

Appendix 1

Bayesian networks to identify potential high-risk multimorbidity and intervention clusters in inpatients: an explorative data mining study

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Description of diagnosis/multimorbidity clusters (coded according to the German modification of the International Classification of Diseases, 10th revision [ICD-10])

D1 [I25.12] Chronic ischemic heart disease, two-vessel disease – [Z95.5] Presence of an implant or transplant after coronary artery surgery – [I21.4] Acute subendocardial myocardial infarction – [Z95.1] Presence of an aortocoronary bypass – [I25.14] Stenosis of the left main trunk – [I25.13] Three-vessel disease – [E78.0] Pure hypercholesterolemia – [I10.00] Benign essential hypertension – [O24.4] Diabetes mellitus, occurring during pregnancy – [O68.2] Complications of contractions and childbirth due to abnormal fetal heart rate with meconium in the amniotic fluid – [B95.1] *Streptococcus*, group B, as a cause of diseases classified in other chapters – [I10.9] Essential hypertension, not further described – [E11.90] Diabetes mellitus, type 2, without complications – [E78.9] Disturbance of the lipoprotein metabolism – [O34.2] Care of the mother due to previous surgical intervention – [O80] Spontaneous birth of a singleton – [O90.8] Other postpartum complications – [O70.0] First-degree perineal laceration under childbirth – [Z22.3] Carriers of other specified bacterial diseases – [O64.0] Birth difficulty due to incomplete rotation of the child's head – [O09.7] Duration of pregnancy: More than 41 completed weeks – [O63.0] Protracted opening period – [O71.8] Other specified injuries during childbirth – [O48] Over-carried pregnancy – [O70.1] 2nd degree perineal laceration – [O74.6] Other complications of spinal or peridural anesthesia during labour and childbirth – [O62.1] Secondary contraction weakness – [O63.1] Protracted expulsion period – [O68.0] Complications of labor and childbirth due to abnormal fetal heart rate – [D50.8] Other iron deficiency anemia – [O72.1] Other postpartum bleeding – [O09.6] Pregnancy duration, 37 to 41 completed weeks – [O99.0] Anemia, pregnancy, birth and puerperium complicated – [Z37.0] Liveborn singleton – [Z35.5] Monitoring of an elderly first time pregnant woman – [O42.11] Premature rupture of the membranes, onset of labor after 1–7 days – [O75.8] Other specified complications in labour and childbirth

D2 [T81.8] Other complications of surgery not classified elsewhere – [T81.3] Tearing open a surgical wound – [Y84.9] Incidents caused by medical measures – [T81.0] Hemorrhage and hematoma as complications of surgery – [D62] Acute bleeding anemia – [U69.12] Temporary blood clotting disorder – [D68.4] Acquired deficiency in coagulation factors – [F05.8] Other forms of delir – [T81.4] Infection after surgery

D3 [C78.6] Secondary malignant neoplasm of retroperitoneum and peritoneum – [C78.7] Secondary malignant neoplasm of the liver and intrahepatic bile ducts – [C77.2] Secondary and unspecified malignant neoplasm of lymph nodes, intraabdominal lymph nodes – [C17.2] Malignant neoplasm of the small intestine, ileum – [C79.5] Secondary malignant neoplasm of the bone and bone marrow – [Z92.3] Prior irradiation – [Z92.6] Prior chemotherapy due to malignant neoplasm – [C78.0] Secondary malignant neoplasm of the respiratory and digestive organs

- D4** [G51.0] Facial nerve paresis – [R47.1] Speech and language disorders – [I63.4] Cerebral infarction due to embolism of cerebral arteries – [R47.0] Dysphasia and aphasia – [G81.9] Hemiparesis and hemiplegia – [I69.3] Consequences of a cerebral infarction
- D5** [S06.0] Concussion – [S06.5] Traumatic subdural hemorrhage – [X59.9] Other and unspecified accident – [S01.0] Open wound of the hairy scalp – [S00.05] Superficial injury of the hairy scalp
- D6** [R57.2] Septic shock – [R65.1] Systemic inflammatory response syndrome of infectious origin with organ complications – [A41.9] Sepsis, not further described – [R65.0] Systemic inflammatory response syndrome – [A41.51] Sepsis by other gram-negative pathogens, *Escherichia coli*
- D7** [I48.0/I48.10] Atrial fibrillation, paroxysmal – [I48.11] Atrial fibrillation and atrial flutter, chronic – [Z92.1] Long-term therapy with anticoagulants – [Z86.7] Diseases of the circulatory system
- D8** [T83.5] Infection and inflammatory reaction through prosthesis, implant or transplant in the urinary tract – [Y82.8] Incidents caused by medical devices and products – [T84.0] Mechanical complication of a joint endoprosthesis
- D9** [Z21] Asymptomatic HIV Infection – [U61.9] Number of CD4+ cells not further specified – [U60.1] HIV disease, category A
- D10** [E11.74] Diabetes mellitus, type 2 with diabetic foot syndrome – [I79.2] Peripheral angiopathy – [G63.2] Diabetic polyneuropathy
- D11** [I50.14] Cardiac insufficiency, NYHA IV – [I50.01] Secondary right heart insufficiency – [I11.00] Hypertensive heart disease with (congestive) heart failure
- D12** [M48.06] Spinal stenosis, lumbar region – [G55.3] Compression of nerve roots and nerve plexus in other diseases of the spine and the back – [M43.16] Spondylolisthesis, lumbar region
- D13** [U80.4] *Escherichia*, *Klebsiella* and *Proteus*, ESBL resistance – [B96.2] *Escherichia coli* and other Enterobacteriaceae as cause of diseases classified in other chapters – [N39.0] Urinary tract infection, localisation not described in detail
- D14** [J18.9] Pneumonia – [U69.00] Elsewhere classified hospital-acquired pneumonia in patients 18 years of age and older – [J69.0] Pneumonia due to food or vomit
- D15** [D70.11] Agranulocytosis and neutropenia, critical phase 10 days to less than 20 days – [D61.10] Aplastic anemia due to cytostatic therapy – [D69.58] Purpura and other hemorrhagic diatheses, other secondary thrombocytopenia not referred to as transfusion refractory
- D16** [F10.0] Acute intoxication – [F10.2] Addiction syndrome
- D17** [G30.1] Alzheimer's disease with late onset – [F00.1] Dementia in Alzheimer's disease with late onset (type 1)
- D18** [J34.3] Other diseases of the nose and paranasal sinuses, hypertrophy of the nasal concha – [J34.2] Nasal septum deviation
- D19** [I34.0] Mitral valve insufficiency – [I36.1] Non-rheumatic tricuspid valve insufficiency
- D20** [G30.9] Dementia in Alzheimer's disease, not further described – [F00.9] Dementia in Alzheimer's disease, not further described
- D21** [N77.1] Vaginitis, vulvitis or vulvovaginitis in infectious and parasitic diseases classified elsewhere – [B37.3] Candidiasis
- D22** [S02.3] Fracture of the orbital floor – [S02.4] Fracture of the zygomatic bone and the upper jaw
- D23** [N18.5] Chronic kidney disease, stage 5 – [Z99.2] Long-term dependence on dialysis for renal failure
- D24** [J96.11] Chronic respiratory insufficiency, not classified elsewhere (hypercapnic) – [J96.10] Chronic respiratory insufficiency, not classified elsewhere (hypoxic)

- D25** [O09.5] Pregnancy duration, 34 to 36 completed weeks – [O60.1] Premature spontaneous contractions with premature delivery
- D26** [J96.00] Acute respiratory insufficiency, type I – [J96.01] Acute respiratory insufficiency, type II
- D27** [E11.20] Diabetes mellitus, type 2 with kidney complications – [N08.3] Glomerular diseases in diabetes mellitus
- D28** [O23.5] Infections of the genital tract during pregnancy – [B96.0] *Mycoplasma* and *Ureaplasma* as causes of diseases classified in other chapters
- D29** [L90.5] Atrophic skin diseases, scars and fibroses of the skin – [O99.7] Diseases of the skin and subcutaneous tissue that complicate pregnancy, childbirth and childbirth
- D30** [O30.0] Twin pregnancy – [Z37.2] Twins, both born alive
- D31** [C34.1] Malignant neoplasm of the bronchi and lungs, upper lobe (bronchus) – [C77.1] Secondary and unspecified malignant neoplasm of lymph nodes, intrathoracic lymph nodes
- D32** [G55.1] Compression of nerve roots and nerve plexus in intervertebral disc damage – [M51.1] Lumbar and other disc damage with radiculopathy

Description of intervention clusters (coded according to the Swiss classification of medical interventions [CHOP])

- I1** [80.59.10] Other discus destruction, removal of a free sequestrum – [03.09.34] Access to lumbar spine (by laminotomy or flavectomy), dorsal, 1 segment – [77.79] Bone harvesting from other specified bones, except facial skull bone, for transplantation – [03.09.35] Access to the lumbar spine (by laminotomy or flavectomy), dorsal, 2 segments – [78.50.35] Osteosynthesis by screw-rod system on the spine – [81.05] Thoracic and thoracolumbar spondylodesis, dorsal approach – [81.62.20] Spondylodesis of 3 vertebrae, dorsal – [00.99.20] Microsurgical technique – [00.99.60] Application of a navigation system – [01.24.29] Craniotomy of the calotte as access, other – [03.09.91] Other decompression of the spinal canal – [03.09.36] Access to the lumbar spine (by laminotomy or flavectomy), dorsal, 3 and more segments – [81.63.10] Spondylodesis of 4–6 vertebrae, dorsal – [80.51.10] Excision of an intervertebral discus, open surgery – [84.51.10] Insertion of intercorporeal cages, 1 segment – [81.62.10] Spondylodesis of 2 vertebrae, dorsal – [78.49.81] Transplantation of spongiosa (chips) or corticospongiosa (autogenous) chips from the spine – [81.08] Lumbar and lumbosacral spondylodesis, dorsal approach – [81.62.13] Spondylodesis of 2 vertebrae, dorsal, dynamic – [78.49.86] Use of human, demineralised bone matrix at the spine, without enrichment with bone growth cells
- I2** [36.13.11] (Aorto)coronary bypass to three coronary arteries, conventional technique – [39.61.10] Conventional extracorporeal circulation under normothermal conditions (more than 35 °C) – [36.12.11] (Aorto)coronary bypass to two coronary arteries, conventional Technique – [36.15] Resection of renal artery with anastomosis – [99.B7.13] Intensive care complex treatment, 185 to 360 application points – [39.63] Cardioplegia [99.04.10] – Transfusion of red cell concentrate, 1 TE to 5 TE [35.21.10] – Aortic valve replacement with graft, bioprosthesis – [99.00] Perioperative autologous transfusion of whole blood or blood components – [99.06.99] Transfusion of coagulation factors, others – [39.61.11] Conventional extracorporeal circulation under mild hypothermia (32 - 35 °C) – [88.72.21] Echocardiography, transesophageal, at rest – [36.11.22] Simple (aorto)coronary bypass, open surgical (thoracotomy, minithoracotomy, sternotomy), with autogenous artery, A. mammaria interna (A. thoracica interna) – [38.69] Other excision of lower limb veins – [39.64] Intraoperative cardiac pacemaker – [99.B7.12] Intensive care complex treatment, 120 to 184 expense points – [36.1C.14] Quadruple (aorto)coronary bypass – [38.6A] Endoscopic excision of a blood vessel for transplantation – [39.61.22] Minimal extracorporeal circulation under mild hypothermia (32–35 °C)
- I3** [39.30.19] Application of a vascular closure system, other – [37.22] Left heart catheter – [88.56] Coronary arteriography with two catheters – [88.53] Angiocardiology of structures of the left heart –

[00.46] Insertion of two vessel stents – [00.40] Measure on a vessel – [00.4B.18] ‘PTKI’ on femoral arteries and A. poplitea – [39.50.11] Angioplasty or atherectomy of other non-cardiac coronary artery(s) with single balloon – [00.4B.17] ‘PTKI’ on other abdominal arteries – [39.50.14] Angioplasty or atherectomy of other non-cardiac vessel(s) with drug eluting balloon – [00.4C.11] Insertion of 1 drug-releasing balloon – [39.90.10] Placement of vessel stent(s) in non-cardiac vessels, bare stents – [36.07] Insertion of coronary artery stent(s) with drug release – [00.66.29] Coronary angioplasty, with balloons, other – [00.41] measure on two vessels – [00.47] Insertion of three vessel stents – [36.07.99] Insert coronary artery stent(s) with drug release, others – [39.30.13] Closure of a canal with collagen on blood vessels – [00.45] Insertion of a vessel stent

14 [88.01.99] Computed tomography of the abdomen, other – [87.41.99] Computed tomography of the thorax, other – [88.01.10] Computed tomography of the entire abdomen – [33.24.13] Tracheobronchoscopy (flexible) (rigid) with (excision) biopsy – [33.24.11] Tracheobronchoscopy (flexible) (rigid) with bronchoalveolar lavage – [33.24.14] Tracheobronchoscopy (flexible) (rigid) with transbronchial needle aspiration – [87.04.11] Computed tomography of the neck – [88.38.50] (CT)-angiography of all vessels – [88.97.15] Magnetic resonance imaging facial skull/paranasal sinuses – [99.BA.11] Neurological complex treatment of acute stroke in stroke center, minimum 24 hours to maximum 72 hours – [87.03] Computer tomography of the skull – [88.38.40] Computer tomography of the spinal column – [88.91.10] Magnetic resonance imaging of the brain and brain stem – [89.14.99] Electroencephalography, other – [89.13.10] Neurological complex treatment of acute stroke, between 24 hours and 72 hours – [88.97.10] Magnetic resonance imaging angiography of all vessels – [03.31] Lumbar puncture – [88.41] Arteriography of the cerebral arteries – [99.10.99] - Injection or infusion of thrombolytic substance, other

15 [73.4] Medicinal induction of labour pains – [73.59] Manually supported birth, others – [73.6] Episiotomy – [73.09] Artificial bladder blasting, other – [03.91] Injection of an aesthetic and analgesic into the spinal canal – [72.71] Vacuum extraction with episiotomy – [74.1X.20] Deep cervical caesarean section, secondary – [75.69] Suture of another new birth-related tear – [72.79] Vacuum extraction, other

16 [37.34.22] Localisations in ablation procedures for tachyarrhythmias, AV nodes – [37.34.11] Ablation in tachyarrhythmia, conventional radiofrequency ablation – [37.34.21] Localisations in ablation procedures for tachyarrhythmias, right atrium – [37.34.12] Ablation in tachyarrhythmia, cooled radiofrequency ablation – [37.34.14] Excision or destruction of other lesion or tissue of the heart, other access, ablation using three-dimensional mapping – [37.34.24] Localisations in ablation procedures for tachyarrhythmias, left atrium – [37.34.1B] Ablation in tachyarrhythmia using three-dimensional mapping techniques with measurement of contact pressure – [88.72.24] Echocardiography, transesophageal, with contrast medium – [37.90.21] Transeptal catheter puncture

17 [57.94] Insertion of a transurethral permanent catheter – [59.8X.10] Ureteral catheterisation, insert, transurethral – [87.74] Retrograde pyelography – [56.0X.10] Transurethral removal of an obstruction of the ureter and renal pelvis, removal of a urinary stone – [00.99.30] Laser technology – [59.8X.11] Ureteral catheterisation, change, transurethral – [59.95] Disintegration of a urinary calculus with ultrasound

18 [92.29.81] Radiation planning for percutaneous radiation and brachytherapy, radiation planning for intensity-modulated radiotherapy – [92.29.65] Design and adaptation of fixation and treatment aids for radiotherapy, individual blocks or multi-lamellar collimator – [92.24.22] Teleradiotherapy with photons, linear accelerator, without image-based adjustment, more than 2 irradiation fields – [92.29.70] Radiation simulation for external radiation and brachytherapy – [92.29.63] Construction and adaptation of fixation and treatment aids for radiotherapy, fixation device, complex – [92.29.80] Irradiation planning for percutaneous irradiation and brachytherapy

19 [92.09] Other radioisotope function study – [92.28.13] Radioreceptor therapy with DOTA-conjugated somatostatin analogues – [92.18.08] Whole body scintigraphy for localisation diagnostics, other –

[92.19.08] Other scintigraphy of other localisations – [92.09.10] Single Photon Emission Computed Tomography (SPECT), other localisations – [92.15] Lung scintigraphy

I10 [37.7A.13] Implantation of a transvenous atrial electrode – [39.A2.11] Use of a magnetic resonance imaging capable pacemaker or defibrillator – [37.8A.21] Implantation of a two-chamber pacemaker, without antitachycardia stimulation – [37.7A.11] Implantation of a transvenous ventricle electrode

I11 [00.99.40] Minimally invasive technique – [14.71.19] Other vitrectomy over pars plana – [14.54] Removal of retinal detachment by laser photocoagulation – [14.59.10] Removal of a retinal detachment by heavy fluids

I12 [93.57.12] Continuous suction treatment with vacuum sealing, 8 days and longer – [86.88.59] Installation or replacement of a vacuum sealing system, on skin and subcutis or other localisations – [93.57.11] Continuous suction treatment with vacuum sealing, up to 7 days

I13 [89.0A.32] Nutritional counselling and therapy – [96.6] Enteral infusion of concentrated nutrients – [43.11] Percutaneous [endoscopic] gastrostomy

I14 [39.97.99] Other perfusion, other – [38.45.11] Resection of aorta ascendens or aortic arch with replacement – [39.61.13] Conventional extracorporeal circulation under deep hypothermia (20 to below 26 °C)

I15 [00.94.10] Monitoring of the recurrence nerve in another operation – [00.94.30] Intraoperative neurophysiological monitoring, up to 4 hours – [00.94.17] Monitoring of the facial nerve in another operation

I16 [39.95.21] Haemodialysis: intermittent, anticoagulation with heparin or without anticoagulation – [39.95.B1] Haemodiafiltration: intermittent, anticoagulation with heparin or without anticoagulation

I17 [57.49.12] Other transurethral resection of urinary bladder lesion or tissue – [57.0X.99] Transurethral drainage of the urinary bladder, others

I18 [04.81.12] Injection of aesthetic and analgesic to peripheral nerves, for pain therapy, with imaging techniques (BV) – [93.A3.11] Postoperative acute pain therapy, more than 48 hours

I19 [47.01] Appendectomy, laparoscopic – [00.9A.14] Use of a linear staple suture device, laparoscopic or thoracoscopic

I20 [40.23.11] Excision of an axillary lymph node, with radionuclide marking or dye marking (sentinel lymphnodectomy) – [40.19.20] Intraoperative probe measurement of radionuclide marking during sentinel lymphnodectomy

I21 [74.1X.10] Depth of cervical caesarean section, primary – [00.99.10] Reoperation

I22 [01.24.21] Drill hole preparation of the calotte as access – [01.31.10] Incision on the meninges to empty a subdural hematoma (hygroma)

I23 [69.09] Dilatation and curettage at the uterus, others – [68.12.11] Diagnostic hysteroscopy

I24 [13.71] Implantation of an intraocular lens during cataract extraction, single-session – [13.41] Phacoemulsification and aspiration of a cataract.