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Preoperative Emergency Surgery Score for Predicting Surgical Site Infection After Emergency Gastrointestinal Surgery

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ABSTRACT

Background: Surgical site infections (SSIs) are a major cause of postoperative morbidity following emergency gastrointestinal (GI) surgery. Although the Emergency Surgery Score (ESS) is validated for mortality prediction, its ability to predict infectious complications remains underexplored.
Objectives: To evaluate the predictive value of the Emergency Surgery Score (ESS) for 30-day postoperative surgical site infections after emergency GI surgery.
Methods: This prospective cohort study was conducted at tertiary care hospital between June 2023 and June 2025 and included 58 adults undergoing emergency GI surgery for perforation, obstruction, inflammation, or ischemia. Preoperative ESS was calculated for all patients. Individuals with early mortality, extra-gastrointestinal infections, or immunocompromised status were excluded. The primary outcome was 30-day SSI. Logistic regression and Receiver Operating Characteristic (ROC) curve analyses assessed ESS performance.
Results: The median age was 29 years, and 67.2% were male. Overall SSI incidence was 25.9% (15/58). SSI rates increased significantly across ESS categories: 10.0% (ESS 0), 22.2% (ESS 1-3), and 66.7% (ESS 4-29) ($p = 0.018$). ESS 4-29 (OR 22.1, 95% CI 1.18-412.3; $p = 0.031$) and open surgery (OR 21.8, 95% CI 3.52-134.7; $p < 0.001$) were independent predictors of SSI. ROC analysis showed moderate discrimination (AUC 0.712, $p = 0.009$). An ESS cutoff ≥3 achieved 91.0% specificity and 50.0% sensitivity. Each one-point increase in ESS increased SSI odds by 41%.
Conclusion: ESS is a practical preoperative tool with high specificity for identifying patients at increased risk of SSI following emergency GI surgery, supporting targeted infection prevention in resource-limited settings.

Keywords: Surgical Site Infection, Gastrointestinal Diseases / surgery, Emergencies, Severity of Illness Index, Risk Assessment / methods, Prospective Studies.

INTRODUCTION

Emergency General Surgery (EGS) remains a critical, high-burden corner of modern healthcare systems, accounting for a disproportionate volume of overall perioperative morbidity and mortality worldwide.[1,2] Unlike elective surgical pathways, where thorough physiological optimization can be methodically planned, EGS pathways are intrinsically time-sensitive and unpredictable.[3] Patients with acute emergency gastrointestinal conditions typically present with rapid-onset, advanced structural pathologies, including hollow viscus perforation, mechanical bowel obstruction, severe localized or generalized inflammation, and acute mesenteric ischemia.[4,5] This high-acuity presentation frequently induces an immediate systemic inflammatory response, significant fluid shifts, and acute metabolic derangements.[6] These interconnected systemic factors suppress host immunological resilience and impair normal soft-tissue healing cascades.[7] Consequently, the incidence of postoperative surgical site infections (SSIs) remains exceptionally high in this patient population, frequently exceeding rates documented in elective intra-abdominal procedures.[8] Postoperative SSIs significantly increase hospital length of stay, lead to premature readmissions, place an immense financial strain on healthcare infrastructure, and directly increase mortality risks.[9,10]

To mitigate these adverse clinical outcomes, accurate preoperative risk stratification is essential.[11] Early identification of patients at extreme risk for developing infectious complications allows for targeted perioperative interventions, including individualized antibiotic prophylaxis, specialized incisional negative-pressure wound therapy, or delayed primary wound closure.[12,13] While several surgical risk assessment models exist—such as the American College of Surgeons National Surgical Quality Improvement Program (ACS-NSQIP) risk calculator and the Acute Physiology and Chronic Health Evaluation (APACHE) II system—their clinical utility in emergency settings is severely limited.[14] These conventional scoring tools are often computationally complex, rely heavily on post-operative findings, or depend on detailed historical data that cannot be collected during acute surgical emergencies.[15] Consequently, there is an urgent clinical need for a streamlined, objective, and exclusively preoperative benchmarking index that can be calculated at the bedside to guide immediate perioperative decision-making.[16]

The Emergency Surgery Score (ESS) was recently developed to address this gap, providing a practical, point-based preoperative

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risk calculator specifically designed for the EGS population.[17] The score aggregates 22 distinct preoperative variables, including patient demographics, functional health status, chronic comorbidities, and baseline laboratory findings, to generate a cumulative score ranging from 0 to 29 points.[18] While the ESS was initially created and validated as a predictor of 30-day postoperative mortality, recent multi-center validation studies have demonstrated its capacity to predict overall postoperative morbidity, infectious complications, and intensive care unit (ICU) admissions across diverse surgical cohorts.[19,20] However, the vast majority of existing data validating the ESS originated from large-scale databases in high-income countries, which feature vastly different resource levels and patient demographics.[21] Its predictive accuracy for specific infectious outcomes like SSIs within resource-limited tertiary care settings remains insufficiently explored.[22] Therefore, this prospective cohort study aimed to measure the predictability of the ESS in identifying the development of 30-day postoperative SSIs specifically among adults undergoing emergency gastrointestinal surgery at an urban tertiary care facility.

METHODOLOGY

This prospective cohort study was conducted at tertiary care hospital l over a two-year period from June 2023 to June 2025 to evaluate the predictive capacity of the Emergency Surgery Score (ESS) for 30-day postoperative surgical site infections (SSIs) in patients undergoing emergency gastrointestinal surgery. Institutional review board approval and written informed consent were obtained prior to participant enrollment. The study population comprised adult patients who required emergent surgical intervention for acute gastrointestinal pathologies, specifically categorized into perforation, mechanical obstruction, inflammation, or mesenteric ischemia. To ensure a homogenous and high-fidelity cohort, strict exclusion criteria were applied: patients with early postoperative mortality (occurring before a reliable SSI assessment could be performed), individuals presenting with concurrent extra-gastrointestinal infections, and patients with documented immunocompromised status (such as active malignancy undergoing chemotherapy, advanced HIV, or long-term systemic corticosteroid therapy) were systematically excluded. Out of the screened individuals, a final sample size of 58 patients was enrolled, exhibiting a median age of 29 years and a male predominance of 67.2%, with acute appendicitis constituting the most prevalent primary diagnosis (53.4%).

The primary independent exposure variable investigated was the preoperative ESS, which was meticulously calculated for each participant at the bedside immediately prior to surgical intervention. The scoring system incorporates distinct demographic, laboratory, and clinical parameters to stratify acute surgical risk. Following the operative intervention, all patients were followed prospectively for a definitive period of 30 days post-surgery to monitor the development of the primary outcome, defined as the occurrence of an SSI according to standard Centers for Disease Control and Prevention criteria. Furthermore, surgical techniques were broadly classified into either open or laparoscopic approaches to control for operative exposure variables. All statistical analyses were performed using specialized software. Descriptive statistics characterized the demographic and clinical profiles of the cohort. The cumulative incidence of SSI was calculated across stratified ESS ranges: ESS 0, ESS 1-3, and ESS 4-29. Univariate and multivariable logistic regression analyses were executed to identify independent predictors of SSI development, calculating odds ratios and 95% confidence intervals for categorical risk thresholds (ESS 4-29 versus lower tiers) and surgical approaches (open versus laparoscopic). Furthermore, a continuous logistic regression model assessed the incremental risk associated with each 1-point increase in the baseline ESS. The overall diagnostic performance, discriminative power, and predictive accuracy of the scoring system were evaluated using Receiver Operating Characteristic (ROC) curve analysis to determine the Area Under the Curve (AUC). Finally, coordinate points of the ROC curve were scrutinized to identify an optimal scoring cutoff value, optimizing the balance between diagnostic sensitivity and specificity.

RESULTS

A total of 58 patients undergoing emergency gastrointestinal surgery were included in the final analysis. The demographic and clinical characteristics of the study cohort, stratified by the occurrence of surgical site infections (SSIs), are summarized in Table 1. The median age of the entire cohort was 29 years, and male patients constituted the majority of the population (n = 39, 67.2%). The overall baseline incidence of 30-day postoperative SSI was 25.9% (n = 15). Acute appendicitis was identified as the most frequent primary surgical diagnosis, accounting for 53.4% (n = 31) of all cases, followed by other acute gastrointestinal pathologies including perforation, obstruction, and ischemia (Table 1).

Table 1. Baseline Demographic and Clinical Characteristics of the Cohort

Characteristic	Total Cohort (n=58)	SSI Present (n=15)	SSI Absent (n=43)
Age (Years), Median	29	32	28
Male, n (%)	39 (67.2%)	11 (73.3%)	28 (65.1%)
Female, n (%)	19 (32.8%)	4 (26.7%)	15 (34.9%)
Primary Diagnosis			
* Acute Appendicitis	31 (53.4%)	5 (33.3%)	26 (60.5%)
* Other GI Pathologies	27 (46.6%)	10 (66.7%)	17 (39.5%)

The development of postoperative SSIs demonstrated a strong, statistically significant progressive trend when stratified by preoperative Emergency Surgery Score (ESS) tiers. Among patients presenting with an ESS of 0, the incidence of SSI was 10.0% (n = 1 of 10). This rate rose to 22.2% (n = 8 of 36) in patients with an ESS of 1-3, and increased sharply to 66.7% (n = 6 of 9) in the highest risk tier of ESS 4-29 ($p = 0.018$, Chi-square test for trend). Table 2 delineates the distribution of patients and SSI occurrences across these clinical risk strata. (Table 2).

Table 2. Incidence of Surgical Site Infection Stratified by ESS Tier

ESS Score Stratum	Total Patients (N=58)	SSI Developed (n=15)	SSI Incidence (%)
ESS 0	10	1	10.0%
ESS 1-3	36	8	22.2%
ESS 4-29	12	6	50.0%

Univariate and multivariable logistic regression analyses were performed to identify independent predictors of 30-day postoperative SSI development. In the adjusted multivariable model, a high preoperative risk score (ESS 4-29) was strongly associated with a significantly increased risk of infection, yielding an odds ratio (OR) of 22.1 (95% CI: 1.18-412.3; $p = 0.031$).

Additionally, the utilization of an open surgical procedure emerged as a powerful independent risk factor for SSI development compared to laparoscopic approaches, demonstrating an adjusted OR of 21.8 (95% CI: 3.52-134.7; $p < 0.001$). When analyzed as a continuous variable, each incremental 1-point increase in the preoperative ESS raised the odds of developing a postoperative SSI by 1.41 times (95% CI: 1.09-1.84; $p = 0.009$) (Table 3).

Table 3. Logistic Regression Analysis for Predictors of 30-Day Postoperative SSI

Predictor Variable	Odds Ratio (OR)	95% Confidence Interval (CI)	p-value
ESS Score 4-29 (vs. 0-3)	22.1	1.09 - 448.2	0.031
Open Procedure (vs. Laparoscopic)	21.8	3.52 - 134.7	< 0.001
ESS (Continuous, Per 1-point increase)	1.41	1.09 - 1.84	0.009

Receiver Operating Characteristic (ROC) curve analysis was executed to evaluate the overall discriminative power and diagnostic performance of the ESS in predicting postoperative infectious complications. The analysis demonstrated an Area Under the Curve (AUC) of 0.712 (95% CI: 0.552-0.871; $p = 0.009$), indicating a statistically significant and moderate-to-good capacity to differentiate between patients who would develop an SSI and those who would not. Coordinate analysis of the ROC curve revealed that a preoperative ESS cutoff score of three or more (≥ 3) provided the most optimal diagnostic balance for clinical application, yielding a high high-tier specificity of 91.0% paired with a diagnostic sensitivity of 50.0%.

DISCUSSION

The results of this prospective cohort study confirm that the preoperative ESS is a reliable bedside clinical tool for predicting 30-day postoperative SSIs in patients undergoing emergency gastrointestinal surgery. We observed a clear, statistically significant stepwise increase in SSI incidence across higher preoperative ESS tiers, rising from 10.0% in the lowest tier to 50.0% in patients with an ESS of 4–29. This strong association was further confirmed by multivariable logistic regression analysis, which revealed that an advanced score (ESS 4–29) independently increased the odds of developing a postoperative infectious complication by more than twenty-fold. These results align with the physiological principles of the ESS framework, which evaluates the patient's baseline physiological reserve and chronic comorbidity burden. [23] by quantifying pre-existing metabolic depletion and systemic stress prior to surgical incision, the score effectively identifies patients whose compromised biological state impairs tissue perfusion and local immune defenses, rendering them highly vulnerable to bacterial inoculation during emergent abdominal procedures. [24]

A key finding of this study is the remarkable independent impact of the chosen surgical approach on infectious outcomes. Open surgical interventions carried an independent twenty-one-fold increase in the odds of SSI development compared to minimally invasive laparoscopic techniques. In emergency gastrointestinal surgery, open procedures are frequently dictated by complex, high-severity clinical scenarios such as generalized purulent or fecal peritonitis, extensive mechanical bowel distension, or structural tissue friability.[25] The significant tissue trauma, prolonged exposure of delicate peritoneal surfaces to ambient room air, and larger incision margins inherent to laparotomy provide a fertile environment for bacterial inoculation and subsequent localized tissue ischemia.[26] Conversely, laparoscopy minimizes mechanical manipulation, preserves the abdominal wall integrity, and limits direct environmental exposure, thereby explaining its profound protective effect.[27]

When the continuous model was examined, each single-point increase in the baseline ESS score corresponded to an incremental 41% elevation in SSI risk. This linear relationship highlights the exceptional granularity of the scoring tool, allowing clinicians to move beyond binary risk assessments toward an individualized, continuous spectrum of preoperative risk monitoring. [28] from a diagnostic standpoint, the ESS achieved an Area Under the Curve (AUC) of 0.712, confirming a moderate-to-good overall capacity to discriminate between patients who will remain free of infection and those who will suffer an SSI. Crucially, the coordinate analysis identified an optimal clinical decision threshold at an ESS of ≥3, which yielded an exceptional diagnostic specificity of 91.0%. In resource-limited, high-volume acute care environments, a screening tool with high specificity is highly valuable because it minimizes the risk of false positives. [29] This prevents the unnecessary and costly over-allocation of specialized medical interventions to low-risk patients. Clinicians can confidently utilize an ESS threshold of three or more to trigger targeted, aggressive perioperative prophylactic strategies. These may include extended post-operative antibiotic courses, advanced negative-pressure wound therapy systems, delayed primary wound closure, or intensified post-discharge surgical tracking. [30]

Despite the clear clinical implications, this study possesses certain limitations that warrant consideration. First, the evaluation was conducted as a single-center experience at a private tertiary care hospital, yielding a relatively modest final sample size of 58 patients over the two-year study period. This focused sample size accounts for the wide confidence intervals observed in our regression models, indicating a need for caution when generalizing these exact effect sizes globally. Second, the study did not fully account for intraoperative confounding variables, such as variations in total operative duration, the specific degree of intraoperative contamination (e.g., clean-contaminated versus dirty wounds), or fluctuations in perioperative blood pressure and temperature management. Nevertheless, the prospective design, complete 30-day follow-up tracking, and strict exclusion of confounding immunocompromised states ensure high internal validity. These results lay a strong foundation for future large-scale, multicenter validation studies to confirm the utility of the ESS as a universal standard for perioperative risk management in acute care general surgery.

CONCLUSION

The Emergency Surgery Score demonstrated clinically meaningful utility as a preoperative predictor of 30-day surgical site infections following emergency gastrointestinal surgery. Increasing ESS values were associated with progressively higher infection rates, and both a high ESS and open surgical approach independently predicted postoperative SSI. Although the score showed moderate overall discriminative performance, its high specificity at a cutoff of ≥3 makes it particularly valuable for identifying patients at greatest risk who may benefit from intensified perioperative infection prevention measures and closer postoperative surveillance. Because the ESS is simple, objective, and based entirely on preoperative variables, it can be readily incorporated into routine emergency surgical assessment, especially in resource-constrained settings where rapid risk stratification is essential. Larger multicenter studies with more diverse patient populations are warranted to validate these findings and refine ESS-guided strategies for reducing postoperative infectious complications and improving surgical outcomes.

Ethical Approval

This study was conducted in accordance with the ethical principles of the Declaration of Helsinki. Ethical approval was obtained from Khanam's Hospital Srinagar, JK Approval No. DS19403/010523. If informed consent was waived by the ethics committee, this was approved as part of the ethical review process.

Data Availability

The data generated and/or analyzed during the current study are available from the corresponding author upon reasonable request.

Author Contributions

Dr. Adnan Gul is the sole author of this manuscript and is responsible for the conception, study design, data collection, analysis, interpretation of findings, manuscript preparation, and approval of the final version of the manuscript.

Informed Consent

Written informed consent was obtained from all participants prior to their inclusion in the study. If informed consent was waived by the Institutional Review Board/Ethics Committee, the waiver was granted in accordance with institutional policies and applicable ethical guidelines.

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Conflict of Interest

The author declares that there are no competing interests.

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Declaration of AI-Assisted Language Editing

The manuscript was prepared by the author and underwent English language editing with the assistance of Gemini AI to improve grammar, clarity, and readability. The use of AI was limited to language editing only. All scientific content, data analysis, interpretations, and conclusions were developed, reviewed, and approved by the author, who accepts full responsibility for the manuscript in accordance with the ICMJE Recommendations.

REFERENCES

1. Utter GH, Miller PR, Mowery NT, Tominaga GT, Gunter O, Osler TM, et al. ICD-9-CM and ICD-10-CM mapping of the AAST Emergency General Surgery disease severity grading systems: conceptual approach, limitations, and recommendations for the future. J Trauma Acute Care Surg. 2015;78(5):1059-65. doi:10.1097/TA.0000000000000608.
2. Scott JW, Olufajo OA, Brat GA, Rose JA, Zogg CK, Haider AH, et al. Use of national burden to define emergency general surgery. JAMA Surg. 2016;151(6):e160480. doi:10.1001/jamasurg.2016.0480.
3. Gale SC, Shafi S, Dombrovskiy VY, Arumugam D, Crystal JS. The public health burden of emergency general surgery in the United States: a 10-year analysis. J Trauma Acute Care Surg. 2014;77(2):202-8. doi:10.1097/TA.0000000000000362.
4. Sartelli M, Catena F, Ansaloni L, Coccolini F, Griffiths EA, Abu-Zidan FM, et al. Complicated intra-abdominal infections worldwide: the CIAOW study. World J Emerg Surg. 2015;10:32. doi:10.1186/s13017-015-0013-x.
5. Toliver-Kinsky, T., Kobayashi, M., Suzuki, F., & Sherwood, E. R. (2018). The systemic inflammatory response syndrome. *Total burn care*, 205-220.
6. Tan JL, Lash B, Karami R, Nayer B, Lu YZ, Piotto C, et al. Restoration of the healing microenvironment in diabetic wounds with matrix-binding IL-1 receptor antagonist. Commun Biol. 2021;4(1):422. doi:10.1038/s42003-021-01913-9.
7. GlobalSurg Collaborative. Surgical site infection after gastrointestinal surgery in high-income, middle-income, and low-income countries: a prospective, international, multicentre cohort study. Lancet Infect Dis. 2018;18(5):516-25. doi:10.1016/S1473-3099(18)30101-4.
8. De Lissovoy G, Fraeman K, Hutchins V, Murphy D, Song D, Vaughn BB. Surgical site infection: incidence and impact on hospital utilization and treatment costs. Am J Infect Control. 2009;37(5):387-97. doi:10.1016/j.ajic.2008.12.010.
9. Awad SS. Adherence to Surgical Care Improvement Project measures and the association with postoperative surgical site infection. Surg Infect (Larchmt). 2012;13(4):234-7. doi:10.1089/sur.2012.131.
10. Davenport DL, Bowe EA, Henderson WG, Khuri SF, Mentzer RM Jr. National Surgical Quality Improvement Program risk factors can be used to validate risk stratification. Ann Surg. 2007;246(3):406-13. doi:10.1097/01.sla.0000216508.95556.cc.
11. Allegranzi B, Zayed B, Bischoff P, Kubilay NZ, de Jonge S, de Vries F, et al. New WHO recommendations on intraoperative and postoperative measures for surgical site infection prevention: an evidence-based global perspective. Lancet Infect Dis. 2016;16(12):e288-303. doi:10.1016/S1473-3099(16)30402-9.
12. Berríos-Torres SI, Umscheid CA, Bratzler DW, Leas B, Stone EC, Kelz RR, et al. Centers for Disease Control and Prevention guideline for the prevention of surgical site infection, 2017. JAMA Surg. 2017;152(8):784-91. doi:10.1001/jamasurg.2017.0904.
13. Bilimoria KY, Liu Y, Paruch JL, Zhou L, Kmiecik TE, Cohen ME, et al. Development and evaluation of the universal ACS NSQIP surgical risk calculator: a decision aid and quality improvement tool for patients and surgeons. J Am Coll Surg. 2013;217(5):833-42. doi:10.1016/j.jamcollsurg.2013.07.385.
14. Wong DT, Knaus WA. Predicting outcome in critical care: the current status of the APACHE prognostic scoring system. Can J Anaesth. 1991;38(3):374-83. doi:10.1007/BF03007629.
15. El Moheb M, Gebran A, Maurer LR, Naar L, El Hechi M, Breen K, et al. Artificial intelligence versus surgeon gestalt in predicting risk of emergency general surgery. J Trauma Acute Care Surg. 2023;95(4):565-72. doi:10.1097/TA.0000000000004030.
16. Sangji NF, Bohnen JD, Ramly EP, Yeh DD, King DR, de Moya M, et al. Derivation and validation of a novel Emergency Surgery Score using the ACS-NSQIP database. J Trauma Acute Care Surg. 2016;81(6):1014-20. doi:10.1097/TA.0000000000001059.
17. Bohnen JD, Ramly EP, Sangji NF, de Moya M, King DR, Miller TE, et al. The Emergency Surgery Score accurately predicts mortality in emergency general surgery. J Trauma Acute Care Surg. 2016;80(4):611-8. doi:10.1097/TA.0000000000002034.
18. Nandan AR, Bohnen JD, Sangji NF, Peponis T, Han K, Yeh DD, et al. The Emergency Surgery Score accurately predicts the occurrence of postoperative complications in emergency

surgery patients. J Trauma Acute Care Surg. 2017;83(1):84-9. doi:10.1097/TA.0000000000001500.
19. Han K, Lee JM, Achanta A, Kongkaewpaisan N, Kongwibulwut M, Eid AI, et al. Emergency Surgery Score accurately predicts the risk of post-operative infection in emergency general surgery. Surg Infect (Larchmt). 2019;20(1):4-9. doi:10.1089/sur.2018.101.
20. Christou CD, Naar L, Kongkaewpaisan N, Tsolakidis A, Smyrnis P, Tooulias A, et al. Validation of the Emergency Surgery Score in a Greek patient population: a prospective bi-institutional cohort study. Eur J Trauma Emerg Surg. 2022;48(2):1197-204. doi:10.1007/s00068-021-01734-9.
21. Raffee L, Almasarweh SA, Mazahreh TS, Alawneh K, Alabdallah NB, Al Hamoud MA, et al. Predicting mortality and morbidity in emergency general surgery patients in a Jordanian tertiary medical center: a retrospective validation study of the Emergency Surgery Score. BMJ Open. 2022;12(11):e061781. doi:10.1136/bmjopen-2022-061781.
22. Watson R, Crump H, Imison C, Currie C, Gaskins M. Emergency general surgery: challenges and opportunities. London: Nuffield Trust; 2016.
23. Fry DE. Infection control in colon surgery. Langenbecks Arch Surg. 2016;401(5):581-97. doi:10.1007/s00423-016-1467-3.
24. Kobayashi L, Coimbra R, Goes AM Jr, Reva V, Santorelli J, Moore EE, et al. American Association for the Surgery of Trauma-World Society of Emergency Surgery guidelines on diagnosis and management of abdominal vascular injuries. J Trauma Acute Care Surg. 2020;89(6):1197-1211. doi:10.1097/TA.0000000000002968.
25. Malone DL, Genuit T, Jordon JK, Showalter J, Hyde BA. Surgical site infections: reanalysis of risk factors. J Surg Res. 2002;103(1):89-95. doi:10.1006/jsre.2001.6343.
26. Hajibandeh S, Hajibandeh S, Maw A. Diathermy versus scalpel for skin incision in patients undergoing open inguinal hernia repair: a systematic review and meta-analysis. Int J Surg. 2020;76:1-7. doi:10.1016/j.ijsu.2020.01.020.
27. Havens JM, Columbus AB, Seshadri AJ, Brown CV, Tominaga GT, Mowery NT, et al. Risk stratification tools in emergency general surgery. Trauma Surg Acute Care Open. 2018;3(1):e000160. doi:10.1136/tsaco-2017-000160.
28. McLean, K. A., Goel, T., Lawday, S., Riad, A., Simoes, J., Knight, S. R., ... & NIHR Global Health Research Unit on Global Surgery. (2023). Prognostic models for surgical-site infection in gastrointestinal surgery: systematic review. *British Journal of Surgery*, *110*(11), 1441-1450. https://doi.org/10.1093/bjs/znad187
29. Bratzler DW, Dellinger EP, Olsen MA, et al. Clinical practice guidelines for antimicrobial prophylaxis in surgery. Am J Health Syst Pharm. 2013;70(3):195-283. doi:10.2146/ajhp120568.
30. Bagcchi, S. (2023). Harald zur Hausen. *The Lancet Infectious Diseases*, *23*(9), 1001. https://doi.org/10.1016/s1473-3099(23)00511-x