Continuing Medical Education

Congestive Heart Failure

Perioperative Risk Assessment and Therapeutic Consequences

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Summary

Background: Three million people in Germany, and approximately 20% of older people undergoing surgery, suffer from chronic congestive heart failure. Perioperative hospital mortality is 4.8% in patients known to have chronic congestive heart failure and only 0.78% in other patients (adjusted odds ratio 2.15, 95% confidence interval [2.09; 2.22]). Congestive heart failure is often inadequately diagnosed and treated, and there is often a lack of preoperative guideline-based risk assessment and individualized strategic planning.

Methods: This narrative review is based on pertinent guidelines and publications retrieved by a selective literature search (PubMed/Medline).

Results: The frequency of acute postoperative decompensation is 2.5% among the entire population of patients with congestive heart failure (whether newly diagnosed or previously present as a chronic condition). The 1-year mortality rate is 44% (which can be compared to 11% without cardiac decompensation; adjusted HR, 1.66 [1.3; 2.2]). Patients at risk should be identified and classified at an early stage with bio-marker screening and echocardiography so that they can be managed perioperatively in accordance with the guidelines. Extended cardiovascular monitoring (preload, contractility, afterload) enables individualized volume and fluid substitution. Frequent reexamination in the early postoperative phase allows clinical deterioration to be detected early and treated with drugs. After discharge, the patient's further course must be monitored by his or her primary care physician.

Conclusion: Guideline-based pharmacotherapy, risk stratification, and interdisciplinary perioperative monitoring at close intervals are indispensable for lowering risk and preventing acute decompensation. Randomized clinical trials have been performed for the general treatment of congestive heart failure, but not for its perioperative management.

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Approximately 16 million inpatient surgical procedures are performed in Germany every year (1, 2). Cardiovascular diseases are still the leading cause of death in Germany, accounting for 33.9% of deaths (3). The prevalence of chronic heart failure in the general population is 3–5%. Among persons aged 70 to 74, it is 10% in men and 7% in women (2, 4). Patients with cardiovascular risk factors, and especially those with known chronic heart failure, have an increased risk of perioperative complications (5). Acute decompensation can occur, leading to hypoperfusion of all organ systems.

According to current data, acute decompensation occurs after 2.5% of surgical procedures in patients with an elevated cardiovascular risk profile and is associated with a 1-year mortality of 44%, compared to 11% in patients without cardiac decompensation (adjusted hazard ratio [HR] 1.66, 95% confidence interval: [1.3; 2.2]) (6), regardless of the presence of known chronic or perioperatively newly diagnosed heart failure.

These data underscore the importance of preoperative risk assessment and individualized management for minimizing perioperative complications in patients who are at increased cardiovascular risk and/or suffer from known chronic heart failure. Risk assessment should be both patient-specific and procedure-specific with regard to the type, complexity, and length of the operation. In this review, we discuss aspects of the preoperative, intraoperative, and postoperative management of patients with acute decompensation associated with known chronic or newly diagnosed heart failure.

Information on CME

This article has been certified by the North Rhine Academy for Continuing Medical Education. **The questions may be found at the end of this article.** The closing date for entries is 5 March 2027. **Participation is possible at** cme.aerzteblatt.de

Learning objectives

This article should enable the reader to

- understand the clinical significance of congestive heart failure in the perioperative setting,

Table 1a

The main class I recommendations on drug treatment for congestive heart failure with preserved ejection fraction (HFpEF)

Drug class	Studies	Study design	Effect size [95% CI]	Comparison	N	Side effects
RAAS inhibitors (ACEi, ARB, ARNi)		no recommendation				
Beta-blockers		no recommendation				
MRA		no recommendation				
SGLT2 inhibitors Grade I evidence	EMPEROR (2021) (e16)	double-blinded, randomized trial	● **primary endpoint** rehospitalization/mortality: HR 0.79 [0.69; 0.90]; p < 0.001 for rehospitalization only; no effect on mortality	empagliflozin vs. placebo	5988	urinary tract infection, hypotension
	DELIVER (2022) (28)	double-blinded, randomized trial	● **primary endpoint** clinical worsening: HR 0.79 [0.69; 0.91] death (cardiovascular): HR 0.88 [0.74; 1.05]	dapagliflozin vs. placebo	6263	lower symptom burden with dapagliflozin
Diuretics Grade I evidence	Faris et al. (2002) (e20)	meta-analysis	● **primary endpoint** mortality: OR 0.25 [0.07; 0.84], p < 0.03	diuretics vs. placebo	221	none

ACEi, angiotensin-converting enzyme inhibitor; ARB, angiotensin II receptor blocker; ARNi, angiotensin receptor neprilysin inhibitor; CI, confidence interval; HFpEF, heart failure with preserved ejection fraction; HR, hazard ratio; MRA, mineralocorticoid receptor antagonist; N, number of subjects; OR, odds ratio; RAAS, renin-angiotensin-aldosterone system; SGLT2, sodium-glucose cotransporter 2; vs., versus

- perform perioperative risk stratification of patients with congestive heart failure and optimize their medical treatment, and
- reliably detect the early warning signs of acute decompensation and react appropriately.

Methods

This narrative review is based on pertinent publications up to February 2025 that were retrieved by a selective search in PubMed on heart failure in non-cardiac surgery, as well as on the evidence-based guideline recommendations of the Association of Medical Scientific Societies in Germany (*Arbeitsgemeinschaft der Wissenschaftlichen Medizinischen Fachgesellschaften,* AWMF), the European Society of Cardiology (ESC), the European Society of Anesthesiology and Intensive Care (ESAIC), and the German Society for Anesthesiology and Intensive Care (*Deutsche Gesellschaft für Anästhesiologie und Intensivmedizin,* DGAI).

The diagnosis of congestive heart failure and its significance in the perioperative context

Congestive heart failure can be due to either systolic or diastolic impairment of left ventricular function. Two types of heart failure are distinguished on the basis of the left ventricular ejection fraction (LVEF), a measure of systolic function: heart failure with preserved ejection fraction (HFpEF) and heart failure with reduced ejection fraction (HFrEF) (7). The latter is defined as an ejection fraction less than or equal to 40%, as determined by imaging. A further category has been defined with mildly reduced left ventricular function (HFmEF), corresponding to an ejection fraction between 41% and 49%. The diagnosis of congestive heart failure also requires the following: clinical symptoms (e.g., dyspnea, edema, or weight gain), elevated natriuretic peptides, and evidence of structural or functional impairment (e.g., echocardiographic signs of diastolic dysfunction).

In a cohort of 2601 patients with heart failure in Polish hospitals, 62% had HFrEF, 13% had HFmEF, and 25% had HFpEF (8). Many cases of HFpEF may remain undetected, and thus reliable data on the distribution of heart failure types in the population are lacking (9). A retrospective analysis of 296 057 patients with known chronic heart failure revealed comparable perioperative complication rates and mortality in non-cardiac surgery in patients with HFrEF and HFpEF (10).

Both systolic and diastolic left ventricular dysfunction should be taken into account in presurgical risk assessment. After non-cardiac surgery, 2.5% of high-risk cardiovascular patients (defined as persons aged 65 or above, or persons aged 45 or above with known coronary artery disease [CAD], peripheral arterial occlusive disease [PAOD], or cerebrovascular disease) developed acute decompensation (6), 51% of them for the first time and 49% with pre-existing heart failure. Decompensation was experienced by 10% of all patients with known chronic heart failure and 1.5% without known heart failure.

An analysis of more than 20 million patients undergoing surgery in the USA revealed that in-hospital mortality was higher with a diagnosis of any type of heart failure than without such a diagnosis (4.8% versus 0.78%; p < 0.001; adjusted odds ratio [aOR] 2.15; [2.09; 2.22]). In-hospital mortality in cases of acute worsening of existing chronic heart failure (7.8%) was similar to that in cases of acute new-onset heart failure (8.0%). Patients with known heart failure without acute decompensation had a higher in-hospital mortality rate than those without diagnosed heart failure (3.9% versus 0.78%, p < 0.001; aOR 1.53; [1.47; 1.61]) (11). Proper planning of perioperative strategies must be based on an analysis of possible causes and meticulous risk assessment *(Box)*.

Table 1b

The main class I recommendations on drug treatment for heart failure with moderately reduced ejection fraction (HFmEF)

Drug class	Studies	Study design	Effect size [95% CI]	Comparison	N	Side effects
ACE inhibitors grade IIb evidence	PEP-CHF (2006) (e21)	double-blind randomized	● **primary endpoint:** Mortality/unplanned rehospitalization: HR 0.919 [0.700; 1.208]; p = 0.545	perindopril vs. placebo	201	● tongue and eyelid edema, high creatinine, hypotension
ARB grade IIb evidence	CHARM-Alternativ (2003) (e22)	randomized controlled	● **primary endpoint:** Mortality/unplanned rehospitalization: HR 0.77 [0.67; 0.89]; p = 0.0004	candesartan vs. placebo	2028	● cough (72%), hypotension (13%), renal dysfunction (12%)
ARNi grade IIb evidence	PARADIGM-HF; PARAGON-HF (2020) (e23)	randomized controlled	● **primary endpoint:** First hospital admission/death EF 32.5–42.5%:HR 0.81 [0.69; 0.94]; p = 0.005 EF 42.5–52.5%: HR 0.89 [0.73; 1.10]; p = 0.28	sacubitril/ valsartan vs. valsartan	4570	● hypotension, high creatinine, hyperkalemia
MRA grade IIb evidence	TOP-CAT (2014) (e24)	double-blind randomized	● **primary endpoint:** death/hospital admission HR 0.89 [0.77; 1.04], p = 0.14	spironolactone vs. placebo	3445	● high creatinine, hyperkalemia
Beta-blockers grade IIb evidence	PROSPERO) (e25)	double-blind randomized	● **primary endpoint:** mortality HR 0.59 [0.34; 1.03], p < 0.042	beta-blockers vs. placebo	575	● no data
SGLT2 inhibitors grade I evidence	EMPEROR (2018) (e16) DELIVER(2022) (28)	double-blind randomized	*cf. Table 1a*			
Diuretics grade I evidence	Faris et al. (2002) (e20)	meta-analysis	mortality: OR 0.25 [0.07; 0.84], p < 0.03	diuretics vs. placebo	221	● no data

ACE, angiotensin-converting enzyme; ARB, angiotensin II receptor blocker; ARNi, angiotensin receptor neprilysin inhibitor; CI, confidence interval; EF, ejection fraction; HFmEF, heart failure with mildly reduced ejection fraction; HFpEF; heart failure with preserved ejection fraction; HR, hazard ratio; MRA, mineralocorticoid receptor antagonist; N, number of subjects; OR, odds ratio; SGLT2, sodium-glucose cotransporter 2; vs, versus

The preoperative phase

Cardiac biomarkers for risk stratification

There is ample evidence that patients with perioperatively elevated troponin or B-type natriuretic peptides (BNP) levels have higher mortality and more frequent cardiac complications after non-cardiac surgery than those with normal biomarker levels (12–16). The extent to which these biomarkers contribute to individual event prediction is unclear. The available data suggest that BNP is more important than troponin (12, 14, 17). There is currently no reliable evidence to support biomarker-based adjustment of perioperative management. This issue is being studied by a consortium of German university hospitals as a component of the Peri-OP-Care-HF project (www.periop-carehf.de/). The desirability of measuring biomarkers is undisputed in patients with a clinically suspected perioperative coronary syndrome or acute heart failure. According to the German Society for Anesthesiology and Intensive Care Medicine (DGAI), the German Society for Surgery, and the German Society for Internal Medicine (18), troponin should be measured systematically before and 24–48 hours after surgery in patients with cardiovascular risk factors, symptoms of heart failure, or known cardiovascular disease (class B). This recommendation is based on the significant association between perioperative troponin dynamics beyond the 99th percentile and 30-day mortality (adjusted hazard ratio [HR] 2.7 [1.5; 4.8]) and 1-year mortality (adjusted HR 1.6 [1.2; 2.2]) (19–22). For this group of patients, the systematic determination of BNP in this group is only weakly recommended ("may be considered").

Perioperative indications for preoperative transthoracic echocardiography

In its 2022 guidelines (13), the ESC advocated a significant expansion of the indication for preoperative transthoracic echocardiography (class IIb). The expanded indication would include a weak recommendation for preoperative echocardiography in approximately 17% of non-cardiac surgery patients (23). The German recommendations (18) are stricter: a preoperative transthoracic echocardiogram (TTE) is only recommended for patients with a new heart murmur, cardiac symptoms, or suspected heart failure.

Medication adjustment for chronic heart failure

In patients with HFrEF, SGLT2 inhibitors (SGLT2i) reduce cardiovascular mortality and rehospitalization rates when given in addition to treatment with angiotensin receptor neprilysin inhibitors (ARNi) and angiotensin-converting enzyme inhibitors (ACEi), beta blockers, and mineralocorticoid receptor antagonists (MRAs). There is no class I recommendation for SGLT2 inhibitors combined with sartans (24, 25). The evidence summarized in *Tables 1a–c* concerns the treatment of congestive heart failure in general and applies in the perioperative setting as well. Dapagliflozin, in addition

Table 1c

The main class I recommendations on drug treatment for congestive heart failure with reduced ejection fraction (HFrEF)

Drug class	Studies	Study design	Effect size [95% CI]	Comparison	N	Side effects
ACE inhibitors grade I evidence	Garg et al. (1995) (e26)	meta-analysis	● **primary endpoint:** mortality / rehospitalization OR 0.65 [0.57; 0.74]; p < 0.001	ACE inhibitor vs. placebo	6988	no data
ARB grade I evidence	Mc Murray et.al (2014) (e27)	double-blinded randomized	● **primary endpoint:** death (cardiovascular) HR 0.80 [0.73; 0.87]; p < 0.001	ARB vs. enalapril	8442	hypotension, angioedema
MRA grade I evidence	Zannad et al. (2011) (e28)	double-blinded randomized	● **primary endpoint:** death (cardiovascular) / rehospitalization HR 0.63 [0.54; 0.74]; p < 0.001)	eplerenone vs. placebo	2737	hyperkalemia
Beta-blockers grade I evidence	COPERNIKUS Packer et al. (2002) (e29)	double-blinded randomized	● **primary endpoint:** death (cardiovascular) / rehospitalization 27% risk reduction [16%; 37%], p = 0.00002	carvedilol vs. placebo	2289	bradycardia, syncope, hypotension
	Flather et al. (2005) (e30)	randomized controlled	● **primary endpoint:** mortality / rehospitalization HR 0.86 [0.74; 0.99]; p = 0.039	nebivolol vs. placebo	2128	heart failure (25%), dizziness (15.6%), hypotension (7%)
SGLT2 inhibitors grade I evidence	Mc Murray et al. (2019) (26)	randomized controlled	● **primary endpoint:** death (cardiovascular) / rehospitalization HR 0.74 [0.65; 0.85], p < 0.001	dapagliflozin vs. placebo	4744	volume depletion (7.5%), ketoacidosis (0.1%)
	Packer et al. (2020) (e31)	double-blinded randomized	● **primary endpoint:** death (cardiovascular) / rehospitalization HR 0.75 [0.65; 0.86], p < 0.001	emagliflozin vs. placebo	3730	genital tract infections
Diuretics grade I evidence	Faris et al. (2002) (e20)	meta-analysis	mortality: OR 0.25 [0.07; 0.84], p < 0.03	diuretics vs. placebo	221	no data available

ACE, angiotensin-converting enzyme; ARB, angiotensin II receptor blocker; CI, confidence interval;HFrEF, heart failure with reduced ejection fraction; HR, hazard ratio; MRA, mineralocorticoid receptor antagonist; N, number of subjects; OR, odds ratio; SGLT2, sodium-glucose cotransporter 2; vs., versus

to a dual combination of RAAS inhibitors and beta-blockers, lowers both cardiac (HR 0.82; [0.69; 0.98]) and overall mortality (HR 0.83; [0.71; 0.97] (26). These substances are therefore strongly recommended (class I) for patients with HFrEF (7). A further class I recommendation for SGLT2i therapy in patients with HFmrEF and HFpEF was added in 2023 (27). For patients in these categories, a reduction was found in a composite endpoint of unplanned hospitalizations and cardiovascular mortality (0.79; [0.69; 0.91]) (28). In patients with HFpEF, in addition to SGLT2i, treating the causes of HFpEF is important as well, usually arterial hypertension (7).

Preoperatively, the patient's current treatment regimen for congestive heart failure should be reviewed with regard to drug classes and dosages in the light of the pertinent guidelines. It has been found that guideline recommendations for the treatment of heart failure are often inadequately implemented in clinical practice for non-cardiac surgery patients. In a Dutch study, 56% of patients with chronic heart failure were not receiving quadruple therapy; of the 44% who were receiving quadruple therapy, only 1% were in the therapeutic target range (29).

The perioperative use of ACE and SGLT2 inhibitors

The perioperative management of ACE inhibitor use is debated. A large cohort study (N = 14 500 with chronic ACE inhibitor use) showed a significantly increased risk of stroke, myocardial damage, and death with continued use (30). Despite increased intraoperative hypotension with continued ACE inhibitor therapy (31), two recently published randomized studies (N = 2222 (31), N = 262 (32)) did not reveal any increase in the incidence of myocardial damage (32) or in mortality or postoperative complications (31) through the continued use of ACE inhibitors. This evidence was not available when the German recommendations were written (18); these include a weak recommendation (class B) to pause ACE inhibitors on the day of surgery, but not if they are indicated for the treatment of congestive heart failure.

SGLT2 inhibitor therapy is indicated in heart failure with any value of the left ventricular ejection fraction (LVEF) (7, 27). Fasting and stress reactions predispose patients to (euglycemic) ketoacidosis while they are taking SGLT2 inhibitors (33, 34). There have been no large-scale studies to date on the perioperative incidence of ketoacidosis during SGTL2 inhibitor therapy; a perioperative ketoacidosis rate of ca. 0.2% has been reported in small studies. Small studies have reported a rate of approximately 0.2% of all perioperative cases. Appropriate tests for the evaluation of possible ketoacidosis include:

- blood gas analysis to assess pH, bicarbonate, and anion gap and to evaluate the severity of metabolic acidosis;
- urine or serum testing for ketone bodies (β-hydroxybutyrate is often dominant in ketoacidosis and should be measured in addition to acetoacetate).

Table 2

Pre-, intra-, and postoperative risk stratification according to the recommendations of the ESC, ESAIC, DGAI, and AWMF*

Patient-related risk: A, no cardiovascular risk factors B, HFpEF, HFmEF, and/or known cardiovascular risk factors C, HFrEF	+	Procedure-related risk: 1. Low risk (<1%) 2. Medium risk (1–5%) 3. High risk (>5%)	=	Risk category

	Low risk (A1–3 and B1)	Intermediate risk (B2, C1)	High risk (B3, C2, and C3)
Preoperative evaluation and medication	12-lead ECG, troponin (B1) Continue beta-blockers pause ACE inhibitor for 24 hours (hypotension)	12-lead ECG, troponin, TTE continue beta-blockers pause ACE inhibitor for 24 hours pause SGLT-2 inhibitors for 24–48 hours	12-lead ECG, troponin, NT-proBNP, TTE continue beta-blockers pause ACE inhibitor for 24 hours, and SGLT-2 inhibitor for 72 hours as indicated interdisciplinary discussion of procedure (evaluate potential for optimization)
Intraoperative monitoring	standard monitoring (non-invasive blood pressure measurement)	noninvasive continuous blood pressure measurement as indicated, advanced hemodynamic monitoring (cardiac output, dynamic preload parameters)	invasive continuous blood pressure measurement, advanced hemodynamic monitoring (cardiac output, dynamic preload parameters) Intraoperative TEE (C3) if necessary S1 and S3 guideline recommendations
Postoperative evaluation	none	ECG, troponin within 48 hr	ECG, troponin within 48 hr, postoperative TTE
Postoperative medication	continue beta-blockers	continue beta-blockers, ACE inhibitor	beta-blockers, ACE inhibitors, SGLT-2 inhibitors from 48 hr onward or immediately in special cases when indicated

* modified from (e7)

Examples of precedures with low, intermediate, and high risk:
low risk: e.g., superficial reconstructive procedures, eye and dental surgery, minor urogenital surgery, breast surgery, meniscus surgery, thyroid surgery

intermediate risk: carotid surgery, peripheral vascular surgery/EVAR, hip and spine surgery, splenectomy
high risk: cystectomy, pneumonectomy, amputation, esophagectomy, liver resection, lung transplantation, intestinal perforation

ACE, angiotensin-converting enzyme; AWMF, Association of Scientific Medical Societies in Germany; BNP, B-type natriuretic peptide; DGAI, German Society for Anesthesiology and Intensive Care Medicine; ECG, electrocardiogram; ESC, European Society of Cardiology; ESAIC, European Society of Anesthesiology and Intensive Care; HFmEF, heart failure with mildly reduced ejection fraction; HFpEF, heart failure with preserved ejection fraction; HFrEF, heart failure with reduced ejection fraction; SGLT-2, sodium-glucose cotransporter 2; TEE, transesophageal echocardiography; TTE, transthoracic echocardiography

The clinical signs of ketoacidosis are abdominal pain, nausea, disorientation, and tachypnea (35–38). A recently published secondary data analysis of nearly 35 000 people with diabetes who underwent emergency surgery did not reveal any significant increase in ketoacidosis among those taking SGLT2 inhibitors (39). A retrospective database analysis of approximately 21 000 patients undergoing uninterrupted SGLT-2 inhibitor therapy did not reveal any significant increase in postoperative complications or mortality (40). As the available evidence remains limited, it is recommended that SGLT2 inhibitors should be paused at least 24 and no more than 48 hours before minor procedures and at least 72 hours before major procedures (18) (class B).

Intraoperative phase

Risk-benefit analysis for general vs. regional anesthesia

The anesthetic technique should ideally be chosen by anesthesiologists with experience in managing patients with heart failure, in consideration of their risk stratification, cardiac pathology, and the type of procedure *(Table 2, Box)* (18). Stress in cardiac patients at risk can be reduced by stable intraoperative hemodynamics, relatively shallow anesthesia with a shorter time to extubation, and adequate postoperative analgesia—all of which are important components of any fast-track concept (e1, e2). General anesthesia is generally well tolerated by patients with pre-existing heart failure or a higher risk of perioperative cardiac decompensation when appropriate measures are taken.

With adequate preparation, hypoxia during induction of anesthesia is brief and rarely clinically relevant. Prolonged ischemia is usually caused by blood loss, volume shift, hypoxemia, and endothelial reactions.

Left and right ventricular afterload are influenced by anesthesia. Right ventricular afterload is lowered by preoxygenation but (unlike left ventricular afterload) increased by positive pressure ventilation, whether invasive or noninvasive. Avoiding invasive ventilation and extubating the spontaneously breathing patient as early as possible are clearly advisable in patients with heart failure, especially those with pre-existing right ventricular disease. Supplementary sedation for patients being operated on under regional anesthesia may cause undetected hypoventilation and hypercapnia, leading to increased right ventricular afterload and potentially to the decompensation of right heart failure. Conversely, insufficient stress protection can lead to hypertension and increased afterload and promote left heart decompensation. Patients with mitral insufficiency are at risk of developing pulmonary edema even with moderate blood pressure.

The indication and type of monitoring

There is an international consensus that cardiac patients at risk should be hemodynamically monitored (e3), as is also stated in the recently published German AWMF S1 guideline (e4): invasive continuous blood pressure monitoring should be initiated before the induction of anesthesia to ensure a mean arterial pressure of >60 (65) mmHg for adequate end-organ perfusion. To assess volume responsiveness, the S1 guideline and S3 guideline "Intravascular Volume Therapy in Adults" (e4, e5) recommend the determination of dynamic preload parameters such as stroke volume variation or pulse pressure variation, which can be measured by transpulmonary thermodilution or pulse wave analysis. The lactate concentration and central venous saturation are helpful additional parameters for assessing oxygen supply. Both guidelines explicitly recommend transesophageal echocardiography to assess contractility (systolic pump function, ejection fraction, signs of diastolic dysfunction) and any relevant structural heart disease. Alternatively, advanced hemodynamic monitoring can be used to monitor cardiac output, contractility, and dynamic preload and afterload. Highly invasive techniques such as transpulmonary or pulmonary artery thermodilution should only be used in patients with severe cardiac comorbidity (pulmonary hypertension, severe heart failure) or in high-risk procedures, such as liver transplantation (e3). Pulse wave analysis is a minimally invasive method for perioperative hemodynamic monitoring (e3). Measurement of the central venous pressure as a guide for volume therapy is not recommended. Right heart failure remains the indication for this hemodynamic parameter.

Box

Perioperative strategic planning

- **Causes of perioperative acute decompensation**
  - anesthesia-induced vasodilation
  - hypotension
  - tachycardia
  - surgical blood loss
  - myocardial hypoxia and hypoperfusion
  - anemia
  - volume overload with increased preload and afterload
  - acute stress response and systemic inflammation
- **Risk assessment and strategic planning**
  - assessment of the hemodynamic compensation stage
  - existing, clinically manifest heart failure symptoms (e.g., leg edema, as this is a prognostic factor)
  - ensuring a compensated, euvolemic, and oligosymptomatic status
  - optimization of heart failure drugs and diuretics
  - consideration of cardiac and procedure-related risk
  - NO elective procedures in acutely decompensated heart failure (ESC guideline)

Postoperative Phase

Postoperative Monitoring

Patients with heart failure are at increased risk of postoperative cardiovascular complications (e6). Close clinical monitoring enables the detection of impending decompensation and the initiation of therapeutic measures. Clinical signs (peripheral edema, rapid weight gain, new dyspnea) may point to deterioration (e7). The hemodynamic and respiratory situation should be monitored by the measurement of blood pressure, SpO_2 and, if necessary, blood gas analysis for the early detection of impaired circulation or oxygenation. The Surgical Apgar Score can be used to assess the risk of postoperative complications as a function of blood loss, lowest mean arterial blood pressure, and lowest perioperative heart rate (e7, e8).

In patients with signs of impending acute decompensation, balancing the fluid intake and output is essential for controlling volume status. The assessment of volume status is complex and should be performed multimodally (organ and vascular sonography, echocardiography, pulse contour analysis, thermodilution, clinical findings, and BNP value) (e9). Hypervolemia is associated with worse outcomes in patients with or without heart failure. In a retrospective study of 7896 patients who did not have pre-existing HFrEF, a 5% positive fluid balance on postoperative days 1 and 2 was associated with an increased 30-day mortality (day 1: HR 1.87; [1.22; 2.86]; day 2: HR 1.91; [1.25; 2.91]) (e10). There have not been any studies on the significance of perioperative fluid balance in patients with heart failure. Independently of the volume status assessment, cardiological evaluation and further diagnostic testing should ensue whenever acute decompensation is suspected: ECG (arrhythmia), echocardiography (worsening of systolic or diastolic biventricular function), high-sensitivity troponin (perioperative myocardial ischemia) (e7). A particularly relevant, often underestimated phenomenon in postoperative management is myocardial injury after noncardiac surgery (MINS). In a meta-analysis of 169 studies and 530 867 operations, the incidence of MINS was 17.9% in the entire population (mainly older adults with pre-existing cardiovascular disease undergoing elective or emergency operations in vascular, general and orthopedic surgery) (e11).

Recommendations on pharmacotherapy

Drug treatment after surgery depends on the presence or absence of congestive heart failure and on its classification (HFrEF vs. HFpEF).

In patients with existing heart failure, the current therapy must be continued. In particular, drugs such as ACE inhibitors, ARN inhibitors, beta blockers, and MRAs should not be abruptly stopped after surgery, as this increases the risk of cardiac decompensation (e7). If paused perioperatively, these drugs should be restarted as soon as the patient is hemodynamically stable. ACE inhibitors, ARN inhibitors, and beta blockers are mainstays of treatment, as they not only lower mortality but also markedly reduce the risk of cardiovascular complications

Further information on CME

- The completion time for all newly started CME units is 12 months. The results can be accessed 4 weeks following the start of the CME unit.
- CME points can be managed with the "uniform CME number" (einheitliche Fortbildungsnummer, EFN). The EFN must be stated during registration on www.aerzteblatt.de ("Mein DÄ") or entered in "Meine Daten," and consent must be given for results to be communicated. The 15-digit EFN can be found on the CME card (8027XXXXXXXXXX).

(e7). In two observational studies, patients who did not continue taking an ACE inhibitor/angiotensin II receptor blocker (ARB) postoperatively had a higher 30-day mortality rate (e12, e13). SGLT2 inhibitors should also be restarted, because they have positive cardiovascular effects in patients with HFrEF and HFpEF and lower the risk of rehospitalization (e14–e17). In these two studies, ACE inhibitor or ARB therapy was discontinued in 25% and 34% of patients, respectively, resulting in a 2– to 3-fold increase in the risk of 30-day mortality. If heart failure was not treated as recommended in the current ESC guidelines before surgery, this should be done after surgery (e17, e18). A stepwise approach is recommended: ACE inhibitors/ARN inhibitors and beta blockers should be introduced first, and beta-blockers should be titrated in only after the patient's hemodynamic status has stabilized. MRA and SGLT2 inhibitors can then be added to optimize treatment. The quadruple therapy mentioned above is only recommended for HFrEF and, to a limited extent, for HFmrEF. The introduction of the individual substances in the perioperative context should be staggered to minimize side effects such as hypotension or worsening renal function.

Challenges in postoperative drug treatment

Postoperative drug treatment can be challenging, especially in patients with multiple comorbidities. Patients with markedly impaired renal function, including those who are undergoing continuous renal replacement therapy (CRRT), are a special group for which only sparse evidence is available (e18). For these patients, beta-blockers are recommended regardless of the level of renal function. In addition, the updated ESC guidelines recommend the administration of SGLT2 inhibitors and finerenone (an alternative to other MRAs) in patients with diabetes and chronic renal failure and an estimated glomerular filtration rate (eGFR) of at least 25 mL/min/1.73 m^2 (e17). The potential benefit of the SGLT2 inhibitor dapagliflozin in patients with chronic renal failure, including those already receiving dialysis, is being studied in the Renal LifeCycle Trial (e19), which is currently recruiting patients. A subgroup analysis of the DAPA-CKD trial found no increased rate of adverse events with dapagliflozin use when dialysis became necessary during the course of treatment (e19). Future studies are needed to determine whether SGLT2 inhibitors can also be used safely in patients with heart failure and perioperatively reduced renal function.

Management after hospital discharge

The proper management of patients with congestive heart failure after their discharge from the hospital can help prevent cardiac decompensation and rehospitalization (e18). Patients should see their primary care physician within seven days of discharge for rechecking of their medical regimen for congestive heart failure and for the early detection of any potential complications (e7). The hospital discharge summary should include concrete recommendations for pharmacotherapy, including measures that have already been undertaken and further adjustments that will be necessary in the future. The need for diuretics should be critically re-evaluated to avoid the provision of unnecessary treatment.

Patients who have not been followed by a cardiologist in the outpatient setting to date should be referred to one for this purpose.

Overview

Patients with heart failure are a vulnerable high-risk group. The evidence indicates that both systolic and diastolic dysfunction increase the risk of perioperative complications and mortality, regardless of whether heart failure is pre-existing or new. Given the high prevalence of cardiovascular disease in an ever-older surgical patient population, risk stratification is essential. Preoperative assessment, guideline-based drug optimization, and individualized perioperative interdisciplinary management are essential measures for preventing cardiac decompensation and improving the quality of care.

Conflict of interest statement
The authors declare that they have no conflicts of interest.

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Complete list of full references including eReferences:
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CLINICAL SNAPSHOT

Four-Valve Endocarditis Initially Presenting With Peripheral Embolism

Figure 1: Thrombus removed intraoperatively from the axillary artery in the setting of infective endocarditis. The macroscopic specimen was a fresh, spindle-shaped thrombus measuring 3 cm in length, removed by open thrombectomy.

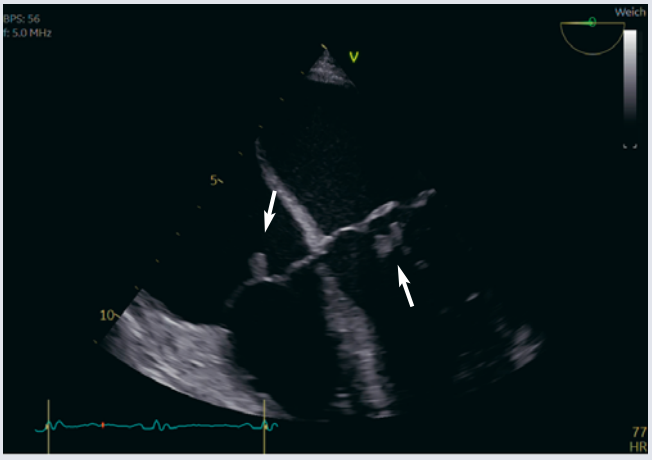

Figure 2: Transesophageal echocardiography showing hypoechoic, mobile structures on the mitral (right arrow) and tricuspid (left arrow) valves, consistent with vegetations in the setting of infective endocarditis.

Although infective endocarditis is rare (3–10/100 000/year), it increasingly affects older patients with damaged or prosthetic heart valves; men are twice as likely to be affected as women. A 66-year-old male patient presented with pain in his right hand. Clinically, the radial artery pulse was not palpable, and duplex ultrasound revealed a thrombotic occlusion of the axillary artery. Laboratory tests showed a marked inflammatory response (leukocytosis, CRP of 182 mg/L). Following emergency thrombectomy *(Figure 1)*, empiric antibiotic therapy (ampicillin, flucloxacillin, and gentamicin) was initiated. Transesophageal echocardiography *(Figure 2)* showed vegetations (irregularly shaped, mobile masses) on the mitral, aortic, tricuspid, and pulmonary valves. A diagnosis of four-valve infective endocarditis was made. Blood cultures remained sterile, indicating culture-negative endocarditis. Over the course of follow-up, the vegetations regressed without relevant valvular dysfunction. Follow-up at 6 months showed a stable clinical condition. In cases of peripheral embolism accompanied by a systemic inflammatory response, endocarditis should be considered promptly. Causes of culture-negative forms include prophylactic antibiotic treatment, difficult-to-detect pathogens (*Coxiella*, *Bartonella*, *Tropheryma*), and autoimmune disorders (Libman–Sacks endocarditis).

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Questions on this article

Participation is possible at cme.aerzteblatt.de.

The submission deadline is 5 March 2027.

Only one answer is possible per question. Please select the answer that is most appropriate.

Question 1

Which statement about the prevalence and perioperative significance of congestive heart failure is correct?

a) As the population ages, heart failure is likely to become less common.
b) The prevalence of chronic heart failure in the general population is 3–5%.
c) 21.5% of patients with congestive heart failure who undergo surgery suffer from acute perioperative cardiac decompensation.
d) Approximately 6 million surgical procedures are performed in Germany each year.
e) Heart failure has no effect on the complication rate after surgery.

Question 2

Which statement about the classification of heart failure by ejection fraction (EF) is correct?

a) In HFrEF, imaging studies show an ejection fraction of ≤ 40%.
b) HFmrEF can be diagnosed from an ejection fraction of < 30%.
c) As left ventricular function is preserved in HFpEF, no increase in perioperative risk is to be expected.
d) Unlike HFrEF, there are a variety of drug therapy options for HFpEF.
e) HFpEF is so common that undetected cases are presumed to be rare.

Question 3

When should transthoracic echocardiography be performed?

a) for preoperative diagnosis in low-risk patients
b) for postoperative diagnosis in high-risk patients
c) for intraoperative monitoring in intermediate-risk patients
d) for intraoperative monitoring in high-risk patients
e) for postoperative diagnosis in low-risk patients

Question 4

For what drug class is there a class I recommendation for the treatment of heart failure with preserved pump function?

a) beta-blockers
b) angiotensin-converting enzyme inhibitors
c) angiotensin II receptor blockers
d) renin-angiotensin-aldosterone system inhibitors
e) SGLT-2 inhibitors

Question 5

What drug is supported by level I evidence for heart failure with moderately impaired pumping function?

a) SGLT-2 inhibitors
b) angiotensin II receptor blockers
c) angiotensin receptor neprilysin inhibitors
d) angiotensin-converting enzyme inhibitors
e) beta-blockers

Question 6

What statement about the perioperative care of patients with known heart failure is correct?

a) Preoperative echocardiography is generally not indicated if an ECG is available.
b) Invasive arterial blood pressure measurement before the induction of anesthesia is recommended for patients with high cardiac risk.
c) The presence of heart failure should not affect the choice of anesthetic technique.
d) Postoperative troponin determination is only necessary in patients with chest pain.
e) Postoperative monitoring is only necessary in patients with HFrEF.

Question 7

Which statement about the choice of anesthetic technique for patients with heart failure is correct?

a) General anesthesia is absolutely contraindicated in patients with heart failure.
b) Regional anesthesia is generally superior to general anesthesia.
c) Positive pressure ventilation during general anesthesia lowers right ventricular afterload.
d) The anesthetic technique should be chosen on an individual basis, in consideration of the cardiac pathology and the type of procedure.
e) Anesthesia should generally be administered with nitrous oxide rather than propofol.

Question 8

Which of the following measures is a component of the recommended monitoring for patients with heart failure after surgery?

a) systematic recording of intake and output to guide fluid balance
b) invasive blood pressure measurement at least until postoperative day 3
c) Mottling score at least every 8 hours to assess the microcirculation
d) routine chest CT to detect pulmonary congestion
e) daily transthoracic echocardiography for early detection of diastolic dysfunction

Question 9

Among other things, the COPERNICUS trial yielded data on cardiovascular mortality in patients with reduced pump function when treated with carvedilol versus placebo. What side effects were reported?

a) vertigo
b) ketoacidosis
c) bradycardia
d) angioedema
e) hyperkalemia

Question 10

When should troponin be measured, as recommended by multiple medical specialty societies?

a) in general, before any thoracic surgical procedure
b) in patients undergoing pacemaker implantation
c) as part of the routine postoperative assessment, even in low-risk patients
d) in cases of clinical suspicion of perioperative coronary syndrome
e) in patients with type 2 diabetes and a BMI above 30 kg/m^2

Supplementary material to accompany the article

Congestive Heart Failure

Perioperative Risk Assessment and Therapeutic Consequences

by Vera von Dossow, Giovanni Lurati Buse, Tau Hartikainen, Martin Mirus*, and Johannes T. Neumann*

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