Health-economic Footprint
Patient Blood Management

PBM Footprint

Results from the expertise project

December 2018
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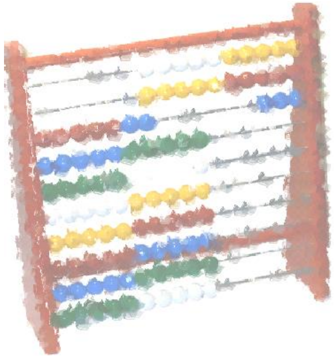

Agenda

0. Structure of the expertise

Chapter 1: Introduction

Chapter 2: Blood products

Chapter 3: PBM study and data situation

Chapter 4: Aggregated statistics

Chapter 5: Individual analysis

Chapter 6: PBM footprint modelling

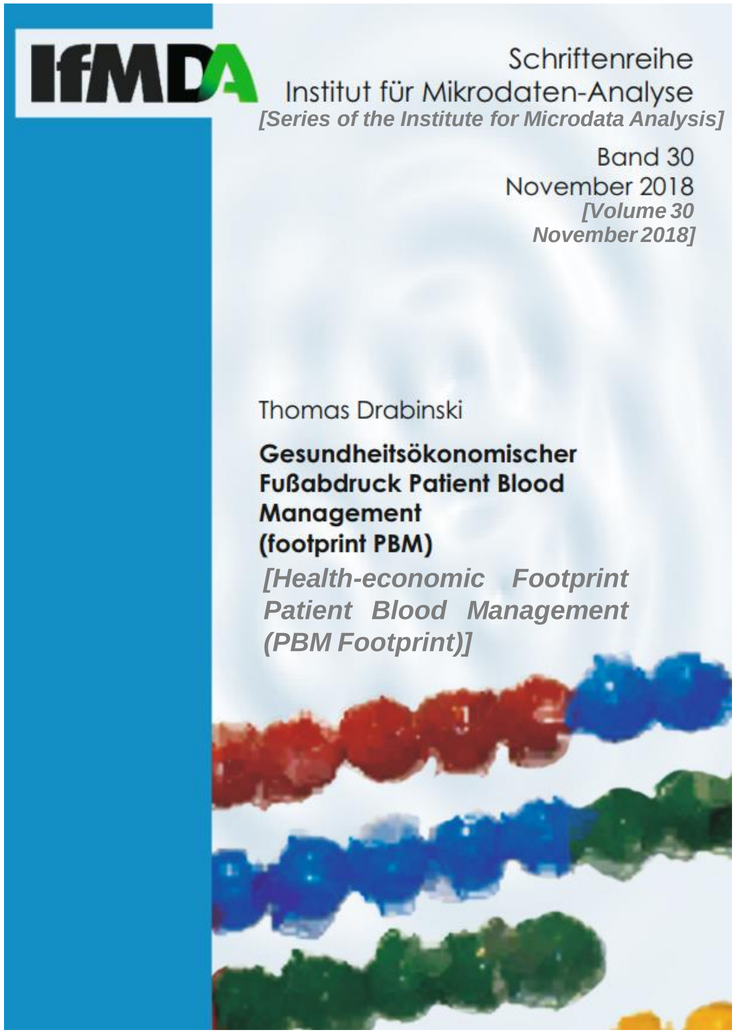

Table of contents

0. Structure of the expertise

Table of contents

The three risk factors

With plannable and non-plannable interventions in the hospital (particularly: surgery / surgical interventions) three risk factors for patients can be identified:

1. Anaemia
2. Blood loss
3. Transfused RBC products (allogeneic)

- Risk factors can negatively affect treatment results (outcome) and treatment costs.
- Hence Patient Blood Management (PBM) is the heading for actions to reduce the three risk factors.

Definition of PBM

“Patient Blood Management (PBM) is a pre-, intra- and postoperative set of actions …

- *to avoid anaemia,*
- *to reduce unnecessary blood loss in the hospital, and*
- *to use allogeneic blood products adequately (in particular: erythrocyte concentrates/ECs).”*

Groups of PBM interventions and actions

1. Prevention and management of anaemia: Diagnostics and treatment of **preoperative** anaemia (prior to elective interventions involving a transfusion risk > 10%).
2. Reduction / prevention of unnecessary blood loss in the hospital: Minimising **intraoperative** blood loss; minimising blood collection for laboratory diagnostics; all measures with allogeneic blood-sparing effects.
3. Patient-friendly use of allogeneic blood products: Exhausting anaemia tolerance, restrictive transfusion triggers.

Significance of PBM for the target groups in the health care system

- Patient: Improved health ("benefit"); reduced morbidity; fewer sick days and days of absence from work; lower likelihood for reduction in earning capacity; reduced mortality.
- Hospital: Improved patient care ("quality"); lower surgical complication rates; reduced length of stay in the hospital; fewer reoperations; lower infection rates and fewer rehospitalisations; less frequent intensive-medical care
- Outpatient sector: Improved care management by cross-sector cooperation (pre and post hospitalisation)
- Cost carrier: Promoting efficient allocation; reduced treatment costs (e.g., reduced DRG expenditures, lower number of hospitalised patients) and follow-up costs (sickness cash benefits, rehabilitation, outpatient costs, and drug therapy costs)
- Health politics: Ensuring economy and patient safety ("cost/benefit")

0. Structure of the expertise

Chapter 1: Introduction

Chapter 2: Blood products

Chapter 3: PBM study and data situation

Chapter 4: Aggregated statistics

Chapter 5: Individual analysis

Chapter 6: PBM footprint modelling

2. Blood products

EU14 comparison

Table 2.1 Comparison across Europe: whole-blood donations and use of erythrocyte concentrates (EC) [2014]

2014	Population [1.000]	Units of whole blood donated [number]	Whole blood donations [proportion per 1.000 inhabitants]	Use of ECs [number]	Use of ECs [proportion per 1.000 inhabitants]
Austria	8,585	384,082	44.7	357,197	41.6
Belgium	11,209	469,208	41.9	443,023	39.5
Czechoslovakia	10,530	411,800	39.1	373,900	35.5
Denmark	5,660	275,864	48.7	249,303	44.0
Finland	5,472	216,463	39.6	196,005	35.8
France	66,074	2,532,137	38.3	2,445,524	37.0
Germany	81,198	4,431,843	54.6	4,170,589	51.4
Italy	60,783	2,587,869	42.6	2,456,571	40.4
Netherlands	16,865	441,503	26.2	433,354	25.7
Norway	5,166	188,559	36.5	175,172	33.9
Spain	46,296	1,621,707	35.0	1,493,024	32.2
Sweden	9,747	462,269	47.4	455,063	46.7
Switzerland	8,200	310,836	37.9	296,080	36.1
United Kingdom	64,600	2,030,713	31.4	1,956,837	30.3
EU14 total / Ø	400,385	16,364,853	40.9	15,501,642	38.7

Source: Own presentation and calculation. EDQM (2014).

- In the EU14 comparison, in no other country the amount of blood donated and used is a high as in Germany!

Table 2.7 Population movement until 2060 and demand for ECs [in millions, Germany, simulation]

Year	Population [mill.]	ECs [mill.]
2017	82.834	3.427
2020	83.017	3.547
2030	83.029	3.878
2040	82.257	4.202
2050	80.778	4.348
2060	79.090	4.297

Source: Own presentation and calculation. StaBu (2016b, 2017a, 2017c, 2017d, 2018a).

- The demographic change will cause an increase in the number of blood products required.

- Blood donation services:
  - Number of blood donors is declining.
  - Baby boomers (age 65 to 90 years): increasing demand for ECs.

50-100 studies on this subject:

- Preoperative anaemia: Prevalence and effects
- EC transfusions: Effects on outcome and cost perspective
- PBM: Intravenous iron therapy, effects of PBM programmes and cost perspective

Studies with heterogeneous content; nevertheless with a clear picture:

- Preoperative anaemia leads to a poorer outcome and higher costs in surgery.
- EC transfusions also lead to a poorer outcome and higher costs.
- Ultimately, preoperative anaemia increases the likelihood of EC transfusions.
- PBM is an appropriate set of actions to improve outcomes and reduce costs.

Intermediate result 1:

- (Preoperative) anaemia is frequently diagnosed before operations and may be assumed in 20 to 40% of all surgical patients in the hospital.
- In all probability, half of these anaemia cases are attributable to iron deficiency, and 90% of all preoperative anaemias are {supposedly} not treated preoperatively.
- Assuming that 30% of all surgical patients are anaemic, half of them due to iron deficiency, and additionally assuming that 90% of these patients do not receive preoperative treatment, then, “on average”: **13.5% of all surgical patients are highly probable to present with (undiagnosed) untreated preoperative iron deficiency anaemia.**

Intermediate result 2:

- Preoperative anaemia is a risk factor for patients.
- Hence, a **two to threefold increase in mortality is observed in preoperatively anaemic patients**.
- Moreover, the length of stay in the hospital is increased by several days (approx. +25%) and, therefore, also the costs from the hospitals' and cost carriers' perspective.
- In addition, the risk of receiving an EC transfusion increases, again entailing further risks and costs.
- Negative outcomes are also more frequent in preoperatively anaemic patients: the need for postoperative intensive-medical care increases (with the severity of the anaemia), morbidity rises, e.g. from renal damage and/or infections.

PBM context: 5 relevant ICD-10-GM codes

- D50.0: Iron deficiency anaemia secondary to blood loss (chronic)
- D50.8: Other iron deficiency anaemias
- D50.9: Iron deficiency anaemia, unspecified
- D62: Acute posthaemorrhagic anaemia
- E61.1: Iron deficiency

Table 4.8 Coded EC blood units 2016 by sex and age group [OPS 8-800.c]

Age	Men	Women	Total
<1	23,094	17,862	40,955
1-5	8,772	7,127	15,898
5-10	6,179	4,287	10,466
10-15	6,014	5,444	11,458
15-20	10,479	8,381	18,860
20-25	12,867	10,570	23,437
25-30	15,049	17,236	32,284
30-35	16,002	22,795	38,797
35-40	23,301	22,928	46,229
40-45	29,511	25,370	54,880
45-50	57,080	43,842	100,922
50-55	99,290	66,503	165,793
55-60	141,903	86,126	228,029
60-65	184,594	115,004	299,598
65-70	213,196	140,760	353,956
70-75	239,610	172,982	412,592
75-80	323,371	279,354	602,725
80-85	217,885	240,368	458,252
85-90	120,076	188,697	308,773
90-95	36,987	95,083	132,070
>95	5,959	21,256	27,214
Total	1,791,215	1,591,969	3,383,184

Source: Own presentation and calculation. StaBu (2017a).

Database (§ 21 KHEntgG / Sect. 21 Hospital Reimbursement Act)

Research Data Centre (RDC) of the Federal and Statistical Offices of the Länder. DRG-Statistik 2015, own calculations.

- 2015 DRG Statistics is made accessible for research purposes by the Federal Statistical Office.
- Use of 2015 DRG Statistics via the research project “Control of risk factors via patient-individualized haemotherapy” at the Clinic for Anaesthesiology, Intensive Care Medicine and Pain Therapy of Frankfurt University Hospital.
- Sociodemographic characteristics (e.g. age and sex)
- Medical characteristics (e.g. ICD and OPS)
- Accounting characteristics (e.g. DRG proceeds)
- Other characteristics (e.g. outcome characteristics)
- 10% random sample from the complete survey patients (approx. 1.8 million patients)

Three ICD aggregates (secondary diagnoses)

A) <u>Preoperative anaemia:</u> Iron deficiency anaemia (D50.8 + D50.9)

B) <u>Intra- and postoperative anaemia:</u> Anaemia secondary to blood loss / haemorrhage (D50.0 + D62)

C) Iron deficiency (E61.1)

Patient groups

(1) All patients, undifferentiated (“all patients”)

(2) In-patients with elective surgery (“focus group”)

- No semi-in-patient, pre-inpatient or out-patient treatment
- No childbirths or in-patient deliveries
- No emergency cases, no occupational or other accidents (only “normal cases”)
- No patients with flat-rate payments outside of DRG partition “O” (surgical payment)

Table 5.2 Aggregated results on anaemia and units of blood [2015, extrapolation]

Description	All patients [number][a]	Focus group[b] [number]
a. Treatment cases[c] [mill.]	18.672	4.591
b. OPS[d] [mill.]	65.713	23.194
c. Casemix proceeds [10^3 mill. €]	65.247	24.787
d. Patients Aggregate A [mill.]	0.320	0.029
e. Patients Aggregate B [mill.]	0.761	0.275
f. Patients Aggregate C [mill.]	0.030	0.004
g. EC blood units[e] [mill.]	3.151	1.026
h. Patients with EC blood units [mill.]	0.823	0.227
j. ICD[f] [mill.]	120.140	24.356
j. Length of hospital stay [mill. days]	116.745	29.371
Index numbers		
k. Proportion of patients w/ EC in cases (h/a) [%]	4.43	4.95
l. EC per patient w/ EC (g/h) [number/patient]	3.83	4.51
m. Anaemia patients among patients w/ EC (d/h) [%]	38.92	7.74

Source: Research Data Centre (RDC) of the Federal and Statistical Offices of the Länder. DRG-Statistik 2015, own calculations.

Table 5.3 Schema of a 2x2 table for anaemia vs. EC

Therapy → Risk factor ↓	EC transfusion	No EC transfusion
Anaemia	a	b
No anaemia	c	d

Source: Own presentation.

The relative risk can be calculated as:

$$RR = \frac{a}{a+b} : \frac{c}{c+d} \tag{5.1}$$

- Relative risk describes the extent to which there is an association (dependency, causality) between risk factor (iron deficiency anaemia) and therapy (EC transfusion).
- Results for RR > 2.6: Strong association / serious causality is likely.

Hedderich/Sachs (2016)

- A dependency between risk factor and therapy ist likely if 5 conditions are met::

1. Repeatability of the association, the effect, both in different studies and in different subgroups of the same study.
2. The nature of the effect should be clear such as in a dose-effect relationship.
3. The effect should be specific with regard to cause and effect.
4. The cause must always precede the effect.
5. The effect should be biologically plausible and experimentally reproducible as far as possible.

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Table 5.4 2x2 table iron deficiency anaemia (Aggregate A) and EC transfusion frequencies [number of patients, patient group: all patients, 2015, extrapolation]

Therapy → Risk factor ↓	EC[c] transfusion	No EC transfusion
Iron deficiency anaemia[b]	60,940	259,280
No iron deficiency anaemia	761,870	17,589,930

Notes: [a] Extrapolated frequencies. Extrapolation is based on the extrapolation factor *HRF* = 10. [b] Iron deficiency anaemia = patients with ICD D50.8 and D50.9 coding (primary or secondary diagnoses). [c] Irrespective of the number of blood bags administered. The values for "Aggregate B" (anaemia secondary to blood loss or haemorrhage, "posthaemorrhagic anaemia") are: a = 497,500, b = 263,000, c = 325,310, d = 17,586,210. The values for "Aggregate C" (iron deficiency) are: a = 6,620, b = 23,520, c = 816,190, d = 17,825,690.

Source: Research Data Centre (RDC) of the Federal and Statistical Offices of the Länder. DRG-Statistik 2015, own calculations.

Table 5.5 Risk measures regarding the association between iron deficiency anaemia (Aggregate A) and EC transfusion [all patients, 2015]

Risk measure	Value	Lower 95% CI[a]	Upper 95% CI
RR (relative risk)	4.584	4.550	4.618
OR (odds ratio)	5.426	5.377	5.476

Notes: [a] CI = confidence interval. The relative risk for Aggregate B (anaemia secondary to blood loss or haemorrhage) is: RR = 36.019 [95% CI: 35.883; 36.155]. The relative risk for Aggregate C (iron deficiency) is: RR = 5.017 [95% CI: 4.910; 5.125].

Source: Research Data Centre (RDC) of the Federal and Statistical Offices of the Länder. DRG-Statistik 2015, own calculations.

5.3.3 Results: Association between risk factor (exposure) and therapy (RBC, output)

Table 5.6 2x2 table iron deficiency anaemia (Aggregate A) and EC transfusion average costs per patient [mean value, all patients, 2015]

Therapy → Risk factor ↓	EC transfusion	No EC transfusion
Iron deficiency anaemia	€ 8,703	€ 3,562
No iron deficiency anaemia	€ 14,069	€ 3,040

Notes: The values for Aggregate B (anaemia secondary to blood loss or haemorrhage) are: a = € 15,554, b = € 5,829, c = € 10,795, d = € 3,006. The values for Aggregate C (iron deficiency) are: a = € 11,323, b = € 4,698, c = € 13,690, d = € 3,046.

Source: Research Data Centre (RDC) of the Federal and Statistical Offices of the Länder. DRG-Statistik 2015, own calculations.

Table 5.7 2x2 table iron deficiency anaemia (Aggregate A) and EC transfusion average length of hospital stay per patient [days, mean value, all patients, 2015]

Therapy → Risk factor ↓	EC transfusion	No EC transfusion
Iron deficiency anaemia	15.7	8.3
No iron deficiency anaemia	19.2	5.6

Notes: The values for Aggregate B (anaemia secondary to blood loss or haemorrhage) are: a = 20.4, b = 9.9, c = 16.7, d = 5.6. The values for Aggregate C (iron deficiency) are: a = 19.4, b = 11.2, c = 18.9, d = 5.7.

Source: Research Data Centre (RDC) of the Federal and Statistical Offices of the Länder. DRG-Statistik 2015, own calculations.

5.3.3 Results: Association between risk factor (exposure) and therapy (RBC, output)

Table 5.8 2x2 table iron deficiency anaemia (Aggregate A) and EC transfusion frequencies [number of patients, focus group in-patients with elective operation, 2015, extrapolation[a]]

Therapy → Risk factor ↓	EC[c] transfusion	No EC transfusion
Iron deficiency anaemia[b]	7,090	22,110
No iron deficiency anaemia	220,300	4,344,700

Notes: [a] Extrapolated frequencies. Extrapolation is based on the extrapolation factor *HRF* = 10. [b] Iron deficiency anaemia = patients with ICD D50.8 and D50.9 coding (primary or secondary diagnoses). [c] Irrespective of the number of blood bags administered. The values for “Aggregate B” (“posthaemorrhagic anaemia”) are: a = 182,300, b = 93,030, c = 45,090, d = 4,273,840. The values for “Aggregate C” (iron deficiency) are: a = 990, b = 2,890, c = 226,400, d = 4,363,980.

Source: Research Data Centre (RDC) of the Federal and Statistical Offices of the Länder. DRG-Statistik 2015, own calculations.

Table 5.9 Risk measures regarding the association between iron deficiency anaemia (Aggregate A) and EC transfusion [focus group in-patients with elective operation, 2015]

Risk measure	Value	Lower 95% CI[a]	Upper 95% CI
RR (relative risk)	5.031	4.929	5.137
OR (odds ratio)	6.324	6.155	6.498

Notes: [a] CI = confidence interval. The relative risk for “Aggregate B” (“posthaemorrhagic anaemia”) is: RR = 63.420 [95% CI: 62.817; 64.030]. The relative risk for “Aggregate C” (iron deficiency) is: RR = 5.173 [95% CI: 4.902; 5.460].

Source: Research Data Centre (RDC) of the Federal and Statistical Offices of the Länder. DRG-Statistik 2015, own calculations.

Table 5.10 2x2 table iron deficiency anaemia (Aggregate A) and EC transfusion average costs per patient [mean value, focus group in-patients with elective operation, 2015]

Therapy → Risk factor ↓	EC transfusion	No EC transfusion
Iron deficiency anaemia	€ 21,744	€ 7,883
No iron deficiency anaemia	€ 21,173	€ 4,560

Notes: The values for "Aggregate B" („posthaemorrhagic anaemia") are: a = € 20,187, b = € 8,667, c = € 25,252, d = € 4,488. The values for Aggregate C (iron deficiency) are: a = € 22,977, b = € 9,489, c = € 21,183, d = € 4,574.

Source: Research Data Centre (RDC) of the Federal and Statistical Offices of the Länder. DRG-Statistik 2015, own calculations.

Table 5.11 2x2 table iron deficiency anaemia (Aggregate A) and EC transfusion average length of hospital stay per patient [days, mean value, focus group in-patients with elective operation, 2015]

Therapy → Risk factor ↓	EC transfusion	No EC transfusion
Iron deficiency anaemia	27.8	11.4
No iron deficiency anaemia	23.6	5.5

Notes: The values for Aggregate B (anaemia secondary to blood loss or haemorrhage) are: a = 22.9, b = 12.1, c = 27.4, d = 5.3. The values for Aggregate C (iron deficiency) are: a = 30.3, b = 13.9, c = 23.7, d = 5.5.

Source: Research Data Centre (RDC) of the Federal and Statistical Offices of the Länder. DRG-Statistik 2015, own calculations.

Outcome perspective:

„Reason for discharge and transfer“ (§ 21 KHEntgG)

- y = 1 „discharged fit for work “
- y = 2 „discharged unfit for work “
- y = 9 „no details on fitness for work“

- 01y Treatment completed regularly
- 02y Treatment completed regularly, post-discharge treatment planned
- 03y Treatment terminated for other reasons
- 04y Treatment terminated against medical advice
- 059 Change of responsibility of the cost carrier (for per day remuneration)
- 069 Transfer to another hospital
- 079 Death
- 089 Transfer to another hospital as part of a cooperation
- 099 Discharge to a rehabilitation facility
- 109 Discharge to a care facility
- 119 Discharge to a hospice
- 139 External transfer for psychiatric treatment
- 14y Treatment terminated for other reasons, post-discharge treatment planned
- 15y Treatment terminated against medical advice, post-discharge treatment planned
- 179 Internal transfer with change between the partitions of the DRG flat-rate payments, according to the National Hospital Rate Ordinance (BPflV), or for special facilities pursuant to Sect. 17b subsect. 1 sentence 15 Hospital Law (KHG)

All patients: summary statistics

Description	Iron deficiency anaemia [number of persons, Aggr. A]	Posthaemorrhagic anaemia [number of persons, Aggr. B]	Iron deficiency [number of persons, Aggr. C]
E1 - Treatment completed, discharged fit for work	13,100	18,850	930
E2 - Treatment completed, discharged unfit for work	100,980	173,100	6,480
E3 - Treatment completed, no details on fitness for work	166,340	322,690	17,720
E4 - Transfer to another hospital	11,600	64,630	1,250
E5 - Death or transfer to a hospice	8,890	62,450	980
E6 - Discharge to a rehabilitation facility	5,720	86,630	900
E7 - Discharge to a care facility	13,060	30,440	1,670
E8 - Other discharges	530	1,710	210
Total	320,220	760,500	30,140

Focus group: summary statistics

Aggregate	Iron deficiency anaemia [number of persons, Aggr. A]	Posthaemorrhagic anaemia [number of persons, Aggr. B]	Iron deficiency [number of persons, Aggr. C]
E1 - Treatment completed, discharged fit for work	1,160	5,850	100
E2 - Treatment completed, discharged unfit for work	7,820	52,710	1,170
E3 - Treatment completed, no details on fitness for work	15,410	113,650	1,970
E4 - Transfer to another hospital	1,460	25,780	220
E5 - Death or transfer to a hospice	900	16,730	110
E6 - Discharge to a rehabilitation facility	1,940	55,690	250
E7 - Discharge to a care facility	480	4,540	60
E8 - Other discharges	30	380	0
Total	29,200	275,330	3,880

Focus group: association between RBC (ECs transfusion) and mortality

Table 5.20 2x2 table EC transfusions and mortality frequencies [number of patients, focus group in-patients with elective operation, 2015, extrapolation]

Outcome → Risk factor ↓	Deaths	Not deceased patients
EC transfusion	22,270	204,910
No EC transfusion	17,370	4,346,510

Source: Research Data Centre (RDC) of the Federal and Statistical Offices of the Länder. DRG-Statistik 2015, own calculations.

Table 5.21 Risk measures for the association between EC transfusions and mortality [focus group in-patients with elective operation, 2015]

Risk measure	Value	Lower 95% CI[a]	Upper 95% CI
RR (relative risk)	24.628	24.155	25.110
OR (odds ratio)	27.196	26.648	27.754

Notes: [a] CI = confidence interval.

Source: Research Data Centre (RDC) of the Federal and Statistical Offices of the Länder. DRG-Statistik 2015, own calculations.

Association 1:

- If a patient receives – for whatever reasons – an EC blood transfusion in the course of an elective surgery, this patient’s mortality risk is increased 25-fold as compared to an elective surgery without RBC transfusion (EC).

Focus group: Association between iron deficiency anaemia and mortality

Table 5.22 2x2 table iron deficiency anaemia and mortality frequencies [number of patients, focus group in-patients with elective operation, 2015, extrapolation]

Outcome → Risk factor ↓	Deaths	Not deceased patients
Iron deficiency anaemia	900	28,270
No iron deficiency anaemia	38,740	4,523,150

Source: Research Data Centre (RDC) of the Federal and Statistical Offices of the Länder. DRG-Statistik 2015, own calculations.

Table 5.23 Risk measures for the association between iron deficiency anaemia and mortality [focus group in-patients with elective operation, 2015]

Risk measure	Value	Lower 95% CI[a]	Upper 95% CI
RR (relative risk)	3.633	3.404	3.878
OR (odds ratio)	3.717	3.476	3.975

Notes: [a] CI = confidence interval.

Source: Research Data Centre (RDC) of the Federal and Statistical Offices of the Länder. DRG-Statistik 2015, own calculations.

Association 2:

- If a patient with iron deficiency anaemia undergoes a plannable surgery, this patient's mortality risk is increased almost 4-fold.

Definition Patient Blood Management footprint (PBM footprint):

- *“Balance from savings and costs which can be achieved by PBM actions/measures.”*
- PBM actions are a pre-, intra- and postoperative set of measures consisting of 3 pillars:
  - Pillar 1: Prevention and management of (iron deficiency) anaemia
  - Pillar 2: Measures to reduce or avoid unnecessary blood loss in the hospital
  - Pillar 3: Patient-friendly use of RBC products (EC transfusions)

$$\text{PBM footprint} = AC - TC \qquad (6.1)$$

AC: Avoidable cost from preoperative anaemia management

- Treatment risks ↓ (elective operations)
- Quality of care ↑ & quality of life ↑
- Treatment costs ↓ & follow-up costs ↓
  - **Costs avoided ≅ potentially avoidable costs**
- **“What-if” analysis:**
  - ✓ **What effects are likely if the risks from iron deficiency anaemia and associated EC transfusions (RBC) are not realized.**

TC: Therapy and treatment costs incurred by PBM

TC = € 176.68 × 58,884 = € 10 mill.

58,884 = 29,170 (Tab. 6.1) x 0.135 (intermediate result 1) x 220,100 (Tab. 6.1)
176.68 Tab. 3.3 (p. 92)

6.2 Concept of avoidable costs: what-if analysis

Table 6.1 2x2 table iron deficiency anaemia and EC transfusion [number of patients, 2015, focus group plannable operation]

Therapy → Risk factor ↓	EC transfusion	No EC transfusion	Total
Iron deficiency anaemia	a 7,080	b 22,090	29,170
No iron deficiency anaemia	c 220,100	d 4,341,790	4,561,890
Total	227,180	4,363,880	4,591,060

Table 6.2 Simulation: 2x2 table iron deficiency anaemia and EC transfusion after implementation of preoperative anaemia management [number of patients, 2015, focus group plannable operation]

Therapy → Risk factor ↓	EC transfusion	No EC transfusion	Total
Iron deficiency anaemia	a 3,657	b 25,785	29,442
No iron deficiency anaemia	c 194,043	d 4,367,575	4,561,618
Total	197,700	4,393,360	4,591,060

Source: Research Data Centre (RDC) of the Federal and Statistical Offices of the Länder. DRG-Statistik 2015, own calculations.

Step 1: 13.5% of all surgical patients presenting with untreated preoperative iron deficiency anaemia (intermediate result 1) are taken into account. These persons are no longer allocated to cell "c" but to cell "a" (new values: a = 36,794, c = 192,588).

Step 2: In patients with iron deficiency anaemia, the risk of administration of an EC transfusion is more likely by the factor 5.031. The frequency in cell "a" is divided by the factor 5.031. The number of patients receiving an EC transfusion now is reduced by 29,480 and these are therefore allocated to cell "b" (new values: a = 7,313, b = 51,570).

Step 3: Assuming (normative assumptions) that half of the patients with iron deficiency anaemia can be treated effectively by preoperative iron deficiency anaemia therapy prior to the elective operation (increasing the Hb value), the frequencies in "a" and "b" are halved in accordance with the assumption. The patients treated this way are now kept in cells "c" and "d". Therapy rates exceeding 50% may be possible in patients with iron deficiency anaemia having an elective operation, e.g. if they receive parenteral iron supplementation, if possible, 4 weeks prior to the intervention (provided this is medically justifiable as determined by an individual risk-benefit assessment). Froessler et al (2016) analyse the increase in Hb values resulting from a 4-week therapy.

The approximate value of a statistical life (VSL) arises from the following formula:

$$VSL = \frac{\text{GDP}}{\text{population}} \times \text{life expectancy} \qquad (6.3)$$

$$VSL = € \ 2.996 \text{ mill. per capita} \qquad (6.4)$$

Alignment with the base value recommended by the OECD (US-$ 3.00 million for 2005) shows that the established value of € 2.996 million per person can assumed to be plausible.

Hence, the value for one day (VSL^d) is:

$$VSL^d = \frac{VSL}{(365 \times \text{life expectancy})} = € \ 101.74 \text{ per day} \qquad (6.5)$$

Table 6.3 Costs directly avoidable by preoperative anaemia management [simulation, 10^3 mill. €, costs = casemix proceeds, focus group plannable operation]

Reason for discharge	Costs saved [10^3 mill. €]
E1 - Treatment completed, discharged fit for work	0.008
E2 - Treatment completed, discharged unfit for work	0.040
E3 - Treatment completed, no details on fitness for work	0.141
E4 - Transfer to another hospital	0.097
E5 - Death or transfer to a hospice	0.105
E6 - Discharge to a rehabilitation facility	0.075
E7 - Discharge to a care facility	0.012
E8 - Other discharges	0.001
Total	0.479

Source: Research Data Centre (RDC) of the Federal and Statistical Offices of the Länder. DRG-Statistik 2015, own calculations.

Table 6.3 shows that the costs carriers can save a total of some € 479 mill. in direct hospital costs by the implementation of preoperative anaemia management.

$$AC_1 = € \ 0.479 \times 10^3 \text{ mill.} \qquad (6.6)$$

6.4.2 Quantification of avoidable costs: hospital days

Table 6.4 Hospital days avoidable by preoperative anaemia management [simulation, days, 2015, focus group plannable operation]

Reason for discharge	Length of stay saved [days]
E1 - Treatment completed, discharged fit for work	11,083
E2 - Treatment completed, discharged unfit for work	54,884
E3 - Treatment completed, no details on fitness for work	199,118
E4 - Transfer to another hospital	83,592
E5 - Death or transfer to a hospice	79,562
E6 - Discharge to a rehabilitation facility	84,765
E7 - Discharge to a care facility	17,597
E8 - Other discharges	4,325
E - Total	528,531

Source: Research Data Centre (RDC) of the Federal and Statistical Offices of the Länder. DRG-Statistik 2015, own calculations.

According to Table 6.4, the implementation of preoperative anaemia management saves some 528,531 days of length of hospital stay.

Assuming that the value of a day not spent in a hospital corresponds to $VSL^d = €\ 101.74$ per day and per person, this results in avoidable indirect costs for society to the amount of:

$$AC_2 = 528{,}531 \times €\ 101.74 = €\ 0.054 \times 10^3 \text{ mill.} \quad (6.7)$$

Approach 1. The concept of avoidable costs allows to read the avoidable deaths for the reason for discharge outcome perspective "E5 - Death or transfer to a hospice" from the (internal) results tables. This amounts to:

$$\text{Total of avoidable deaths} = 2{,}752 \qquad (6.8)$$

Central result 1: Preoperative anaemia management must be assumed to allow for the avoidance of a total of 2,752 deaths annually in plannable operations at DRG hospitals. In addition to this there are the avoidable deaths outside of DRG hospitals (e.g., purely private hospitals) and in other surgical facilities.

Central result 2: Assuming that the value of a statistical life (*VSL*) amounts to € 2.996 mill., preoperative PBM leads to avoidable indirect costs for society to the amount of at least:

$$AC_3 = 2{,}752 \times € \; 2.996 \text{ mill.} = € \; 8.246 \times 10^3 \text{ mill.} \qquad (6.10)$$

$$FP_{preop}^{PBM} = AC_1 + AC_2 + AC_3 - TC \qquad (6.11)$$

$$FP_{preop}^{PBM} = € \; 8.769 \times 10^3 \text{ mill.} \qquad (6.12)$$

Final result:

- Global preoperative anaemia management results in a profit for society (PBM footprint) to the amount of € 8.769 × 10^3 mill.

Conclusions (1/2)

- Preoperative anaemia management not globally implemented results in:
  - Unnecessary deaths
  - Unnecessary expenditures for statutory and private health insurances
  - Overuse of hospital infrastructure
  - Poorer outcome quality for patients and their families

Conclusions (2/2)

- Moreover, the economical profit for society is increased significantly if, in addition to preoperative anaemia management (Pillar 1), intra- and postoperative measures are implemented in the hospitals, including:
  - Measures to reduce or avoid unnecessary blood loss (Pillar 2) and
  - Patient-friendly use of allogeneic blood products (Pillar 3).
- The potentials of Pillars 2 and 3 are immense:
  - See values for “Aggregate B” in Tables 5.4 through 5.11!

Thank you for your attention!

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