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# Differentiated approach to treatment of severe acute pancreatitis based on organ failure pattern

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Severe acute pancreatitis (SAP) complicated by organ failure (OF) is associated with mortality rates of 15–40 %. While the step-up approach has proven superior to primary necrosectomy, its universal application fails to account for the heterogeneity of clinical trajectories. Early stratification of patients based on OF patterns may facilitate the development of personalised treatment protocols.

**Objective** – to evaluate the effectiveness of a differentiated treatment approach to severe acute pancreatitis based on organ failure patterns in comparison to standard disease management.

**Materials and methods.** A quasi-experimental study with historical control was conducted in 77 patients with SAP or high risk of its development. The comparison group (n = 41, 2014–2019) received standard treatment with retrospectively confirmed OF development. The main group (n = 36, 2022–2024) underwent prospective stratification using a prognostic model within 24 hours of admission, identifying three OF patterns: early respiratory-renal, late respiratory, and early multisystem. Pattern-specific protocols were applied: aggressive early drainage for the early respiratory-renal pattern, a maximal conservative approach for the late respiratory pattern, and intensive monitoring with readiness for emergency interventions for the early multisystem pattern. The primary endpoint was hospital length of stay (LOS). Secondary endpoints included OF development, intensive care unit (ICU) utilisation, surgical interventions, and mortality.

**Results.** Median hospital LOS decreased from 35 [23–65] to 27 [15–33.25] days (p = 0.015), representing a 22.9 % reduction. OF development was prevented in 33.3 % of high-risk patients (the number needed to treat is 3). The incidence of persistent OF decreased from 90.2 % to 50.0 % (odds ratio (OR) = 0.11, 95 % confidence interval (CI): 0.03–0.37, p < 0.0001), and multiorgan failure from 31.7 % to 5.6 % (p = 0.004). The treatment effect was pattern-dependent (interaction p < 0.0001): the late respiratory pattern showed a 44.4 % LOS reduction (61.1 ± 27.2 to 34.0 ± 23.6 days, p = 0.005), the early multisystem pattern demonstrated a 47.2 % reduction (50.2 ± 32.8 to 26.5 ± 19.3 days, p = 0.042), while the early respiratory-renal pattern showed a non-significant increase (+31.3 %, p = 0.870). The proportion of staged open operations decreased from 58.5 % to 22.2 % (p = 0.001) without affecting emergency surgery rates. Mortality decreased from 12.2 % to 8.3 % (p = 0.579).

**Conclusions.** Pattern-oriented treatment of SAP significantly reduces hospitalisation duration and prevents OF development in one-third of high-risk patients. Treatment efficacy is heterogeneous across patterns, with the greatest benefit observed in late respiratory and early multisystem variants. This approach transforms the surgical paradigm from reactive to proactive, optimising intervention timing based on predicted clinical trajectory. Further multicentre validation is warranted to confirm these findings.

**Keywords**
pancreatitis, multiple organ failure, acute necrotizing pancreatitis, hospital length of stay, treatment outcome, risk assessment, inflammation.

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Severe acute pancreatitis (SAP) is associated with a mortality rate of 15–30 % when organ failure (OF) develops and up to 40 % in cases of infected pancreatic necrosis [10, 11, 15]. According to the Atlanta 2012 classification, the presence and duration of OF represent key prognostic factors [2]. The modern «step-up» approach, validated in the PANTER and POINTER trials, has demonstrated

advantages of delaying invasive interventions up to 4 weeks [4, 8, 21]. However, universal application of this strategy does not account for the heterogeneity of clinical course, potentially leading to suboptimal outcomes in some patients.

Analysis of large patient cohorts demonstrates significant variability in OF development trajectories in SAP. In 20–30 % of patients, OF develops within the first 48–72 hours, while in others it occurs in the second or third week of the disease [6, 9]. This heterogeneity suggests the existence of distinct disease phenotypes that potentially require differentiated approaches to timing and the extent of interventions.

The concept of personalised medicine, successfully implemented in oncology and cardiology, supports patient stratification based on biomarkers and clinical characteristics. In the context of SAP, this approach could optimise treatment tactics according to the predicted disease trajectory. However, there is a lack of validated models for early stratification and corresponding differentiated treatment protocols.

**Hypothesis:** Early identification of the OF pattern, followed by the application of a differentiated treatment protocol for SAP, is expected to improve clinical outcomes compared to the standard unified approach.

**Objective** – to evaluate the effectiveness of a differentiated treatment approach to severe acute pancreatitis based on organ failure patterns in comparison to standard disease management.

## Materials and methods

### Study design

A quasi-experimental study with historical control was conducted to evaluate the effectiveness of the pattern-oriented approach to SAP treatment. This design was chosen due to ethical considerations, as randomising patients to a control group would have been unacceptable after the identification of high-risk patterns. The study protocol was approved by the Commission on Ethics and Bioethics of Poltava State Medical University (No. 203, dated March 24, 2022).

### Study population

The study comprised 77 patients with SAP or high risk of its development, divided into two groups from different time periods. The comparison group consisted of 41 patients hospitalised during 2014–2019, in whom OF development was retrospectively confirmed according to modified Marshall criteria. The main group included 36 patients hospitalised during 2022–2024, to whom the improved pattern-oriented treatment algorithm was applied.

### Methodology for the development of a prognostic model

The development of the pattern-oriented approach was implemented through three consecutive stages. In the first stage, agglomerative hierarchical clustering using Ward's method and Euclidean distance was performed to analyse 13 variables characterising OF dynamics in patients from group 1. These variables included time to OF development, episode duration, number of affected systems, and the presence of transient and persistent forms of respiratory, renal, and cardiovascular dysfunction. The optimality of the identified clusters was confirmed by the ratio of within-class (67.02 %) variance to between-class (32.98 %) variance.

### Characteristics of identified organ failure patterns

Cluster analysis identified three clinically distinct patterns, each exhibiting unique trajectories of disease progression.

The early respiratory-renal pattern encompassed 39.0 % of the comparison group patients and was characterised by the earliest development of OF, with a median of 4.5 days from disease onset (interquartile range 2.0–13.5). This pattern was distinguished by a high frequency of early OF within the first 48 hours in 68.8 % of cases, a predominance of persistent respiratory dysfunction in 75.0 % of patients, and exclusively persistent renal failure in 31.3 %. This variant was associated with the shortest hospitalisation duration (median 22.5 days).

The late respiratory pattern was observed in 39.0 % of patients and was distinguished by delayed onset, with a median time to OF development of 30.0 days (interquartile range 22.8–49.0). No cases of early OF were identified in this group; instead, in 93.8 % of cases, organ dysfunction developed exclusively in the late phase of the disease after day 14. Isolated respiratory system involvement was noted in 87.5 % of patients, with minimal involvement of other organs. This pattern was associated with the longest hospitalisation (median 62.0 days).

The early multisystem pattern, representing the least common variant (22.0 % of patients), demonstrated intermediate temporal characteristics, with a median OF development of 7.0 days (interquartile range, 6.0–11.0 days). However, this pattern was associated with the most severe clinical course. Multiple episodes of organ dysfunction (four or more) were observed in 77.8 % of patients, with a high frequency of both transient cardiovascular and persistent renal failure (77.8 % each). Patients with this variant required the longest intensive care unit stay (median 9.0 days).

The identified patterns demonstrated statistically significant differences across all key parameters ($p < 0.0001$ for time of onset), justifying the need to develop differentiated treatment protocols.

In the second stage, a comprehensive statistical analysis of clinical and laboratory parameters from the first day of hospitalisation was conducted to determine predictors of the identified patterns. For practical clinical application, a simplified algorithm for pattern determination based on key predictors was developed, demonstrating 74.5 % accuracy.

The hierarchical decision-making structure was constructed using the CHAID (Chi-squared Automatic Interaction Detector) classification tree method, with a maximum depth of 4 levels and a minimum of 10 observations per node.

### Prognostic model structure

A two-stage prognostic model for risk stratification and OF pattern determination was formed. In the first stage, five high-risk criteria were evaluated during the first six hours from hospitalisation: heart rate > 88 bpm, presence of at least one systemic inflammatory response syndrome (SIRS) criterion, BISAP (Bedside Index for Severity in Acute Pancreatitis) score ≥ 1 point, creatinine level > 87 μmol/L, and total protein < 64 g/L. The presence of at least one criterion indicated a high risk of OF development with 94.9 % sensitivity and 93.3 % specificity.

The second stage, implemented over 6–24 hours, involved determining the specific pattern using a hierarchical algorithm. Patients with a heart rate < 85 bpm combined with a history of arterial hypertension were classified as having an early multisystem pattern. A heart rate > 95 bpm and creatinine level > 102 μmol/L indicated an early respiratory-renal pattern. A combination of tachycardia with SIRS signs indicated a late respiratory pattern. In cases not meeting any of the above combinations, the systemic immune-inflammatory index (SII = platelets × neutrophils / lymphocytes) was also evaluated for final stratification.

### Differentiated treatment algorithm

A modified differentiated treatment algorithm was developed based on identified patterns, incorporating the critical timing of complications and the specific features of each pattern's course. The algorithm provided pattern-specific surgical tactics, including the differentiated application of the step-up approach, optimised intervention timing, and individualised intensive care.

The main group comprised 36 patients hospitalised during 2022–2024 who had a high risk of OF development on admission. Unlike the comparison group, where patterns were determined retrospectively after the onset of complications, the main group underwent prospective stratification using prognostic model criteria for OF pattern determination within the first 24 hours, followed by application of a differentiated treatment protocol.

Inclusion criteria required adult patients aged 18 years or older with acute pancreatitis diagnosed according to the Atlanta 2012 criteria, who were hospitalised within 72 hours from symptom onset. For the comparison group, confirmation of OF during hospitalisation was mandatory, whereas for the main group, the presence of high-risk criteria for OF development was sufficient. Exclusion criteria included chronic pancreatitis, prior pancreatic surgery, or pancreatic malignancies.

### Differentiated treatment protocols

Patients in the comparison group received standard treatment according to 2014–2019 protocols based on a reactive approach to managing complications. In contrast, the main group was treated using a pattern-oriented protocol that applied differentiated tactics depending on the identified variant of progression.

For the early respiratory-renal pattern, the protocol provided aggressive early tactics, including ascites drainage within the first 72 hours when the volume exceeded 500 ml, aimed at reducing intra-abdominal pressure and improving ventilation. Prophylactic respiratory support via continuous positive airway pressure (CPAP) or high-flow oxygenation was provided concurrently with aggressive renoprotection, maintaining diuresis at a rate of least 0.5 ml/kg/hour. Importantly, necrosectomy was deliberately delayed until the fourth week for necrosis maturation.

For the late respiratory pattern, the most conservative approach was applied, with avoidance of invasive interventions during the first two weeks. Drainage of fluid collections was deferred until at least the third week and was performed only in the presence of infection. From the fourth week onwards, the classical step-up approach was used, gradually increasing the invasiveness of interventions. Respiratory therapy was prescribed preventively for atelectasis prophylaxis.

The early multisystem pattern required the most aggressive management, including immediate admission to the intensive care unit and 24-hour surgical team availability for emergency interventions. Drainage of fluid collections commenced in the second week regardless of infection status, and early initiation of renal replacement therapy was considered in cases of renal failure.

### Study variables

A comprehensive assessment of clinical status and treatment outcomes was conducted by analysing the following groups of parameters:

Demographic and anthropometric data: age, sex, body mass index.

Aetiological factors: biliary, alcoholic, drug-induced, alimentary, and idiopathic aetiology.

Comorbidity: assessed using the Charlson comorbidity index, which includes 19 categories of comorbid conditions with scores from 1 to 6 depending on mortality risk. Arterial hypertension, ischaemic heart disease, diabetes mellitus, chronic respiratory, renal, and hepatic diseases were registered separately.

Severity indicators at admission: BISAP scale from 0 to 5 points, presence of SIRS criteria, the modified CT severity index (mCTSI) from 0 to 10 points for assessing inflammatory changes, and the percentage of pancreatic necrosis.

First-day laboratory parameters: complete blood count with differential white cell count, SII index, biochemical markers (creatinine, urea, total protein, bilirubin, alanine aminotransferase (ALT), aspartate aminotransferase (AST), amylase, glucose, fibrinogen), and urine parameters.

Organ failure characteristics: presence and type (transient $< 48$ hours or persistent $\geq 48$ hours), affected systems (respiratory, cardiovascular, renal), time of onset (early before day 14 or late after day 14), number of episodes, and the maximum Multiple Organ Dysfunction Score (MODS).

Surgical interventions: total number of operations and procedures, timing of the first intervention, types of operations (elective or emergency for infection/haemorrhage/peritonitis), number of re-operations, performed drainage and necrosectomies.

Local complications: necrotising pancreatitis, infected and sterile pancreatic necrosis, acute peripancreatic fluid collections (APFC), acute necrotic collections (ANC), walled-off necrosis (WON), pleural effusion, and ascites.

### Endpoints and data collection

The primary endpoint was the total length of hospitalisation as an integrative indicator of disease severity and treatment effectiveness. Secondary endpoints included frequency of OF development and its characteristics with differentiation into transient, persistent, and multiorgan forms. Important indicators were ICU length of stay, the total number of surgical interventions divided into staged and emergency procedures, the development of local complications including infected pancreatic necrosis, and hospital mortality.

### Statistical analysis

Statistical analysis was performed using XLSTAT v. 2021.2. Power calculations indicated that a minimum of 35 patients per group was required. This sample size was needed to detect a 25 % difference in hospitalisation duration. The significance level was set at 0.05, and the power at 80 %. Categorical variables are presented as absolute numbers and percentages. Continuous variables are described as either the median with interquartile range or the mean with standard deviation, depending on their distribution. The Shapiro-Wilk test was used to assess the normality of the distributions.

Categorical variables were compared using the chi-square test. For small expected frequencies, Fisher's exact test was used. Continuous variables were compared using the Mann-Whitney U test, as most parameters did not follow a normal distribution. To assess differential treatment effects by pattern, analysis of variance with covariates and an interaction term between group and pattern was applied. Predictors of binary outcomes were determined using logistic regression. The number of interventions was modelled with Poisson regression. Time to surgery was analysed using Cox regression.

An extended sensitivity analysis was conducted. This involved excluding deaths, including only patients with confirmed OF, and removing outliers that exceeded three standard deviations above the mean. Statistical significance was set at $p < 0.05$. The Tukey correction was applied for multiple comparisons.

### Study limitations

The quasi-experimental design does not completely exclude confounders, particularly the general improvement in medical care observed between the study periods. Differences in inclusion criteria, with the retrospective cohort comprising only patients with confirmed OF and the prospective cohort including high-risk patients, introduce methodological heterogeneity. The single-centre setting further limits the generalisability of findings to other populations and healthcare systems. To mitigate these limitations, an extended statistical analysis was conducted using multiple methods to evaluate intervention effects.

## Results

### Study population characteristics

A total of 77 patients with SAP were divided into a comparison group (group 1, $n = 41$, period 2014–2019) and a main group (group 2, $n = 36$, period 2022–2024). In the comparison group, all

patients developed confirmed OF during acute pancreatitis, whereas the main group included high-risk patients. In group 2, the implementation of differentiated pattern-oriented surgical tactics resulted in OF development in only 24 patients (66.7 %).

The groups' demographic and clinical characteristics were comparable (Table 1).

The median age was 43.0 [34.0–56.0] years in the comparison group and 46.5 [40.0–55.0] years in the main group (p = 0.272). Males predominated (68.3 % vs. 63.9 %, p = 0.683) with median body mass index (BMI) 26.3 and 25.5 kg/m$^2$, respectively (p = 0.955). Biliary aetiology dominated in both groups (61.0 % vs. 66.7 %, p = 0.604), while alcoholic aetiology accounted for approximately one quarter of cases (29.3 % vs. 25.0 %, p = 0.675).

The comorbidity profile was characterised by a high prevalence of cardiovascular pathology without intergroup differences: arterial hypertension was diagnosed in 58.5 % and 55.6 % (p = 0.792), and ischaemic heart disease in 56.1 % and 41.7 % of patients, respectively (p = 0.206). The median Charlson Comorbidity Index was 5.0 [4.0–6.0] in the comparison group and 4.0 [3.0–5.0] in the main group (p = 0.106).

Disease severity at admission was comparable: SIRS frequency was 36.6 % vs. 30.6 % (p = 0.577), and BISAP ≥ 2 was observed in 19.5 % vs. 13.9 % (p = 0.331). The only statistically significant difference was found for mCTSI distribution (p = 0.020), which may reflect the evolution of diagnostic capabilities at our hospital over time.

First-day laboratory parameters showed statistically significant differences between the groups, including higher total protein levels (68.3 ± 8.6 vs. 61.3 ± 8.6 g/L, p = 0.002), which may suggest

Table 1. **Baseline characteristics of study groups**

| Parameter | Group 1 (n = 41) | Group 2 (n = 36) | p |
|---|---|---|---|
| Demographics | | | |
| Age, years | 43.0 [34.0–56.0] | 46.5 [40.0–55.0] | 0.272 |
| Male sex | 28 (68.3 %) | 23 (63.9 %) | 0.683 |
| BMI, kg/m$^2$ | 26.3 [24.2–30.2] | 25.5 [24.2–31.6] | 0.955 |
| Aetiology | | | |
| Biliary | 25 (61.0 %) | 24 (66.7 %) | 0.604 |
| Alcoholic | 12 (29.3 %) | 9 (25.0 %) | 0.675 |
| Idiopathic | 4 (9.8 %) | 3 (8.3 %) | 0.828 |
| Comorbidity | | | |
| Charlson Index | 5.0 [4.0–6.0] | 4.0 [3.0–5.0] | 0.106 |
| Arterial hypertension | 24 (58.5 %) | 20 (55.6 %) | 0.792 |
| IHD | 23 (56.1 %) | 15 (41.7 %) | 0.206 |
| Diabetes mellitus | 4 (9.8 %) | 5 (13.9 %) | 0.573 |
| Severity at admission | | | |
| SIRS positive | 15 (36.6 %) | 11 (30.6 %) | 0.577 |
| BISAP ≥ 2 | 8 (19.5 %) | 5 (13.9 %) | 0.331 |
| mCTSI ≥ 6 | 21 (51.2 %) | 15 (41.7 %) | 0.035 |
| Key laboratory parameters, Day 1 | | | |
| Lymphocytes, × 10$^9$/L | 1.84 ± 0.48 | 1.63 ± 0.47 | 0.012 |
| Total protein, g/L | 61.3 ± 8.6 | 68.3 ± 8.6 | 0.002 |
| Creatinine, μmol/L | 107.1 ± 46.0 | 107.9 ± 81.3 | 0.450 |

Note. Categorical variables are presented as the number of cases and percentage, while quantitative indicators are presented as Median [Q1-Q3] or Mean ± SD.
BMI – body mass index; IHD – ischemic heart disease.

better prior hydration, and lower lymphocyte counts ((1.63 ± 0.47) vs. (1.84 ± 0.48) × $10^9$/L, p = 0.012) in the main group. The systemic immune-inflammatory index tended to be higher in the main group (2297.2 ± 1424.3 vs. 1839.6 ± 630.6; p = 0.089), but this difference was not statistically significant. Other admission parameters were comparable between the groups.

### Distribution by organ failure patterns

Patient stratification by patterns revealed clinically important differences between the groups (Table 2).

The comparison group exhibited an equal distribution between early respiratory-renal and late respiratory patterns (39.0 % each), with a smaller proportion of early multisystem (22.0 %). In the main group, the distribution shifted towards a multisystem pattern (41.7 %), with a reduction in early respiratory-renal cases to 22.2 %. However, these differences did not reach statistical significance ($\chi^2 = 4.07$; p = 0.124).

Table 2. **Patient distribution by organ failure patterns**

| Pattern | Group 1 (n = 41) | Group 2 (n = 36) |
|---|---|---|
| Early respiratory-renal | 16 (39.0 %) | 8 (22.2 %) |
| Late respiratory | 16 (39.0 %) | 13 (36.1 %) |
| Early multisystem | 9 (22.0 %) | 15 (41.7 %) |

### Primary endpoint: length of hospitalisation

The total length of hospitalisation, chosen as an integrative indicator of treatment effectiveness, demonstrated a statistically and clinically significant reduction. The median decreased from 35 [23–65] days in the comparison group to 27 [15–33.25] days in the main group (U = 977.5, z = 2.43; p = 0.015), reflecting a reduction in patient hospital stay by 8 days (22.9 %). The mean duration decreased from 44.1 ± 28.5 to 30.2 ± 21.2 days.

### Differential effect by patterns: interaction analysis

Analysis of variance with covariates revealed a highly significant interaction between the treatment group and the corresponding OF pattern (F = 6.179; p < 0.0001), explaining 30.3 % of the total hospitalisation variability ($R^2 = 0.303$, adjusted $R^2 = 0.254$). Importantly, age and BMI did not enter the final model through stepwise selection (p > 0.05), confirming that their effects are independent of these potential confounders (Table 3).

The most pronounced therapeutic effect was observed in patients with the late respiratory OF pattern. In this group, mean hospitalisation duration decreased from 61.1 ± 27.2 days in the comparison group to 34.0 ± 23.6 days in the main group, corresponding to an absolute reduction of 27.1 days or 44.4 % (p = 0.005 by Mann-Whitney for subgroup analysis). Post-hoc Tukey analysis further confirmed that the late respiratory pattern in group 1 was associated with the longest hospitalisation among all six subgroups (patterns of groups 1 and 2), with statistically significant differences compared to all other combinations (p < 0.05).

Patients with the early multisystem pattern also demonstrated an excellent response to differentiated treatment, as hospital stay was reduced from 50.2 ± 32.8 to 26.5 ± 19.3 days, representing a 47.2 % improvement (p = 0.042). Notably, this pattern was the only one to demonstrate a statistically significant reduction in ICU stay, decreasing from 8.2 ± 5.0 to 4.5 ± 7.8 days (p = 0.036).

Paradoxically, the early respiratory-renal pattern was associated with less favourable outcomes. Hospitalisation duration increased from 23.6 ± 8.6 days to 31.0 ± 21.9 days (+31.3 %). However, this difference was not statistically significant (p = 0.870) and was accompanied by greater variability. This pattern had the shortest natural treatment duration in the retrospective cohort, which may suggest that excessive interventions were administered in the prospective group.

Table 3. **Pattern-specific treatment effects on hospitalisation duration (M ± SD)**

| Pattern | Group 1 (n = 41) | Group 2 (n = 36) | Difference | | p* |
|---|---|---|---|---|---|
| | | | Days | % | |
| Early respiratory-renal | 23.6 ± 8.6 | 31.0 ± 21.9 | +7.4 | +31.3 | 0.870 |
| Late respiratory | 61.1 ± 27.2 | 34.0 ± 23.6 | –27.1 | –44.4 | 0.005 |
| Early multisystem | 50.2 ± 32.8 | 26.5 ± 19.3 | –23.7 | –47.2 | 0.042 |

Note. *Mann-Whitney test for each pattern separately;
ANCOVA (Analysis of Covariance) for overall model: F = 6.179; p < 0.0001, $R^2 = 0.303$.

## Organ failure modification

The application of the pattern-oriented approach resulted in enhanced OF parameters (Table 4).

The frequency of any OF development decreased from 100 % in comparison group 1 to 66.7 % in main group 2 ($p < 0.0001$), indicating prevention in 12 of 36 high-risk patients. The number needed to treat (NNT) to prevent one case of OF was 3.

Among the 24 patients in the main group who developed OF, a significant change in the nature of OF was observed. The frequency of persistent OF, which defines a severe course according to Atlanta 2012 criteria, decreased from 90.2 % (37/41) to 50.0 % (18/36), with an odds ratio (OR) of 0.11 (95 % confidence interval (CI): 0.03–0.37; $p < 0.0001$). The incidence of multiorgan failure declined from 31.7 % to 5.6 %, OR = 0.13 (95 % CI: 0.03–0.60; $p = 0.004$).

Analysis of the number of OF episodes demonstrated a shift toward milder forms. The median number of episodes decreased from 2 [1–3] to 1 [1–2]. Notably, no patients in the main group experienced ≥ 4 OF episodes during the AP course, compared to 24.4 % (10/41) in the comparison group ($p = 0.002$, Fisher's exact test).

## Surgical paradigm transformation

Surgical activity structure demonstrated cardinal transformations. The proportion of patients who did not undergo open surgical intervention increased from 26.8 % (11/41) to 52.8 % (19/36), $\chi^2 = 5.52$; $p = 0.047$. The most significant reduction occurred in staged open operations, which declined from 58.5 % (24/41) to 22.2 % (8/36), $p = 0.001$. In contrast, the frequency of emergency operations remained stable: for infection, 26.8 % vs. 27.8 % ($p = 0.925$); for haemorrhage, 7.3 % vs. 2.8 % ($p = 0.363$); for peritonitis, 4.9 % vs. 8.3 % ($p = 0.532$).

Kaplan-Meier analysis of time to first surgical intervention revealed no statistically significant difference in median values between groups (30 vs. 32 days, log-rank $\chi^2 = 0.041$; $p = 0.839$). However, the distribution of timing differed markedly: the 25th quartile was 5 [2–23] days in the comparison group vs. 26 [18–32] days in the main group, indicating a five-fold delay in early surgical interventions.

## Predictors of surgical interventions

Poisson regression for operation count ($R^2 = 0.437$) identified OF development in the late phase of acute pancreatitis as the most powerful predictor of multiple interventions with IRR (incidence rate ratio) = 4.70 (95 % CI: 1.67–13.24; $p = 0.001$). The pattern-oriented approach showed a trend toward a 33 % reduction in total operations (IRR = 0.67; 95 % CI: 0.34–1.31). However, the result did not reach statistical significance ($p = 0.236$).

Cox regression analysis for time to surgery indicated that classic severity predictors (age, BMI,

Table 4. **Organ failure characteristics in the study groups**

| Parameter | Group 1 (n = 41) | Group 2 (n = 36) | OR (95 % CI) | p |
|---|---|---|---|---|
| OF development | | | | |
| Any OF | 41 (100.0 %) | 24 (66.7 %) | – | < 0.0001 |
| Persistent OF | 37 (90.2 %) | 18 (50.0 %) | 0.11 (0.03–0.37) | < 0.0001 |
| Transient OF | 22 (53.7 %) | 18 (50.0 %) | 0.86 (0.36–2.08) | 0.745 |
| Multiorgan OF | 13 (31.7 %) | 2 (5.6 %) | 0.13 (0.03–0.60) | 0.004 |
| Number of OF episodes | | | | |
| 1 | 13 (31.7 %) | 19 (52.8 %) | | |
| 2 | 12 (29.3 %) | 13 (36.1 %) | | 0.051† |
| 3 | 6 (14.6 %) | 4 (11.1 %) | | |
| ≥ 4 | 10 (24.4 %) | 0 | | |
| ICU Utilisation | | | | |
| ICU admission | 8 (19.5 %) | 15 (41.7 %) | 2.94 (1.08–8.00) | 0.034 |
| ICU duration, days* | 5.0 [1.0–9.0] | 2.5 [0.0–7.0] | – | 0.136 |

Note. * Fisher's exact test for distribution; Median [Q1-Q3].
OR: odds ratio; CI: confidence interval.

BISAP) did not enter the final model. Instead, the time of complication type determined the timing of intervention: emergency operations for peritonitis had HR (hazard ratio) = 2.70 (95 % CI: 0.59–12.47; p = 0.203), infectious complications – HR = 1.83 (95 % CI: 0.87–3.85; p = 0.110), while staged open operations demonstrated a protective effect with HR = 0.75 (95 % CI: 0.20–2.84; p = 0.672).

### Intensive care resource utilisation

Paradoxical dynamics were observed in the requirement for ICU admission. The frequency of ICU admissions increased from 19.5 % to 41.7 % (OR = 2.94; 95 % CI: 1.08–8.00; p = 0.034), while the median duration of stay decreased from 5.0 [1.0–9.0] to 2.5 [0.0–7.0] days (p = 0.136). These findings suggest a shift from a reactive model, characterised by prolonged ICU stays for patients with established complications, to a proactive model involving short-term monitoring of high-risk patients.

### Local Complications

The frequency of necrotising pancreatitis remained comparable between the groups (80.5 % vs. 77.8 %, p = 0.770). Infected pancreatic necrosis showed a trend toward reduction from 46.3 % to 30.6 % (p = 0.152). Acute peripancreatic fluid collections were observed in 85.4 % and 75.0 % of cases, respectively (p = 0.248). The frequency of infected peripancreatic collections increased from 17.1 % to 36.1 %. However, this difference did not reach statistical significance. Walled-off necrosis was rare in both groups (2.4 % vs. 2.8 %, p = 0.929).

### Mortality

Hospital mortality decreased from 12.2 % (5/41) to 8.3 % (3/36). However, this difference did not reach statistical significance due to the small number of events (OR = 0.66; 95 % CI: 0.16–2.71; p = 0.579). The clinical significance lies in the absolute reduction in death risk of 3.9 %, corresponding to an NNT of 26 to prevent one death.

### Sensitivity analysis

A comprehensive sensitivity analysis was conducted to confirm the reliability of the findings and to exclude the influence of random factors (Table 5). This approach facilitates the assessment of the stability of group differences across various data analysis approaches.

A comparison of all study patients, based on the intention-to-treat principle, revealed a statistically significant reduction in hospitalisation duration for the group receiving enhanced treatment (group 2) compared to the group receiving traditional treatment (group 1). The median hospital stay was 27 days (mean 30.2 ± 21.2 days) in group 2 vs. a median of 35 days (mean 44.1 ± 28.5 days) in group 1. The reduction in hospital stay ranged from 8 to 14 days (p = 0.015), indicating that the improved algorithm decreased patient hospitalisation by nearly two weeks.

Excluding patients with fatal outcomes from the analysis (5 cases in group 1 and 3 cases in group 2) further accentuates the advantages of the improved approach. The difference in hospitalisation duration increases to 15 days (p = 0.012). The treatment effect remains moderate (effect size r = 0.352), with a 67.6 % probability that a randomly selected patient from group 1 will have a longer hospitalisation. Statistical analysis of anomalous values indicates that the longest hospitalisation (116 days) is not a statistical outlier, and the exclusion of extreme values minimally affects the results.

The practical value of the improved approach was assessed by calculating the number of patients who required treatment using the proposed algorithm. For OF prevention, the NNT (Number Needed to Treat) was 3 patients; for persistent OF prevention, the NNT was 2.5 patients; and for death prevention, 26 patients required treatment, respectively.

These indicators demonstrate the high effectiveness of the proposed approach, particularly in preventing the development and progression of OF.

Table 5. **Sensitivity analysis for the primary endpoint**

| Analysis | Group 1 (n = 41) | Group 2 (n = 36) | Difference | p |
|---|---|---|---|---|
| Main analysis (ITT), days (Median [Q1-Q3], Mean ± SD) | 35 [23–65]<br>44.1 ± 28.5 | 27 [15–33.25]<br>30.2 ± 21.2 | –8<br>–13.9 | 0.015 |
| Excluding deaths, days (Mean ± SD) | 45.0 ± 29.7 (n = 36) | 29.9 ± 22.0 (n = 33) | –15.1 | 0.012 |
| Outlier analysis (Grubbs criterion)* | – | – | – | 0.155 |

Note. ITT: intention-to-treat (analysis of all study patients).
* G = 3.002 < Gcrit = 3.292.

## Discussion

### Interpretation of the main results

The study demonstrates that personalisation of SAP treatment through early identification of OF patterns leads to clinically and economically significant improvements in outcomes [1, 5, 18, 23]. A reduction in median hospitalisation by 8 days (22.9 %) exceeds the minimal clinically important difference and aligns with recent studies on personalised medicine in critical conditions.

A key outcome is the prevention of OF in 33.3 % of high-risk patients (NNT = 3). Thus, for every three patients treated according to the differentiated protocol, one patient completely avoids the development of OF. Considering that OF is the main determinant of mortality in pancreatitis, this preventive effect is highly significant for improving survival rates.

Heterogeneity of treatment effects based on OF pattern is confirmed by a highly significant interaction in the ANCOVA model ($p < 0.0001$), which validates the central hypothesis regarding the necessity of personalised treatment. Notably, the model accounts for 30.3 % of the variability in hospitalisation duration without incorporating traditional severity predictors such as age or BMI, underscoring the fundamental role of OF patterns in determining disease trajectory [13].

The effectiveness of the pattern-oriented approach is based on three interconnected mechanisms. First, early stratification within the first 24 hours enables the initiation of preventive measures before irreversible pathophysiological changes occur. In contrast to the traditional reactive approach, which initiates interventions after complications manifest, the proactive model allows for modification of the natural disease course. Second, optimising the timing of interventions according to each pattern's expected trajectory prevents both premature operations with elevated complication risk and delayed interventions during necrosis progression. Third, differentiated therapy intensity avoids unnecessary interventions in favourable variants while ensuring adequate aggressiveness in unfavourable ones. This staged, physiology-guided strategy is consistent with broader surgical principles of damage control [17].

A reduction in persistent OF frequency from 90.2 % to 50.0 % (OR = 0.11) suggests effective interruption of the pathophysiological cascade. This outcome results from pattern-specific interventions, including aggressive early drainage of ascites-peritonitis in the early respiratory-renal pattern, an absolutely conservative approach in the late respiratory pattern, and readiness for emergency interventions in the early multisystem pattern. The complete absence of patients with multiple OF episodes in the main group, compared to 24.4 % in the retrospective cohort, further demonstrates the approach's capacity to prevent recurrent episodes of organ dysfunction.

The late respiratory pattern, which had the most severe natural course (a 61-day hospitalisation) demonstrated the maximum response to pattern-oriented therapy, achieving a 44 % reduction in hospitalisation duration. This finding aligns with POINTER trial data, which indicate that delayed interventions are most effective for patients experiencing late complications [3, 4]. These patients typically have sufficient time for preventive measures, with a median manifestation period of 38.5 days. Employing conservative tactics until day 14, followed by a step-up approach, corresponds to this pattern's natural evolution, in which necrosis develops slowly and often remains sterile with adequate supportive therapy. The findings expand upon this concept by demonstrating the feasibility of prospectively identifying such patients.

The early multisystem pattern showed comprehensive improvements, with overall hospitalisation reduced by 47.2 % and ICU stay by 45 %. This variant is characterised by a fulminant onset and early multiorgan dysfunction, which is traditionally associated with the worst prognosis. Implementation of aggressive early therapy and continuous emergency intervention readiness enabled effective control of the multiorgan dysfunction cascade. The complete elimination of multiple OF episodes ($\geq 4$) in this group further supports the effectiveness of the selected treatment tactics.

The paradoxical worsening of results for the early respiratory-renal pattern, evidenced by a 31.3 % increase in hospitalisation duration, warrants critical evaluation. In the retrospective cohort, this variant exhibited the shortest natural treatment duration of 23.6 days, suggesting a relatively favourable prognosis. Potential contributing factors include: (1) impact of early frequent invasive interventions; (2) disruption of natural compensatory mechanisms; (3) inaccurate stratification in the small subgroup (n = 8). Importantly, in the historical group, this pattern had the shortest hospitalisation duration (23.6 days), further indicating a relatively favourable natural course that did not require treatment intensification. These findings underscore the need for personalisation, not only by intensifying interventions, but also by considering reductions in their number and type.

The present findings expand upon the step-up approach paradigm established in the landmark

PANTER and TENSION trials [14, 19, 20]. While these studies proved the advantage of minimally invasive staged interventions over primary open necrosectomy for all patients, the current study highlights the need for personalisation within the step-up protocol. The observed reduction in new multiorgan failure frequency from 31.7 % to 5.6 % exceeds the PANTER trial results, where this indicator decreased from 40 % to 12 % [16, 21]. This improvement may be explained by the universal approach's failure to account for population heterogeneity, whereas pattern-specific tactics enable optimisation of intervention timing for each clinical variant.

It is important to note that this study does not position the pattern-oriented approach in opposition to the classic step-up method, but rather integrates personalisation into the existing paradigm [7, 22]. For the late respiratory pattern, the standard step-up protocol was effectively applied, yielding the most favourable outcomes for this variant. These findings indicate that the limitation lies not in the step-up approach itself, but in its universal application without consideration of individual course features.

The restructuring of surgical activity reflects a fundamental shift from surgery as the main treatment method to its use as a reserve option when conservative and minimally invasive therapies fail. A 62 % reduction in staged open operations, alongside stable emergency intervention rates, suggests an optimisation of surgical indications rather than mere avoidance of surgery. Additionally, a five-fold increase in the 25th quartile time to first operation, from 5 to 26 days, demonstrates abandonment of the early surgical debridement concept in favour of maximum delay.

The identification of OF in the late phase of AP (after day 14) as the most powerful predictor of multiple surgical interventions with IRR = 4.70 ($p = 0.001$) has important practical implications. Patients who develop OF after day 14 have an almost five-fold higher risk of requiring repeated operations. Paradoxically, classic severity predictors at admission (BISAP, age, BMI) did not enter the model, underscoring the advantage of dynamic monitoring over static risk stratification.

### Paradigm shift in intensive care

The increase in ICU admission frequency from 19.5 % to 41.7 %, accompanied by a simultaneous reduction in median length of stay, reflects a shift in intensive care philosophy regarding the management of severe pancreatitis. Rather than relying on a reactive model in which patients are admitted to the ICU with established complications for extended periods, a proactive strategy of involving early, short-term monitoring of high-risk patients has been adopted. Although this approach temporarily increases ICU burden in the short term, the overall reduction in intensive care bed-days and prevention of severe complications justify this approach.

### Clinical and economic implications

From a practical viewpoint, implementing the pattern-oriented approach requires reorganisation of the treatment process. Staff must be trained in the stratification algorithm within the first 24 hours to ensure round-the-clock readiness for emergency interventions in cases of the multisystem pattern and to optimise patient routing between departments. However, the potential savings of 589 bed-days per 77 patients and the reduction in the need for surgical interventions justify these organisational efforts.

The economic effectiveness of this approach, demonstrated by an NNT of 3 for the prevention of OF, makes it particularly attractive for healthcare systems with limited resources. Considering that the treatment cost for a patient with persistent multiorgan failure can exceed $100,000, preventing one such case for every three patients treated results in substantial cost savings. Additionally, the reduction in the frequency of staged open operations allows operating resources to be allocated to other patients.

### Future perspectives and directions for development

The results justify the need for a multicentre randomised controlled trial to definitively validate the pattern-oriented approach. It is essential to modify protocols for early respiratory-renal patterns to incorporate less aggressive tactics. The integration of machine learning can enhance the accuracy of early stratification, particularly for cases that are borderline between patterns [12, 24]. Additionally, developing biomarker panels represents a promising direction for determining objective patterns and monitoring therapeutic responses.

## Conclusions

A differentiated approach to SAP treatment, guided by early determination of OF patterns, significantly reduces hospitalisation duration by 22.9 % and prevents OF development in one out of three high-risk patients.

The effectiveness of pattern-oriented therapy is heterogeneous: the greatest reduction in hospitalisation duration is observed in late respiratory (44 %) and early multisystem (47 %) patterns, whereas the early respiratory-renal pattern requires protocol modification.

Implementing a differentiated approach restructures surgical activity, resulting in a 62 % reduction in staged operations while maintaining a stable frequency of emergency interventions, which suggests more optimised surgical treatment indications.

A proactive monitoring strategy in intensive care units increases ICU admission frequency but reduces the overall duration of intensive care and helps prevent the development of persistent multiorgan failure.

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## Declaration of interests

The authors declare no conflict of interest.

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## Authors contributions

H. O. Levytskyi: conceptualization, methodology, investigation, data curation, formal analysis, writing – original draft. V. D. Sheiko: supervision, validation, writing – project administration, review, editing.

## Statement on the use of generative artificial intelligence

the authors confirm that no generative AI systems were used to generate or interpret the content of this manuscript (text, figures, or data). Standard office tools (e.g., spelling/grammar checks in word processors) were used only for formatting and language polishing without content generation. No AI systems developed by the aggressor state were used.

## References

1. Antcliffe DB, Burrell A, Boyle AJ, Gordon AC, McAuley DF, Silversides J. Sepsis subphenotypes, theragnostics and personalized sepsis care. Intensive Care Med. 2025;51(4):756-68. Epub 2025/03/31 21:16. doi: 10.1007/s00134-025-07873-6. PubMed PMID: 40163135; PubMed Central PMCID: PMCPMC12055953.
2. Banks PA, Bollen TL, Dervenis C, Gooszen HG, Johnson CD, Sarr MG, et al. Classification of acute pancreatitis-2012: revision of the Atlanta classification and definitions by international consensus. Gut. 2013;62(1):102-11. Epub 20121025. doi: 10.1136/gutjnl-2012-302779. PubMed PMID: 23100216.
3. Besselink MG, van Santvoort HC, Nieuwenhuijs VB, Boermeester MA, Bollen TL, Buskens E, et al. Minimally invasive 'step-up approach' versus maximal necrosectomy in patients with acute necrotising pancreatitis (PANTER trial): design and rationale of a randomised controlled multicenter trial [ISRCTN13975868]. BMC Surg. 2006;6:6. Epub 2006/04/12. doi: 10.1186/1471-2482-6-6. PubMed PMID: 16606471; PubMed Central PMCID: PMCPMC1508161.
4. Boxhoorn L, van Dijk SM, van Grinsven J, Verdonk RC, Boermeester MA, Bollen TL, et al. Immediate versus Postponed Intervention for Infected Necrotizing Pancreatitis. N Engl J Med. 2021;385(15):1372-81. Epub 2021/10/07. doi: 10.1056/NEJMoa2100826. PubMed PMID: 34614330.
5. Duan XP, Qin BD, Jiao XD, Liu K, Wang Z, Zang YS. New clinical trial design in precision medicine: discovery, development and direction. Signal Transduct Target Ther. 2024;9(1):57. Epub 2024/03/05. doi: 10.1038/s41392-024-01760-0. PubMed PMID: 38438349; PubMed Central PMCID: PMCPMC10912713.
6. Fu CY, Yeh CN, Hsu JT, Jan YY, Hwang TL. Timing of mortality in severe acute pancreatitis: experience from 643 patients. World J Gastroenterol. 2007;13(13):1966-9. Epub 2007/04/28. doi: 10.3748/wjg.v13.i13.1966. PubMed PMID: 17461498; PubMed Central PMCID: PMCPMC4146974.
7. Garami A, Hegyi P. Precision Medicine in Pancreatitis: The Future of Acute Pancreatitis Care. Function (Oxf). 2023;4(3):zqad015. Epub 2023/05/12. doi: 10.1093/function/zqad015. PubMed PMID: 37168493; PubMed Central PMCID: PMCPMC10165548.
8. Hollemans RA, Bakker OJ, Boermeester MA, Bollen TL, Bosscha K, Bruno MJ, et al. Superiority of Step-up Approach vs Open Necrosectomy in Long-term Follow-up of Patients With Necrotizing Pancreatitis. Gastroenterology. 2019;156(4):1016-26. Epub 2018/11/06. doi: 10.1053/j.gastro.2018.10.045. PubMed PMID: 30391468.
9. Johnson CD, Abu-Hilal M. Persistent organ failure during the first week as a marker of fatal outcome in acute pancreatitis. Gut. 2004;53(9):1340-4. Epub 2004/08/13. doi: 10.1136/gut.2004.039883. PubMed PMID: 15306596; PubMed Central PMCID: PMCPMC1774183.
10. Kokosis G, Perez A, Pappas TN. Surgical management of necrotizing pancreatitis: an overview. World J Gastroenterol. 2014;20(43):16106-12. Epub 2014/12/05. doi: 10.3748/wjg.v20.i43.16106. PubMed PMID: 25473162; PubMed Central PMCID: PMCPMC4239496.
11. Leppaniemi A, Tolonen M, Tarasconi A, Segovia-Lohse H, Gamberini E, Kirkpatrick AW, et al. 2019 WSES guidelines for the management of severe acute pancreatitis. World J Emerg Surg. 2019;14:27. Epub 2019/06/19. doi: 10.1186/s13017-019-0247-0. PubMed PMID: 31210778; PubMed Central PMCID: PMCPMC6567462.
12. Levytskyi H, Sheiko V. The Use of Artificial Intelligence Models for Predicting the Dynamics of Acute Pancreatitis Progression. Ukrainian Medical Journal. 2024;163(5). doi: 10.32471/umj.1680-3051.163.253646.
13. Li CL, Lin XC, Jiang M. Identifying novel acute pancreatitis sub-phenotypes using total serum calcium trajectories. BMC Gastroenterol. 2024;24(1):141. Epub 2024/04/24. doi: 10.1186/s12876-024-03224-9. PubMed PMID: 38654213; PubMed Central PMCID: PMCPMC11036611.
14. Onnekink AM, Boxhoorn L, Timmerhuis HC, Bac ST, Besselink MG, Boermeester MA, et al. Endoscopic Versus Surgical Step-Up Approach for Infected Necrotizing Pancreatitis (ExTENSION): Long-term Follow-up of a Randomized Trial. Gastroenterology. 2022;163(3):712-22 e14. Epub 2022/05/18. doi: 10.1053/j.gastro.2022.05.015. PubMed PMID: 35580661.
15. Petrov MS, Shanbhag S, Chakraborty M, Phillips AR, Windsor JA. Organ failure and infection of pancreatic necrosis as determinants of mortality in patients with acute pancreatitis. Gastroenterology. 2010;139(3):813-20. Epub 20100609. doi: 10.1053/j.gastro.2010.06.010. PubMed PMID: 20540942.
16. Podda M, Pellino G, Di Saverio S, Coccolini F, Pacella D, Cioffi SPB, et al. Infected pancreatic necrosis: outcomes and clinical predictors of mortality. A post hoc analysis of the MANCTRA-1 international study. Updates Surg. 2023;75(3):493-522. Epub 2023/03/11. doi: 10.1007/s13304-023-01488-6. PubMed PMID: 36899292; PubMed Central PMCID: PMCPMC10005914.
17. Quinn J, Panasenko SI, Leshchenko Y, Gumeniuk K, Onderkova A, Stewart D, et al. Prehospital Lessons From the War in Ukraine: Damage Control Resuscitation and Surgery Experiences From Point of Injury to Role 2. Mil Med. 2024;189(1-2):17-29. Epub 2023/08/30. doi: 10.1093/milmed/usad253. PubMed PMID: 37647607.
18. Reddy K, Sinha P, O'Kane CM, Gordon AC, Calfee CS, McAuley DF. Subphenotypes in critical care: translation into clinical practice. Lancet Respir Med. 2020;8(6):631-43. Epub 2020/06/12. doi: 10.1016/S2213-2600(20)30124-7. PubMed PMID: 32526190.
19. Van Brunschot S, van Grinsven J, van Santvoort HC, Bakker OJ, Besselink MG, Boermeester MA, et al. Endoscopic or surgical step-up approach for infected necrotising pancreatitis: a multicentre randomised trial. Lancet. 2018;391(10115):51-8. Epub 20171103. doi: 10.1016/S0140-6736(17)32404-2. PubMed PMID: 29108721.
20. Van Brunschot S, van Grinsven J, Voermans RP, Bakker OJ, Besselink MG, Boermeester MA, et al. Transluminal endoscopic step-up approach versus minimally invasive surgical step-up approach in patients with infected necrotising pancreatitis (TENSION trial): design and rationale of a randomised controlled multicenter trial [ISRCTN09186711]. BMC Gastroenterol. 2013;13:161. Epub 2013/11/28. doi: 10.1186/1471-230X-13-161. PubMed PMID: 24274589; PubMed Central PMCID: PMCPMC4222267.

21. Van Santvoort HC, Besselink MG, Bakker OJ, Hofker HS, Boermeester MA, Dejong CH, et al. A step-up approach or open necrosectomy for necrotizing pancreatitis. N Engl J Med. 2010;362(16):1491-502. doi: 10.1056/NEJMoa0908821. PubMed PMID: 20410514.
22. Wang Z, Wang W, Xu J, He Q, Sun C, Xie S, et al. Development and validation of dynamic clinical subphenotypes in acute pancreatitis patients using vital sign trajectories in intensive care units: a multinational cohort study. Signal Transduct Target Ther. 2025;10(1):180. Epub 2025/06/05. doi: 10.1038/s41392-025-02261-4. PubMed PMID: 40467599; PubMed Central PMCID: PMCPMC12137743.
23. Wilson JG, Calfee CS. ARDS Subphenotypes: Understanding a Heterogeneous Syndrome. Crit Care. 2020;24(1):102. Epub 2020/03/25. doi: 10.1186/s13054-020-2778-x. PubMed PMID: 32204722; PubMed Central PMCID: PMCPMC7092435 worked as a consultant for Bayer, Roche/Genentech, CSL Behring, Prometic, and Quark. JGW receives grant funding from NIH.
24. Zhang C, Peng J, Wang L, Wang Y, Chen W, Sun MW, et al. A deep learning-powered diagnostic model for acute pancreatitis. BMC Med Imaging. 2024;24(1):154. Epub 2024/06/21. doi: 10.1186/s12880-024-01339-9. PubMed PMID: 38902660; PubMed Central PMCID: PMCPMC11188273.

# Диференційований підхід до лікування тяжкого гострого панкреатиту залежно від патерну органної недостатності

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Тяжкий гострий панкреатит (ТГП) з органною недостатністю (ОН) асоціюється з летальністю 15–40 %. Хоча підхід step-up довів перевагу над первинною некректомією, його універсальне застосування не враховує гетерогенності клінічного перебігу. Рання стратифікація пацієнтів на основі варіантів перебігу ОН може забезпечити персоналізовані протоколи лікування.

**Мета** — оцінити ефективність диференційованого підходу до лікування тяжкого гострого панкреатиту на основі варіантів перебігу органної недостатності порівняно зі стандартною тактикою.

**Матеріали та методи.** Проведено квазіекспериментальне дослідження з історичним контролем за участю 77 пацієнтів із ТГП або високим ризиком його розвитку. Група порівняння (n = 41, 2014–2019) отримувала стандартне лікування з ретроспективно підтвердженим розвитком ОН. Основна група (n = 36, 2022–2024) підлягала проспективній стратифікації за прогностичною моделлю протягом 24 год після госпіталізації з визначенням трьох патернів ОН: ранній респіраторно-ренальний, пізній респіраторний та ранній мультисистемний. Застосовували патерн-специфічні протоколи: агресивне раннє дренування для раннього респіраторно-ренального патерну, максимально консервативний підхід для пізнього респіраторного патерну, інтенсивний моніторинг з готовністю до екстрених втручань для раннього мультисистемного патерну. Первинна кінцева точка – тривалість госпіталізації, вторинні – розвиток ОН, переведення у відділення інтенсивної реанімації, хірургічні втручання, летальність.

**Результати.** Медіана госпіталізації знизилась з 35 [23–65] до 27 [15,00–33,25] днів (p = 0,015), тобто на 22,9 %. Розвиток ОН попереджено у 33,3 % пацієнтів із групи високого ризику (NNT = 3). Частота ОН, що персистує, зменшилась з 90,2 до 50,0 % (відношення шансів – 0,11, 95 % довірчий інтервал – 0,03–0,37; p < 0,0001), мультиорганної недостатності – з 31,7 до 5,6 % (p = 0,004). Ефект лікування значуще залежав від патерну (p < 0,0001): пізній респіраторний патерн – зменшення тривалості госпіталізації на 44,4 % (з (61,1 ± 27,2) до (34,0 ± 23,6) дня, p = 0,005), ранній мультисистемний патерн – на 47,2 % (з (50,2 ± 32,8) до (26,5 ± 19,3) дня, p = 0,042), ранній респіраторно-ренальний патерн – незначуще збільшення (+31,3 %, p = 0,870). Частота проведення етапних відкритих операцій зменшилася з 58,5 до 22,2 % (p = 0,001) без впливу на частоту екстрених втручань. Летальність знизилась з 12,2 до 8,3 % (p = 0,579).

**Висновки.** Патерн-орієнтоване лікування ТГП вірогідно зменшує тривалість госпіталізації та запобігає розвитку ОН у третини пацієнтів із групи високого ризику. Ефективність терапії відрізняється залежно від патерну з максимальною користю для пізнього респіраторного та раннього мультисистемного варіантів. Запропонований підхід трансформує хірургічну парадигму з реактивної на проактивну, оптимізуючи терміни втручань на основі прогнозованої клінічної траєкторії. Необхідно провести багатоцентрову валідацію для підтвердження результатів.

**Ключові слова:** панкреатит, мультиорганна недостатність, гострий некротизувальний панкреатит, тривалість госпіталізації, результат лікування, оцінка ризику, запалення.

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