	Main results
E1	Assifi et al.[6]	Determine whether SAS predicts perioperative morbidity and mortality.	553 patients who underwent successful pancreaticoduodenectomy from 2000 to December 2010 were examined. Postoperative complications were classified using the Clavien scale and the SAS with a determined range of 0-10.	Statistical analysis determined that SAS was a predictor of grade 2 or higher complications ($p < 0.0001$), significant morbidity ($p = 0.01$) and pancreatic fistula ($p = 0.04$) but not mortality ($p = 0.20$).
E2	Aoyama et al.[7]	To investigate the effects of SAS on the survival of patients with pancreatic cancer undergoing pancreaticoduodenectomy followed by adjuvant chemotherapy.	This study included 103 patients who underwent curative surgical treatment for pancreatic cancer from 2005 to 2014. Patients with SAS of 0-4 were classified as low risk, while those with SAS of 5-10 were classified as high risk. Risk factors and recurrence-free survival were identified.	The recurrence-free survival rates at 3 and 5 years after surgery were 23 and 14.4%, respectively, in the low SAS group and 32.3 and 21.4%, respectively, in the high SAS group, which obtained a significant difference ($p = 0.039$).
E3	La Torre et al.[8]	To detect significant parameters that affect postoperative outcomes in pancreatic surgery and evaluate the role of SAS in predicting morbidity, pancreatic fistulas and mortality.	Data were collected from 143 patients who underwent pancreatic resection for pancreatic and periampullary adenocarcinoma. Preoperative and intraoperative parameters were statistically analyzed to evaluate their potential prognostic effects.	Low SAS, hypoalbuminemia, and the need for blood transfusions were significant independent predictors of postoperative morbidity. SAS has been shown to significantly predict major complications, surgical site infections, and mortality.
E4	Pearson et al.[4]	Propose a change in the SAS for patients undergoing liver transplantation.	The SAS-LT was developed using a retrospective cohort of consecutive liver transplants from July 2007 to November 2013. Its predictive ability for early postoperative outcomes was compared to the model for end-stage liver disease (MELD). Disease Scores, Sequential Assessment of Organ Failure, and Assessment of Acute Physiology and Chronic Health III Using Multivariable Logistic Regression and Receiver Operating Characteristics Analysis.	Of 628 transplants, death or severe perioperative morbidity occurred in 105 (16.7%). The SAS-LT had similar predictive ability for acute physiology and chronic health assessment III, model for end-stage liver disease, and sequential organ failure assessment scores.

Continue...

Table 3. Continuation.

Study	Authors	Objectives	Methods	Main results
E5	Mitsiev et al.[9]	Define a classification of simple complications after hepatectomy.	119 patients undergoing liver resection were included. Postoperative complications were determined at follow-up based on the Centers for Disease Control. Clinicopathological factors were used to calculate SAS. Circulating levels of liver injury markers were analyzed as critical elements in postsurgical complications.	SAS was reduced in patients with complications compared to those without complications. The best cutoff value for SAS was ≤ 6/≥ 7, at which sensitivity and specificity were maximum. ALT/AST levels significantly differed in the group with 9-10 SAS points (p = 0.01 and 0.02). In conclusion, SAS provides accurate risk stratification for major postsurgical complications after hepatectomy and may help improve overall patient outcomes.
E6	Tomimaru et al.[10]	Use SAS in patients undergoing hepatectomy for HCC.	This study included 158 patients who underwent hepatectomy for HCC. The association between SAS and postoperative complications was examined. Patients had postoperative morbidities classified as Clavien-Dindo grade II or higher.	Postoperative complications occurred in 28 (17.7%) of the 158 patients. The SAS was significantly lower in cases with complications than those without. Multivariate analysis revealed that postoperative complications significantly correlated with SAS.

Source: Elaborated by the authors

DISCUSSION

SAS in pancreatic surgeries, whether pancreaticoduodenectomy[6,7] followed or not by chemotherapy, whether pancreatic resection due to periampullary adenocarcinoma[8] (neoplasia around the ampulla of Vater), was presented as a significant, simple, immediate and objective perioperative predictor (from pre-surgical preparation to discharge) of morbidity and mortality in patients undergoing these surgical procedures.

Pancreaticoduodenectomy is historically associated with high mortality rates, and pancreatic cancer is one of the most lethal[6,7]. For this type of cancer, surgical resection is the only option for curing or extending the patient's life expectancy. However, advances in modern surgery have decreased the number of deaths. In contrast, postoperative morbidity rates remain high, with the most frequent complications being delayed gastric emptying, pancreatic fistula, surgical site infection and cardiopulmonary events[6].

Surgical scores help stratify risk factors that can lead to adverse perioperative outcomes. Some algorithms, such as APACHE (Acute Physiology and Chronic Health Evaluation) and POSSUM (Operative Severity Score for the Enumeration of Mortality), are used as predictors. Still, they are tools with complex calculations and many variables. APACHE was developed with 34 parameters and updated to APACHE II with 12 parameters; POSSUM was designed with 12 biological factors as variables. Both are very complex and difficult to apply compared to SAS, which has only three accessible variables to apply[6].

In addition to being helpful and efficient in pancreatic surgeries, SAS was considered proper for indicating post-liver surgery complications.[9,10], more specifically, hepatectomy for hepatocellular carcinoma (HCC)[10], the most common malignant liver cancer with high prevalence in Asia and Western countries. Liver resection is one of the curative methods for this pathology, along with the indication of liver transplantation if the nodules meet the Milan criteria. In this context, both surgeries imply probable postoperative complications.

Regarding SAS in liver transplantation, the study carried out by Pearson et al.[4] aimed to propose a change in the SAS, creating the surgical Apgar score for liver transplant (SAS-LT). In the original SAS, the three variables are estimated blood loss in mL, lowest mean arterial pressure in mmHg, and lowest heart rate in bpm (Table 1). In SAS-LT, the three variables remain. However, the estimated blood loss is replaced by the volume of packed red blood cells in milliliters during surgery with lower mean arterial pressure in mmHg and lower heart rate (Table 4)[4].

The SAS can be adapted to evaluate patients undergoing liver transplantation specifically since the SAS-LT has advantages compared to other scores that evaluate perioperative morbidity, such as MELD and APACHE 3. The data are easy to obtain, the calculation is simple, does not require sophisticated monitoring, has few variables, and the postoperative assessment is immediate, facilitating decision-making[4].

Table 4. Modified SAS for Liver Transplantation (SAS-LT).

	0	1	2	3	4
Volume of packed red blood cells in mL	≥ 10.001	6.001-10.000	1.001-6.000	≤ 1.000	-
Lowest mean arterial pressure in mmHg	< 40	40-54	55-69	≥ 70	-
Lower heart rate	> 85	76-85	69-75	56-65	≤ 55

Source: Pearson et al.[4]

CONCLUSION

The SAS can be widely used to identify a high risk of significant complications and death after surgical procedures, characterized in this study as hepatobiliopancreatic surgeries and liver transplantation. Furthermore, it may help optimize the use of postoperative intensive care beds. For example, suppose the patient has a SAS of 1 to 4. In that case, they will be referred for monitoring in a surgical ICU, with the assessment of vital signs every hour, frequent laboratory evaluation and intensive care, unlike what happens with a patient who has a SAS of 8 to 10, who may recover in an intermediate care unit with less intensive care.

SAS is an efficient strategy for improving perioperative survival rates. It can predict the chance of morbidity and mortality of a given patient undergoing surgery. Another attribute of this score is objectivity, as it has only three variables: uncomplicated calculations, ease of use and ability to predict the risk of adverse outcomes. The same qualities are attributed to the specific score for liver transplantation (SAS-LT).

Such a scoring system may be of clinical utility to guide decisions on rapid post-transplant and perioperative risk screening of general surgeries or the assignment of intensive care. Therefore, it is noted that the results demonstrated in all the studies analyzed in this review are good. However, more studies are necessary to elucidate the efficiency and objectivity of SAS in specific types of surgical procedures.

CONFLICT OF INTEREST

Nothing to declare.

AUTHOR'S CONTRIBUTION

Substantive scientific and intellectual contributions to the study: Fonseca Neto OCL, Paiva LN; **Conception and design:** Fonseca Neto OCL, Paiva LN; **Data analysis and interpretation:** Fonseca Neto OCL, Paiva LN; **Article writing:** Fonseca Neto OCL, Paiva LN; **Critical revision:** Fonseca Neto OCL, Paiva LN; **Final approval:** Fonseca Neto OCL, Paiva LN.

DATA AVAILABILITY STATEMENT

All dataset were generated or analyzed in the current study.

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REFERENCES

1. Apgar V. A proposal for a new method of evaluation of the newborn infant. Anesth Analg [periódicos na Internet] 2015 [accessed on 15 Feb 2023];120(5):1056-9. Available at: https://journals.lww.com/anesthesia-analgesia/Fulltext/2015/05000/A_Proposal_for_a_New_Method_of_Evaluation_of_the.22.aspx

2. Gawande AA, Kwaan MR, Regenbogen SE, Lipsitz, SA, Zinner MJ. An Apgar score for surgery. J Am Coll Surg 2007;204(2):201-8. https://doi.org/10.1016/j.jamcollsurg.2006.11

3. Klein KB, Stafinski TD, Menon D. Predicting survival after liver transplantation based on pre-transplant MELD score: a systematic review of the literature. PLoS One 2013;8(12):e80661. https://doi.org/10.1371/journal.pone.0080661

4. Pearson, ACS, Subramanian A, Schroeder DR, Findlay JY. Adapting the surgical Apgar score for perioperative outcome prediction in liver transplantation: a retrospective study. Transplant Direct 2017;3(11):e221. https://doi.org/10.1097/TXD.0000000000000739

5. Mendes KDS, Silveira, RCCP, Galvão CM. Revisão integrativa: método de pesquisa para a incorporação de evidências na saúde e na enfermagem. Texto Contexto Enferm 2008;17(4):758-64. https://doi.org/10.1590/S0104-07072008000400018

6. Assifi MM, Lindenmeyer J, Leiby BE, Grunwald Z, Rosato EL, Kennedy EP, et al. Surgical Apgar score predicts perioperative morbidity in patients undergoing pancreaticoduodenectomy at a high-volume center. J Gastrointest Surg 2011;16(2):275-81. https://doi.org/10.1007/s11605-011-1733-1

7. Aoyama T, Kazama K, Murakawa M, Atsumi Y, Shiozawa M, Kobayashi S, et al. The surgical Apgar score is an independent prognostic factor in patients with pancreatic cancer undergoing pancreatoduodenectomy followed by adjuvant chemotherapy. Anticancer Res. 2016 [accessed on 25 Feb 2023];36(5):2497-503. Available at: https://ar.iiarjournals.org/content/36/5/2497.long

8. La Torre M, Ramacciato G, Nigri G, Balducci G, Cavallini M, Rossi M, et al. Post-operative morbidity and mortality in pancreatic surgery. The role of surgical Apgar score. Pancreatology 2013;13(2):175-9. https://doi.org/10.1016/j.pan.2013.01.011

9. Mitsiev I, Rubio K, Ranvir VP, Yu D, Palanisamy AP, Chavin KD, et al. Combining ALT/AST values withsurgical APGAR score improves prediction of major complications after hepatectomy. J Surg Res 2021;4(4):656-70. https://doi.org/10.26502/jsr.10020179

10. Tomimaru Y, Takada K, Shirakawa T, Noguchi K, Morita S, Imamura H, et al. Surgical Apgar score forpredicting complications after hepatectomy for hepatocellular carcinoma. J Surg Res 2018;222:108-14.https://doi.org/10.1016/j.jss.2017.10.013