Supplementary Online Content

Rühlmann F, Tichelbäcker T, Mackert AF, et al. Incidence, associated risk factors, and outcomes of postoperative arrhythmia after upper gastrointestinal surgery. *JAMA Netw Open.* 5(7):e2223225. doi:10.1001/jamanetworkopen.2022.23225

**eFigure 1.** Flowchart of Patient Enrollment  
**eFigure 2.** English Version of the Patient Survey  
**eTable 1.** Demographic and Clinical Data of All Enrolled Patients  
**eTable 2.** Survey Results at 1 Year of Follow-up

This supplementary material has been provided by the authors to give readers additional information about their work.
Screening for all patients who underwent surgery of the upper GI
- including esophagus, stomach, and pancreas
- procedure was between 2012-2018
- With monitoring postoperatively at least 18 hours on ICU/IMC

n=1418

Exclusion of patients with pre-existing arrhythmia or pacemaker
n= 208

Enrollement in the present study and object of further analysis
n= 1210
**Survey**

Please mark applicable answer!

1) Which year the surgery at UMG was performed?

| 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 |
|------|------|------|------|------|------|------|

2) Which organ was the surgery performed on?

| Esophagus | Gaster | Colon | Liver | Pancreas | Adrenal gland | other |
|-----------|--------|-------|-------|----------|---------------|-------|

3) Were any arrhythmia known before surgery?

| Yes (type?) | No |
|-------------|----|

4) Was any arrhythmia diagnosed after discharge from hospital (UMG)?

| Yes (type?) | No |
|-------------|----|

If yes, after what time period did the arrhythmia occur?

| Still in hospital | During first 4 weeks after discharge | During first 3 months after discharge | During first 6 months after discharge | During first year after discharge | After first year after discharge |
|-------------------|-------------------------------------|--------------------------------------|--------------------------------------|----------------------------------|---------------------------------|

5) Did you developed a stroke after discharge?

| Ja | Nein |
|----|------|

If yes, after what time period did the stroke occur?

| Still in hospital | During first 4 weeks after discharge | During first 3 months after discharge | During first 6 months after discharge | During first year after discharge | After first year after discharge |
|-------------------|-------------------------------------|--------------------------------------|--------------------------------------|----------------------------------|---------------------------------|

6) Do you take any blood-thinning medication?

| Yes (what sort of medication?) | no |
|-------------------------------|----|

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### eTable 1. Demographic and Clinical Data of All Enrolled Patients

| parameter                        | level     | total          | male          | female         |
|----------------------------------|-----------|----------------|---------------|----------------|
| n                                |           | 1210           | 703           | 507            |
| Age                              | mean ± sd | 61 ± 14        | 62 ± 13       | 60 ± 15        |
|                                  | median (min; max) | 62 (19; 91)   | 63 (19; 91)   | 62 (22; 88)    |
| Malign diagnosis                 | No        | 398 (32.9%)    | 170 (24.2%)   | 228 (45%)      |
|                                  | Yes       | 812 (67.1%)    | 533 (75.8%)   | 279 (55%)      |
| Surgery                          |           |                |               |                |
| Salvage esophagectomies          |           | 11 (0.9%)      | 6 (0.9%)      | 5 (1.0%)       |
| Abdominothoracic esophagectomies |           | 228 (18.8%)    | 183 (26.0%)   | 45 (8.9%)      |
| Total pancreatectomies           |           | 24 (2.0%)      | 8 (1.1%)      | 16 (3.2%)      |
| Multivisceral resections         |           | 71 (5.9%)      | 45 (6.4%)     | 26 (5.1%)      |
| Partial gastric resections       |           | 77 (6.4%)      | 39 (5.5%)     | 38 (7.5%)      |
| Extended gastrectomies           |           | 105 (8.7%)     | 74 (10.5%)    | 31 (6.1%)      |
| Gastrectomies                    |           | 96 (7.9%)      | 57 (8.1%)     | 39 (7.7%)      |
| Pancreatic head resections       |           | 357 (29.5%)    | 203 (28.9%)   | 154 (30.4%)    |
| Distal pancreatectomies         |           | 78 (6.4%)      | 39 (5.5%)     | 39 (7.7%)      |
| Gastric sleeve/gastric bypass   |           | 157 (13.0%)    | 45 (6.4%)     | 112 (22.1%)    |
| Smaller esophageal resections    |           | 6 (0.5%)       | 4 (0.6%)      | 2 (0.4%)       |
| Hypertension                     | No        | 669 (55.3%)    | 379 (53.9%)   | 290 (57.2%)    |
|                                  | Yes       | 541 (44.7%)    | 324 (46.1%)   | 217 (42.8%)    |
| Diabetes mellitus                | No        | 884 (73.1%)    | 517 (73.5%)   | 367 (72.4%)    |
|                                  | Yes (Type I/II) | 185 (15.3%)   | 127 (18.1%)   | 58 (11.4%)     |
| Metabolic syndrome              |           | 141 (11.7%)    | 59 (8.4%)     | 82 (16.2%)     |
| Venous thrombosis (preoperative) | No        | 1135 (93.8%)   | 653 (92.9%)   | 482 (95.1%)    |
|                                  | Yes       | 75 (6.2%)      | 50 (7.1%)     | 25 (4.9%)      |
| Coronary heart disease           | No        | 1046 (86.4%)   | 582 (82.8%)   | 464 (91.5%)    |
|                                  | Yes       | 164 (13.6%)    | 121 (17.2%)   | 43 (8.5%)      |
| Embolic event                    | No        | 1128 (93.2%)   | 658 (93.6%)   | 470 (92.7%)    |
|                                  | Yes       | 82 (6.8%)      | 45 (6.4%)     | 37 (7.3%)      |
| Myocardial infarction (preoperative) | No    | 1156 (95.5%)   | 661 (94.0%)   | 495 (97.6%)    |
|                                  | Yes       | 54 (4.5%)      | 42 (6.0%)     | 12 (2.4%)      |
| Heart failure                    |           |                |               |                |
| Condition                          | No                  | Yes                  | Total                  |
|-----------------------------------|---------------------|----------------------|------------------------|
|                                  | No                  | Yes                  | Total                  |
|                                  |                     |                      |                        |
| Valvular heart disease            | No                  | Yes                  | Total                  |
|                                  | 1168 (96.5%)        | 42 (3.5%)            | 675 (96.0%)            | 493 (97.2%)            |
| Coagulopathies                    | No                  | Yes                  | Total                  |
|                                  | 1172 (96.9%)        | 38 (3.1%)            | 679 (96.6%)            | 493 (97.2%)            |
| Multiple cardiovascular diseases (≥2) | No                  | Yes                  | Total                  |
|                                  | 1197 (98.9%)        | 13 (1.1%)            | 700 (99.6%)            | 497 (98.0%)            |
| Performed cardiac treatment       | No                  | Yes                  | Total                  |
|                                  | 1110 (91.7%)        | 100 (8.3%)           | 626 (89.0%)            | 484 (95.5%)            |
| Premedication                     | Anticoagulants      | Antiarrhythmics      | Diuretics              | Ras-inhibitors         | Oral antidiabetics      |
|                                  | 288 (23.8%)         | 326 (26.9%)          | 293 (24.2%)            | 469 (38.8%)            | 133 (11.0%)             |
|                                  | 190 (27.0%)         | 177 (25.2%)          | 163 (23.2%)            | 270 (38.4%)            | 80 (11.4%)              |
|                                  | 98 (19.3%)          | 149 (29.4%)          | 130 (25.6%)            | 199 (39.3%)            | 53 (10.5%)              |
| Surgical complications intraoperative | No                  | Yes                  | Total                  |
|                                  | 1131 (93.5%)        | 79 (6.5%)            | 650 (92.5%)            | 481 (94.9%)            |
| Anastomosis-/ stump insufficiency | No                  | Yes                  | Total                  |
|                                  | 1089 (90.0%)        | 121 (10.0%)          | 619 (88.1%)            | 470 (92.7%)            |
| Wound healing deficit/ burst abdomen | No                  | Yes                  | Total                  |
|                                  | 1046 (86.4%)        | 164 (13.6%)          | 595 (84.6%)            | 451 (89.0%)            |
| Chyle/ pancreatic fistula, bile leakage | No                  | Yes                  | Total                  |
|                                  | 979 (80.9%)         | 231 (19.1%)          | 574 (81.7%)            | 405 (79.9%)            |
| Myocardial infarction (postoperative) | No                  | Yes                  | Total                  |
|                                  | 1206 (99.7%)        | 4 (0.3%)             | 699 (99.4%)            | 507 (100.0%)           |
| Revision surgery                  | No                  | Yes                  | Total                  |
|                                  | 1050 (86.8%)        | 594 (84.5%)          | 456 (89.9%)            |
|                          | Yes   | No   | Yes   | No   |
|--------------------------|-------|------|-------|------|
| Organic failure          | 160 (13.2%) | 1095 (90.5%) | 109 (15.5%) | 629 (89.5%) |
|                         | 115 (9.5%) | 74 (10.5%) | 51 (10.1%) | 466 (91.9%) |
| Electrolyte disorders    |       |      |       |      |
|                         | 868 (71.7%) | 502 (71.4%) | 342 (28.3%) | 201 (28.6%) |
|                         | 366 (72.2%) | 141 (27.8%) |       |      |
| Thrombosis (postoperative) |     |      |       |      |
|                         | 1194 (98.7%) | 696 (99.0%) | 16 (1.3%) | 7 (1.0%) |
|                         | 498 (98.2%) | 141 (27.8%) |       |      |
| Infections               | 888 (73.4%) | 498 (70.8%) | 322 (26.6%) | 205 (29.2%) |
|                         | 390 (76.9%) | 117 (23.1%) |       |      |
| Sepsis                   | 1156 (95.5%) | 669 (95.2%) | 54 (4.5%) | 34 (4.8%) |
|                         | 487 (96.1%) | 20 (3.9%) |       |      |
**eTable 2. Survey Results at 1 Year of Follow-up**

| Paroxysmal/persistent arrhythmia after hospitalization | Number of events (dead) (n) | Number at risk (n) | Survival (n) | Survival in % (95% CI) |
|-------------------------------------------------------|----------------------------|--------------------|--------------|-----------------------|
| No (n=54)                                             | 17                         | 38                 | 37           | 68.5 (57.2-82.1)      |
| Yes (n=20)                                            | 6                          | 16                 | 14           | 70 (52.5-93.3)        |