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Do You Speak DRG ?

Measuring the Complexity of Labels of Medicare DRGs, AR-DRGs, and G-DRGs by Counting Conjunctions

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November 2007 · Last update: 14.11.2007

Introduction

Patient Classification Systems are constructed by collapsing similar diagnoses and/or treatments into not too many discrete groups, typically about 500 to 1000. These patient categories are usable if their labels are comprehensible.
In this study, the complexity of the DRG labels of several DRG systems is explored over time.

Data

DRG systems used in the USA (Medicare DRG 1994 until 2008), in Australia (AN-DRG 3.1, AR-DRG 4.1, AR-DRG 5.2), and in Germany (G-DRG 2003 until 2008) were inspected. As data, only the DRG labels had to be looked at.

Methods

For each DRG label, the following conjunctions were counted: "and", "or", "with", "without", "except"; commas, slashes, pairs of brackets and the word "age". Sequenced conjunctions are counted as 1.

Results

Whereas the number of conjunctions used in labels of Medicare DRGs stays relatively unchanged over time (the quota of labels with four or more conjunctions increases from 9 % to 11 %), there is some change within the labels from AN-DRG 3.1 through AR-DRG 4.1 to AR-DRG 5.2 (11 / 15 / 13 %). In contrast, there is a great increase in the use of conjunctions in the G-DRG labels (17 % to 49 %).

Discussion

The use of conjunctions does not only impair the comprehensibility of DRG labels but sometimes makes expressions ambiguous or practically unintellegible.
To get better DRG labels, it could be of help to use logical brackets, to split up complex DRGs for clinical homogeneity, or to construct patient classification systems for use in "cushioned" remuneration systems.

Conclusion

A DRG system should not only be useful for statisticians, but it should also serve as a basis for discussions between clinicians and managers. Thus it is necessary to make sure that DRG labels are compehensible. This is especially important when DRG systems are strongly optimised with regard to statistical performance (as was done with the G-DRG system).

Introduction

When is a language easy to use?

When you learn a new language, it will be easier if you already know some similar words from other languages you have learnt before. And you are more at ease if the new language does not use excessively complex structures. – A DRG system[1] contains a list of labels of patient categories (DRGs) which are offered to be used during discussions between managers and clinicians. This offer will be accepted as a matter of course the more the words used within the DRG labels are comprehensible and the more the structure of the DRG labels is not excessively complex.

DRG systems as interdisciplinary tool

Patient Classification Systems are constructed by collapsing similar diagnoses and/or treatments within not too many discrete groups, typically about 500 to 1000. The aim was to get a handy and comprehensible list of names of clinical treatments that could be used as a basis for managerial discussions and decisions of clinicians and managers. Furthermore, the patient categories should serve as "production units" within a remuneration system.

DRG lists must be handy

Since the beginning of DRG history, it was always a challenge to get a list with not too many entries. Patient categories should be clinically meaningful. And from the economic viewpoint they should be expected to generate similar costs.

Base DRGs

The general approach was to define a list of "Base DRGs" ("Adjacent DRGs") and additional criteria such as age and lists of complications and comorbidities ("CC lists") which could serve to split Base DRGs into subgroups which are statistically as consistent as possible.

[1] DRG = Diagnosis Related Groups. Cf. Fetter et al. [DRGs, 1991]; Fischer [PCS, 1997].

Two approaches to construct subgroups (named "DRGs" were developed: the first was to split only selected Base DRGs into statistically different subgroups. This resulted in DRG lists of typically 500 to 700 DRGs.[2]

DRG systems:
– with selected splits

The second approach was to split all Base DRGs according to the same criteria. Normally, the selected criteria created several split levels according to the severity of the diagnoses. This resulted in systems with typically more than 1000 DRGs.[3]

– with general splits

The statistical goodness of the resulting patient categories ("DRGs") is usually expressed by measuring the explained proportion of variance of the dependent variable (usually length of stay or treatment costs) in comparison to the variance which results when the patients are not categorised. It is called "variance reduction" (R^2). Its value ranges from zero (the groups do not explain any variance) to 1 (the groups are able to explain the full variance).

Variance reduction

The first DRG systems achieved R^2 values ranging from 10 % to 30 %, sometimes 40 % or later even nearly 50 %. From a statistical viewpoint, these were not overwhelming results. But by using more exact methods of cost calculation and exploiting all statistical possibilities, one got higher R^2 values.

Table 1:
G-DRG: Variance reduction of costs

Year	R^2 in % all cases	R^2 in % trimmed	Number of DRGs
2007	70.7	80.5	1 082
2006	68.1	78.9	954
2005	63.9	78.0	878
2004	55.3	70.0	824
2003	46.6	62.3	664

An exceptionally estonishing example is the G-DRG system: the version of 2003 was a mapping of the Australian AR-DRG system 4.1. At that time, with 664 DRGs, a R^2 of 46.6 % was achieved (trimmed: 62.3 %). The actual version for 2007 comprises 1082 DRGs and explains 70.7 % (trimmed: 80.5 %) of the variance. This is a value which is high as one only dreamed at before.

G-DRG with astonishingly high R^2 values
▶ Table 1

In this paper, I want to look into one side-effect of this statistically excellent result: what effects did this refinement work have on the comprehensibilty of the DRG labels?

Data

The following DRG systems that are used in the USA (Medicare DRG 1993/94 until 2007), in Australia (AN-DRG 3.1, AR-DRG 4.1, AR-DRG 5.2), and in Germany (G-DRG 2003 until 2007) were inspected. As data, only the DRG labels had to be looked at. These were available on the internet.[4]

Methods

One aspect of comprehensibility is the logical structure of a statement. In the case of DRG labels, a question can be: how many different expressions for diagnoses and other information are put together? The hypothesis is that each block of words between conjunctions (i. e. words which join terms) can be understood as a logical (and comprehensible) unit. The formal complexity of a DRG label can then be counted by the number of the conjunctions used.

Counting conjunctions

The conjunctions which were counted for each DRG label, were: "and", "or"[5], "with", "without", "except", commas, slashes, pairs of brackets and the word "age".[6] If conjunctions were sequenced, they were counted as one only conjunction.

A little computer program was written to count these words.[7]

[2] Examples of statistically based splitting of Base DRGs are Medicare DRGs, AP-DRGs, AR-DRGs. There are: only binary splits (e. g. Medicare DRGs); splits with three levels (e. g. AP-DRGs "without CC", "with CC" and "with major CC"); or even more sophisticated systems (e. g. AR-DRGs, G-DRGs).

[3] Examples of DRG systems with general splits are RDRGs, APR-DRGs, IR-DRGs (version 1).

[4] Medicare DRG: http:// www.apc-solutions.net / feds.htm and http:// cms.hhs.gov / AcuteInpatientPPS / FFD /; AN-DRG and AR-DRG: http:// www.health.gov.au / internet / wcms / publishing.nsf / Content / health-casemix-ardrg1.htm and previous web pages; G-DRG: http:// www.g-drg.de /.

[5] "OR" at the end of a label is not counted because this signifies "operation room (procedure)".

[6] The correspondig German words were: "und", "oder", "mit"/"bei", "ohne", "ausser", "Alter".

[7] The list of conjunctions was given as a "regular expression" to a program written in perl (http:// www.perl.org /).

Results

Overview

Growth of number of groups, conjunctions and characters

▶ Table 2

The graphic below shows on the first line of graphic panels the growth of the total numbers of DRGs, of conjunctions and of characters used for the DRG labels. On the second line of panels the growth of the average numbers of conjunctions and of characters is shown.

It is remarkable that the change of these numbers for the Australian DRGs (labelled as «AR») is negligible compared to the growth of the same numbers for the German DRGs.

Medicare DRGs shows a very little growth until 2007. A visible change went with the shift to the refined MS-DRG-System in 2008.

Count of conjunctions

▶ Table 3

The next graphic shows the total number of DRGs and the use of conjunctions within American, Australian and German DRG systems over time. The total number of DRGs is displayed by the length of the bars. The bars are split into fields whose relative sizes represent the number of DRGs with a count of conjunctions of 0, 1, 2, . . . This number of conjunctions is written below the bars. The number of DRGs with the same count of conjunctions is shown above the bars. The fields for DRGs with up to tree conjunctions are coloured in blue. The fields for DRGs with four or more conjunctions are coloured in orange and red. Thus the evolution of the relation of the number of DRGs with less than four and with four or more conjunctions can be seen at first glance.

Interpretation:
– Medicare: ± stable
– AR-DRG: ± stable
– G-DRG: ++ increase

It can be seen, that the lengths of the bars (and thus the total numbers of DRGs) remain nearly unchanged for Medicare DRGs and Australian DRGs. Furthermore, the relative proportions of the light blue and the orange fields (thus the numbers of DRGs with three, four conjunctions and more) remain rather stable with Medicare DRGs but increase much with German DRGs. The number of G-DRGs with zero, one or two conjunctions (the total length of the first three fields) has even decreased since 2004, although the total number of G-DRGs has increased.

Table 2: DRG labels: number of groups, conjunctions, characters

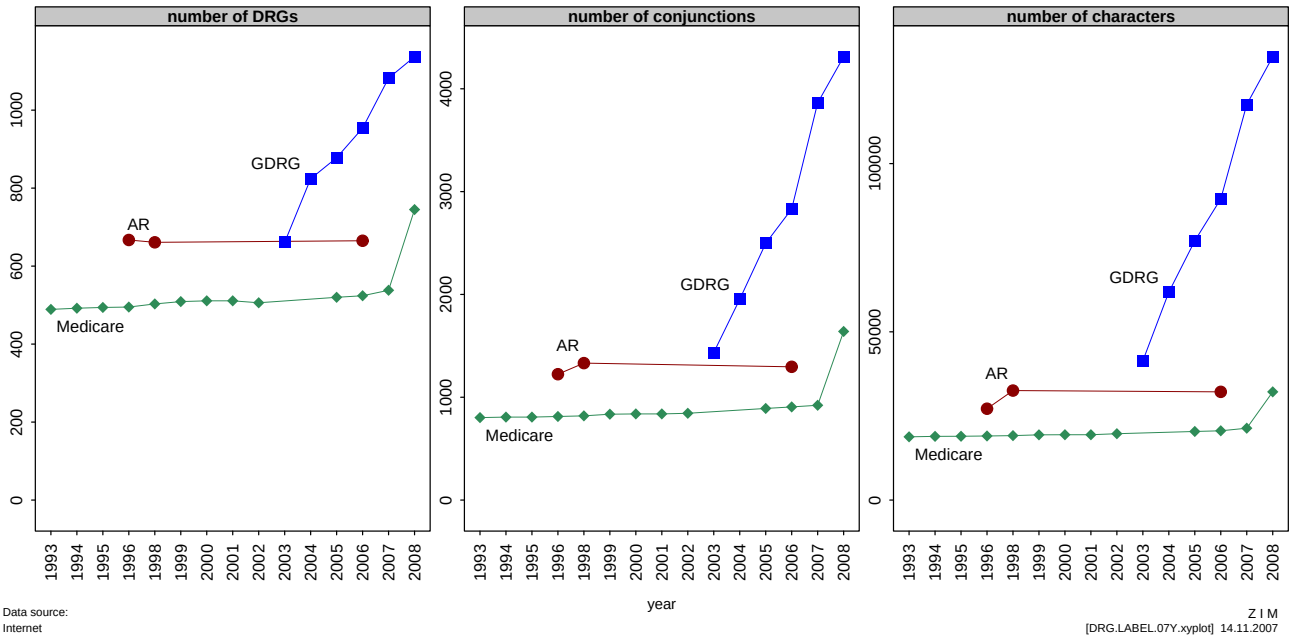
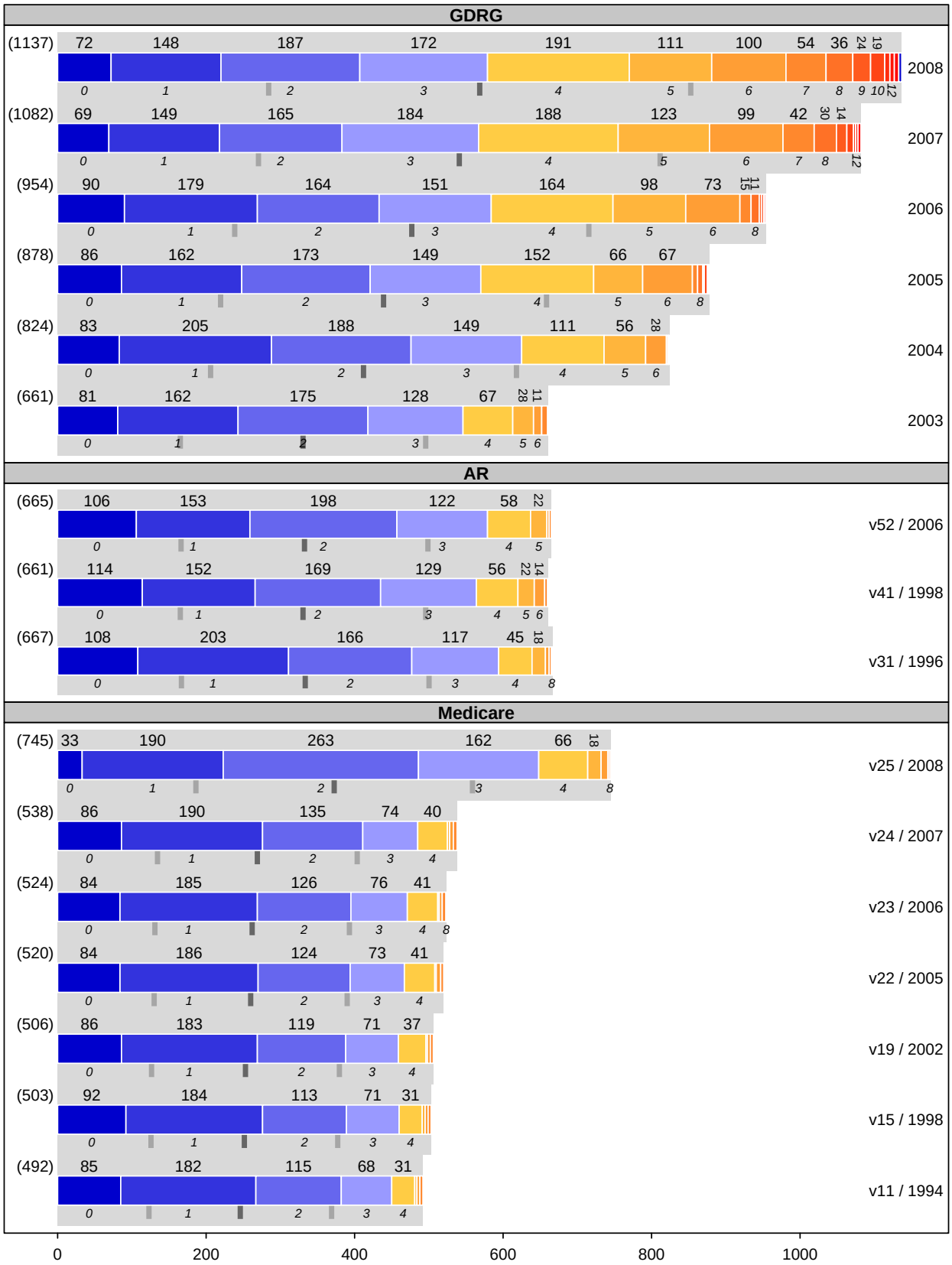


Table 3: DRG labels by number of conjunctions



|−− Cumulated number of DRGs −−>
Below the bars: Grey marks: 1st quartile, median, 3rd quartile. Figures: number of conjunctions per DRG label.
(Conjunctions are: "and", "or", "with", "w", "without", "w/o", "except", "age", comma, slash, brackets.)
Figures above the bars: numbers of DRGs (within brackets: sum).

Data source:
Internet

Z I M
[DRG.LABEL.076.barchart] 14.11.2007

Medicare DRGs (USA)

Number of DRGs: slight increase

↑ Table 3

The first DRG system used for remuneration was Medicare DRG 2.0 (1983). It had 470 DRGs. Ten years later, the number of groups was still below 500. The 2007 version encompasses 538 groups. Thus the increase of the number of Medicare DRGs was rather modest.

$\geq$ 4 conjunctions: 13 %

▶ Table 4

The quota of labels with four conjunctions or more increased from 1992 until 2006 from 9 % to 10 %). Only 13 DRG labels (2.4 %) show five or more conjunctions. Thus most of the DRG labels use three or fewer conjunctions.

The shift to MS-DRG for 2008 (with the introduction of MCCs) brought a serious change: The number of DRGs without a conjunction sank from 84 DRGs to 44 DRGs, whereas the number of DRGs with two conjunctions increased from 126 to 263, and the number of DRGs with three conjunctions increased from 76 to 162. But because the total number also increased (from 538 to 745 DRGs), the quota of labels with four conjunctions or more increased only from 10 % to 13 %.

▶ Table 5

(*Preliminary remark for Table 5:* When we look at the examples of complex Medicare DRG labels, we see immediately that an additional problem arises for people who are not too familiar with medical expressions: words within long DRG labels are abbreviated until they are no longer recognizable.[8] This problem will not be treated in this paper.)

The most complex DRG label was found for Medicare DRG 541 (version 24 for 2007). Eight conjunctions were used (and many abbreviations!). The full label is: *"ECMO or Tracheostomy With Mechanical Ventilation 96+ Hours or Principal Diagnosis Except Face, Mouth and Neck With Major O.R. Procedure"*. (From a purely logical point of view it is not clear if the "or" of the part *"or Principal Diagnosis Except . . ."* corresponds to the "or" of *"or Tracheostomy"* or to the "With" of *"With Mechanical Ventilation 96+ Hours"*. If there is some knowlegde of the matter, then the question can be decided in favour of the second possibility.)

[8] Furthermore, more or less commonly used medical abbreviations (like "ECMO" for "Extracorporeal Membrane Oxygenation" or "FX" for "fracture") are mixted with arbitrary abbreviations just used for this special list of DRG labels (like "TRACH" for "trachestomy", "SPRN" for "sprain", "STRN" for "strain", "DISL" for "dislocation", "PRM" for "permanent", "GNRTR" for "generator").

Table 4: Examples of Medicare DRG labels with few conjunctions

DRG	Version	Conjunctions	Label
1	v23	2	CRANIOTOMY AGE >17 W CC
9	v23	1	SPINAL DISORDERS & INJURIES
20	v23	1	NERVOUS SYSTEM INFECTION EXCEPT VIRAL MENINGITIS
193	v23	3	BILIARY TRACT PROC EXCEPT ONLY CHOLECYST W OR W/O C.D.E. W CC

Table 5: Examples of complex labels of Medicare DRGs

DRG	Version	Conjunctions	Label
3	v25	7	ECMO or trach w MV 96+ hrs or PDX exc face, mouth & neck w maj O.R
541	v24	7	ECMO OR TRACH W MV 96+HRS OR PDX EXC FACE, MOUTH & NECK W MAJ O.R.
4	v25	6	Trach w MV 96+ hrs or PDX exc face, mouth & neck w/o maj O.R
542	v24	6	TRACH W MV 96+HRS OR PDX EXC FACE, MOUTH & NECK W/O MAJ O.R.
563	v25	8	Fx, sprn, strn & disl except femur, hip, pelvis & thigh w/o MCC
251	v24	7	FX, SPRN, STRN & DISL OF FOREARM, HAND, FOOT AGE >17 W/O CC
494	v25	6	Lower extrem & humer proc except hip,foot,femur w/o CC/MCC
219	v24	6	LOWER EXTREM & HUMER PROC EXCEPT HIP,FOOT,FEMUR AGE >17 W/O CC
115	v23	5	PRM CARD PACEM IMPL W AMI/HR/SHOCK OR AICD LEAD OR GNRTR

AN- and AR-DRGs (Australia)

The AN-DRG system 3.1 (with 667 DRGs) was used in 1996. The refined AR-DRG system 4.0 (with 661 DRGs) was introduced in 1998. The currently used system AR-DRG 5.2 encompasses 665 DRGs.

Constant number of DRGs

↑ Table 3

The quota of labels with four conjunctions or more changed from 1996 through 1998 until 2006 from 11 % through 15 % to 13 %. 28 DRG labels (4.2 %) show five or more conjunctions. Thus many DRG labels use three or fewer conjunctions.

$\geq$ 4 conjunctions: 13 %

▶ Table 6

The most complex DRG labels were found for the AR-DRGs belonging to Base AR-DRG I75: Seven conjunctions were used to define each of these three AR-DRGs.

▶ Table 7

To be able to understand the logical structure of the labels, logical brackets are used where necessary (e. g. for AR-DRG H02B, H61B and I73B, shown in the tables below).

Table 6: Examples of AR-DRG labels with few conjunctions

AR-DRG	Version	Conjunctions	Label
B02A	v52	1	Craniotomy W Catastrophic CC
B61A	v52	3	Spinal Cord Conditions W or W/O OR Procedures W Catastrophic or Severe CC
B72B	v52	3	Nervous System Infection Except Viral Meningitis W/O Cat or Sev CC
H02B	v52	3	Major Biliary Tract Procedures W/O Malignancy W (Severe or Moderate CC)

Table 7: Examples of complex labels of AR-DRGs

AR-DRG	Version	Conjunctions	Label
I75B	v52	7	Injury to Shoulder, Arm, Elbow, Knee, Leg or Ankle Age >64 or W CC
I12C	v52	6	Infect/Inflam Bone and Joint W Misc Musc Sys and Conn Tiss Proc W/O Cat or Sev CC
H61B	v52	5	Malignancy of Hepatobiliary Sys,Panc (Age>69 W/O Cat or Sev CC) or W/O Cat CC
P60A	v52	4	Neonate, Died or Transferred <5 Days of Adm, W/O Significant OR Proc, Newborn
P60B	v52	4	Neonate, Died or Transferred <5 Days of Adm, W/O Significant OR Proc, Not Newborn
I73B	v52	4	Aftercare of Musculoskeletal Implants/Prostheses Age >59 or W (Cat or Sev CC)

G-DRGs (Germany)

Strongly increasing number of DRGs

↑ Table 3

$\geq$ 4 conjunctions: 49 %

▶ Table 8

While the G-DRG system started with 661 DRGs for the year 2003; the G-DRG system 2008 has arrived at 1137 DRGs.

The quota of labels with four or more conjunctions increased from 2003 until 2008 from 17 % to 49 %. 367 G-DRG labels (32 %) show five or more conjunctions. Thus nearly half of all DRG labels use four or more conjunctions, and nearly one third use five or more!

Table 8: Examples of G-DRG labels with few conjunctions

G-DRG	Vers.	Conj.	Label (translated)	Label (original)
B73Z	2008	0	Viral Meningitis	Virusmeningitis
I11Z	2008	0	Limb Lengthening Procedures	Eingriffe zur Verlängerung einer Extremität

Table 9: History of labels for G-DRG B02B

G-DRG	Vers.	Conj.	Label (translated)	Label (original)
B02B	2008	10	Complex Craniotomy or Spinal Procedure or Other Expensive Nervous System Procedure With Motor Ventilation Over 95 Hours, Without Radiotherapy More Than 8 Sessions, Age < 6 Years or Age < 18 Years With Major Intracranial Procedure, With Catastrophic CC or Motor Ventilation Over 95 Hours and Motor Ventilation Under 178 Hours	Komplexe Kraniotomie oder Wirbelsäulen-Operation od. andere aufwändige Operation am Nervensystem mit Beatm. > 95 Std., ohne Strahlenth. > 8 Bestrahl., Alter < 6 J. od. < 18 J. mit großem intrakr. Eingr., m. äußerst schw. CC od. Beatm. > 95 und < 178 Std.
B02B	2007	9	Complex Craniotomy or Spinal Procedure or Other Expensive Nervous System Procedure With Motor Ventilation Over 95 Hours, Without Radiotherapy More Than 8 Sessions, Age < 6 Years or Age < 18 Years With Major Intracranial Procedure, With Catastrophic CC or Motor Ventilation Over 95 Hours	Komplexe Kraniotomie oder Wirbelsäulen-Operation od. andere aufwändige Operation am Nervensystem mit Beatmung > 95 Std., ohne Strahlenth. mehr als 8 Bestrahl., Alter < 6 J. od. < 18 J. mit großem intrakran. Eingr., m. äußerst schw. CC od. Beatm. > 95 Std.
B02B	2006	7	Complex Craniotomy or Spinal Procedure or Other Expensive Nervous System Procedure With Motor Ventilation Over 95 Hours, Without Radiotherapy More Than 8 Sessions, Age < 6 Years or Age < 18 Years With Major Intracranial Procedure	Komplexe Kraniotomie oder Wirbelsäulen-Operation oder andere aufwändige Operation am Nervensystem mit Beatmung > 95 Stunden, ohne Strahlentherapie mehr als 8 Bestrahlungen, Alter < 6 Jahre oder Alter < 18 Jahre mit grossem intrakraniellen Eingriff
B02B	2005	4	Craniotomy or Complex Spinal Procedure Without Early Rehabilitation With Radiotherapy More Than 8 Sessions	Kraniotomie oder komplexe Wirbelsäulen-OP ohne Frührehabilitation, mit Strahlentherapie, mehr als 8 Bestrahlungen
B02B	2004	4	Craniotomy With Catastrophic CC or Epilepsy Surgery, Without Early Rehabilitation and Complex Geriatric Treatment	Kraniotomie mit äusserst schweren CC oder Epilepsiechirurgie, ohne Frührehabilitation und Geriatrische Komplexbehandlung
B02B	2003	2	Craniotomy With Severe or Moderate CC	Kraniotomie mit schweren oder mässigen CC

Example:
G-DRG B02B
▶ Table 9

I will take B02B as a first example of a complex G-DRG label. Word-by-word translations are made by the author (with commas set according to the German original).

In the 2007 version this G-DRG is described with the use of nine conjunctions. (Although the resulting label is very complicated, there are G-DRG labels with even more conjunctions!) We can first see a list of three groups of procedures (*complex craniotomy; spinal procedures; other expensive nervous procedures*). Then three conditions are added (*with motor ventilation over 95 hours; without radiotherapy with more than eight sessions; with age < 6 years*). What follows is rather unclear. I interpret it as an alternative age limit (*age < 18 years*): if this limit is fullfilled, the next two conditions have to be coded (*with major intracranial procedure; with catastrophic CC*). But now, the question will arise: why is *motor ventilation* named a second time? Is there another logic than the one described above? Is it not correct to think in terms of a second, age-

Table 10: Examples of complex labels of G-DRGs: Base-DRG B02

G-DRG	Vers.	Conj.	Label (translated)	Label (original)
B02A	2007	5	Complex Craniotomy or Spinal Procedure or Other Expensive Nervous System Procedure With Motor Ventilation Over 95 Hours, With Radiotherapy More Than 8 Sessions	Komplexe Kraniotomie oder Wirbelsäulen-Operation oder andere aufwändige Operation am Nervensystem mit Beatmung > 95 Stunden, mit Strahlentherapie, mehr als 8 Bestrahlungen
B02B	2007	9	Complex Craniotomy or Spinal Procedure or Other Expensive Nervous System Procedure With Motor Ventilation Over 95 Hours, Without Radiotherapy More Than 8 Sessions, Age < 6 Years or Age < 18 Years With Major Intracranial Procedure, With Catastrophic CC or Motor Ventilation Over 95 Hours	Komplexe Kraniotomie oder Wirbelsäulen-Operation od. andere aufwändige Operation am Nervensystem mit Beatmung > 95 Std., ohne Strahlenth. mehr als 8 Bestrahl., Alter < 6 J. od. < 18 J. mit großem intrakran. Eingr., m. äußerst schw. CC od. Beatm. > 95 Std.
B02C	2007	5	Complex Craniotomy or Spinal Procedure or Other Expensive Nervous System Procedure With Motor Ventilation Over 95 Hours, With Radiotherapy Less Than 9 Sessions	Komplexe Kraniotomie oder Wirbelsäulen-Operation oder andere aufwändige Operation am Nervensystem mit Beatmung > 95 Stunden, mit Strahlentherapie, weniger als 9 Bestrahlungen
B02D	2007	8	Complex Craniotomy or Spinal Procedure or Other Expensive Nervous System Procedure With Motor Ventilation Over 95 Hours, Without Radiotherapy, With Complicating Procedures or Major Intracranial Procedure Without Catastrophic CC, Without Motor Ventilation Over 95 Hours	Komplexe Kraniotomie oder Wirbelsäulen-Operation oder andere aufwändige Operation am Nervensystem mit Beatmung > 95 Stunden, ohne Strahlentherapie, mit komplizierenden Prozeduren oder großem intrakran. Eingr. ohne äußerst schw. CC, ohne Beatmung > 95 Std.
B02E	2007	7	Complex Craniotomy or Spinal Procedure or Other Expensive Nervous System Procedure With Motor Ventilation Over 95 Hours, Without Radiotherapy, Age > 5 Years, Without Major Intracranial Procedure, Without Complicating Procedures	Komplexe Kraniotomie oder Wirbelsäulen-Operation oder andere aufwändige Operation am Nervensystem mit Beatmung > 95 Stunden, ohne Strahlentherapie, Alter > 5 Jahre, ohne großen intrakraniellen Eingriff, ohne komplizierende Prozeduren

dependent branch?[9] If one reads Bartkowski et al.[10] one is astonished once more: he says that according to his analyses, the motor ventilation split does not have any relevance in this DRG because cases with such ventilations will be assigned to one of the Pre-MDC Base G-DRGs (A06 to A13).

When compared with the G-DRG label in the sequence of the years since 2003, one sees how the texts have grown, how the conjunctions have been multiplying, how it takes more and more effort to decipher the meaning.

▶ Table 10

Seen in the context of the other DRGs of Base DRG B02, it becomes a challenge to find out the real differences between these DRGs in such a manner that one is able to explain them to someone else (and there will be hardly a difference if he is a clinician or a manager).

[9] In the G-DRG manual you will find the following entry as definiton for the base G-DRG-2007 B02:
«**(**
mindestens eine Prozedur aus den Tabellen TAB-B02-1, TAB-B02-2
und (PCCL > 3 oder Dauer der maschinellen Beatmung > 95 Stunden oder mindestens eine Prozedur aus den Tabellen TAB-B02-3, TAB-B02-4)
oder Prozedur in Tabelle TAB-B02-5
oder (mindestens eine Prozedur aus den Tabellen TAB-B02-6, TAB-B02-7 oder mindestens eine Prozedur aus den Tabellen TAB-B02-8, TAB-B02-9, TAB-B02-10, TAB-B02-11 und PCCL > 3)
und Dauer der maschinellen Beatmung > 95 Stunden
) und (
mindestens eine Prozedur aus den Tabellen TAB-B02-3, TAB-B02-12
oder PCCL > 3
oder Dauer der maschinellen Beatmung > 95 Stunden
oder Komplizierende Prozeduren
oder Prozedur in Tabelle TAB-B02-13
)» [in the original no broken lines and no emphasising]
and as additional definition for the split of B02B:
«(
Alter < 6 Jahre oder Alter < 18 Jahre und Prozedur in Tabelle TAB-B02-4
) und (
PCCL > 3 oder Dauer der maschinellen Beatmung > 95 Stunden
)».
Thus it becomes evident that *motor ventilation* is repeated because it is a condition of the base DRG which not always must be present, and it is also a condition within the split condition which not always must be present. And it becomes also evident that it is nearly impossible to resume such a complicated logical expression in a «short» expression which should be usable as a G-DRG name.

[10] Bartkowski et al. [G-DRG 2006, 2006]: B02-1.

Table 11:
G-DRG 2008: Analysis of the logical structure of Base G-DRG R06

Term	R60A	R60B	R60C	R60D	R60E	R60F	R60G
Acute Myeloic Leukaemia	X	X	X	X	X	X	X
(and)							
- (either) With Extremely Complex Chemoth.	X	-	-	-	-	-	/
- (or) With Intensive Chemotherapy	-	X	O	O	-	-	/
- - (and)							
- - - (or) With Complicating Diagnosis	.	o	/	/	.	.	.
- - - (or) Dialysis	.	o	/	/	.	.	.
- - - (or) Port Implantation	.	o	/	/	.	.	.
- - (and) With Catastrophic CC	.	.	x	/	.	.	.
- (or) With Moderately Complex Chemoth.	-	-	O	O	-	O	/
- - (and)							
- - - (or) With Complicating Diagnosis	.	.	o	-	.	/	.
- - - (or) Dialysis	.	.	o	-	.	/	.
- - - (or) Port Implantation	.	.	o	-	.	/	.
- - (and) With Catastrophic CC	.	.	.	x	.	/	.
- (or) With Locale Chemotherapy	-	-	-	-	-	O	/
- (or) With Dialysis	-	-	-	O	O	-	/
- (or) Catastrophic CC	-	-	-	O	O	-	/
(and) Age < 16 Years	-	-	-	X	/	-	-

A second example: the Leukaemia Base G-DRG R60 is differentiated into seven G-DRGs (R60A until RA60G) according to severity of illness and intensity of treatment. A look at the label list shows that there are rather easily understandable labels with three or fewer conjunctions. But others have nine or ten conjunctions. It is rather hard to understand their meaning by reading them only once.

Example: Base G-DRG R60

▶ Table 12

To understand the labels better, they were subjected to a logical analsis. A certain system could be recognised throughout the DRGs of this Base G-DRG, yet I am still unable to assign quickly a patient which belongs to Base G-DRG R60, to the correct G-DRG.[11]

▶ Table 11

[11] Upper und lower letters show different hierarchical levels of the corresponding terms. – An addition remark: What is the order of the types of chemotherapy like: *extremely complex / moderately complex / intensive / local*, or: *extremely complex / intensive / moderately complex / local*? The latter is used by Bartkowski et al. [G-DRG 2006, 2006]: R60-1 and it could be derived from the order in the label of R60C; the former looks like the intuitively logical form.

Table 12: Examples of complex labels of G-DRGs: Base-DRG R60

G-DRG	Vers.	Conj.	Label (translated)	Label (original)
R60A	2008	1	Acute Myeloic Leukaemia With Extremly Complex Chemotherapy	Akute myeloische Leukämie mit hochkomplexer Chemotherapie
R60B	2008	4	Acute Myeloic Leukaemia With Intensive Chemotherapy With Complicating Diagnosis or Dialysis or Port Implantation	Akute myeloische Leukämie mit intensiver Chemotherapie mit komplizierender Diagnose oder Dialyse oder Portimplantation
R60C	2008	9	Acute Myeloic Leukaemia With Intensive Chemotherapy Without Complicating Diagnosis, Without Dialysis, Without Port Implantation, With Catastrophic CC or With Moderatly Complex Chemotherapy With Complicating Diagnosis or Dialysis or Port Implantation	Akute myeloische Leukämie mit intensiver Chemotherapie ohne komplizierende Diagnose, ohne Dialyse, ohne Portimplantation, mit äußerst schweren CC oder mit mäßig komplexer Chemotherapie mit komplizierender Diagnose oder Dialyse oder Portimplantation
R60D	2008	10	Acute Myeloic Leukaemia With Intensive Chemotherapy Without Complicating Diagnosis, Dialysis or Port Implantation, Without Catastrophic CC or With Moderatly Complex Chemotherapy With Catastrophic CC or With Dialysis or Catastrophic CC, Age < 16 Years	Akute myeloische Leukämie mit intensiver Chemotherapie ohne komplizierende Diagnose, Dialyse oder Portimplant., ohne äußerst schwere CC oder mit mäßig komplexer Chemoth. mit äußerst schweren CC oder mit Dialyse oder äußerst schweren CC, Alter < 16 Jahre
R60E	2008	3	Acute Myeloic Leukaemia With Dialysis or Catastrophic CC, Age > 15 Years	Akute myeloische Leukämie mit Dialyse oder äußerst schweren CC, Alter > 15 Jahre
R60F	2008	6	Acute Myeloic Leukaemia With Moderatly Complex Chemotherapy, Without Complicating Diagnosis, Without Dialysis, Without Port Implantation, Without Catastrophic CC or With Locale Chemotherapy	Akute myeloische Leukämie mit mäßig komplexer Chemotherapie, ohne komplizierende Diagnose, ohne Dialyse, ohne Portimplantation, ohne äußerst schwere CC oder mit lokaler Chemotherapie
R60G	2008	3	Acute Myeloic Leukaemia Without Chemotherapy, Without Dialysis, Without Catastrophic CC	Akute myeloische Leukämie ohne Chemotherapie, ohne Dialyse, ohne äußerst schwere CC

Additional examples

▶ Table 13

The last table shows that the above two examples are not rare cases, but that there is a rather long list of G-DRGs which use many conjunctions and which are therefore hard to understand.

Table 13: Additional examples of complex labels of G-DRGs

G-DRG	Version	Conjunctions	Label
A09A	2008	10	Beatmung > 499 und < 1000 Stunden mit komplexer OR-Prozedur oder Polytrauma und hochkomplexem Eingriff oder Alter < 16 Jahre oder ohne komplexe OR-Prozedur, ohne Polytrauma, mit angeborener Fehlbildung oder Tumorerkrankung, Alter < 3 Jahre
A13A	2008	9	Beatmung > 95 und < 250 Stunden mit hochkomplexem Eingriff oder intensivmedizinischer Komplexbehandlung > 1656 Punkte oder > 1105 Punkte mit komplexer OR-Prozedur oder komplizierenden Prozeduren und bestimmter OR-Prozedur oder bei Lymphom und Leukämie
B03Z	2008	11	Operative Eingriffe bei nicht akuter Para- / Tetraplegie oder Eingriffe an Wirbelsäule und Rückenmark bei bösartiger Neubildung od. mit äußerst schweren od. schw. CC oder Eingriffe b. zerebraler Lähmung, Muskeldystrophie, Neuropathie mit äußerst schw. CC
B17A	2008	12	Eingriffe an peripheren Nerven, Hirnnerven und anderen Teilen des Nervensyst. ohne äußerst schw. CC, ohne kompliz. Diag. oder Eingr. bei zerebr. Lähmung, Muskeldystrophie od. Neuropathie ohne äußerst schw. od. schw. CC, Alter > 18 J., mit komplexer Diag.
B69C	2008	6	Transitorische ischämische Attacke (TIA) und extrakranielle Gefäßverschlüsse mit äußerst schweren CC, ohne neurologische Komplexbehandlung des akuten Schlaganfalls oder Demenz und andere chronische Störungen der Hirnfunktion
B70A	2008	9	Apoplexie oder Transitorische ischämische Attacke (TIA) und extrakranielle Gefäßverschlüsse mit Beatmung > 95 und < 178 Stunden oder Apoplexie mit intrakranieller Blutung und neurologischer Komplexbehandlung des akuten Schlaganfalls, mehr als 72 Stunden
B71C	2008	14	Erkrankungen an Hirnnerven und peripheren Nerven mit komplexer Diagnose, außer bei Para- / Tetraplegie, ohne schwere CC oder ohne komplexe Diagnose, mit äußerst schweren od. schweren CC außer bei Para- / Tetrapl. oder ohne schwere CC bei Para- / Tetrapl.
E69E	2008	10	Bronchitis und Asthma bronchiale, Alter > 5 Jahre und < 16 Jahre, ein Belegungstag oder ohne äußerst schwere oder schwere CC oder Beschwerden und Symptome der Atmung ohne komplexe Diagnose, Alter < 16 Jahre
F24C	2008	14	Impl. Herzschrittm., 2-Kammersyst. ohne kompl. Eingr. oder PTCA mit kompl. Diagn. und hochkompl. Intervent. od. mit PTA, ohne äußerst schw. CC, Alter > 15 J. oder Revision Herzschrittm. od. Kardioverter/Defibr. (AICD) ohne Aggregatwechsel, Alter < 16 J.
G24Z	2008	13	Eingriffe bei Bauchwandhernien, Nabelhernien und anderen Hernien, Alter > 0 Jahre oder beidseitige Eingriffe bei Leisten- und Schenkelhernien, Alter > 0 Jahre und < 56 Jahre oder Eingriffe bei Leisten- und Schenkelhernien, Alter > 55 Jahre
G67B	2008	14	Ösophagitis, Gastroenteritis u. versch. Erkr. d. Verdauungsorg. m. kompl. Diag. od. Alter <1 J. od. gastroint. Blutung, m. äuß. schw. od. schw. CC od. Alt. >74 J. od. Ulkuserkr. m. schw. CC od. Alt. >74 J., >1 Beleg.tag, ohne kompliz. Diag., ohne Dialyse
I75B	2008	11	Schwere Verletzungen von Schulter, Arm, Ellenbogen, Knie, Bein und Sprunggelenk ohne CC oder Entzündungen von Sehnen, Muskeln und Schleimbeuteln ohne äußerst schwere oder schwere CC
L64A	2008	10	Harnsteine und Harnwegsobstruktion, Alter > 75 Jahre od. mit äußerst schweren oder schweren CC oder Urethrastriktur, andere leichte bis moderate Erkr. der Harnorgane, mehr als ein Beleg.tag oder Beschw. und Symptome der Harnorgane oder Urethrozystoskopie

Discussion

We have seen that the use of conjunctions impairs the comprehensibility of DRG labels. The effort required to ascertain the meaning of a logically complex DRG label can be rather great.

Method chosen was a simple one

The method chosen was a simple one. It can be criticised that not all conjunctions used for the analysis have the same impact on comprehensibility. For instance, the use of commas is easier to understand than a sequence of *and*'s and *or*'s. Yet it was helpful to detect quite an interesting set of problematic DRG labels.

The conjunctions "more", "less", "<", ">" were not counted because their relation to the previous words is always strong and the following words (a number and a unit) are much easier to understand than clinical terms.

Logical problems

The overuse of conjunctions led to the following types of problems:

- The logic of sequences of commas, *and*'s and *or*'s is not anymore immediately comprehensible.[12]
- The logic can become ambiguous.[13]
- The logic can even lead to practically unintellegible labels.[14]
- Usability is impaired by concatenating different clinical contents which are expected to have the same costs, into a single DRG.[15]

Other problems

Other techniques which generate not easily understandable labels are:

- The creation and use of new and special abbreviations.[16]
- The use of differentiating terms in only a part of all DRGs of a Base DRG.[17]
- The use of container words like *"certain OR procedures"*.[18]
- The overuse of "hotchpotch" DRGs: DRGs for *"other"* diagnoses.[19]
- The distribution of DRGs which belong to one single Base DRG, into several Base DRGs.[20]

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[12] An example of this case is G-DRG-2007 B69C:
"Transient Ischemic Attack (TIA) and Extracranial Vascular Occlusion With Catastrophic CC, Without Neurological Complex Treatment Of Acute Myocardial Infarction or Dementia and Other Chronic Cerebral Disorders". (The original label was: *"Transitorische ischämische Attacke (TIA) und extrakranielle Gefäßverschlüsse mit äußerst schweren CC, ohne neurologische Komplexbehandlung des akuten Schlaganfalls oder Demenz und andere chronische Störungen der Hirnfunktion"*.)

[13] The label of Medicare DRG 541 version 23 is:
"ECMO or Tracheostomy With Mechanical Ventilation 96+ Hours or Principal Diagnosis Except Face, Mouth and Neck With Major O.R. Procedure". Which other part or parts of the label is the term *"or Principal Diagnosis"* related to? (Ventilation? Tracheostomy? ECMO or Tracheostomy?)
– G-DRG-2007 P67D is another example of this type:
"Newborn, Admission Weight > 2499 g Without Significant O.R. Procedure, Without Mechanical Ventilation > 95 Hours, Without Another Problem or Without a Severe Problem, Sameday". (The original label was: *"Neugeborenes, Aufnahmegewicht > 2499 g ohne signifikante OR-Prozedur, ohne Beatmung > 95 Stunden, ohne anderes Problem oder ohne schweres Problem, ein Belegungstag"*.) Which other part or parts of the label is the term *"sameday"* related to? (Is this G-DRG only assigned to sameday patients? Or is *"sameday"* related to one or some terms of the list of exclusions? – One has to know and study the labels of P67C and P67B to be able to guess the right meaning.)

[14] An example of this case is G-DRG-2007 B71C:
"Cranial and Peripheral Nerve Disorders With Complex Diagnosis, Except With Para-/Quadriplegia, Without Severe CC or Without Complex Diagnosis, With Catastrophic or Severe CC Except With Para-/Quadriplegia or Without Severe CC With Para-/Quadriplegia". (The original label was: *"Erkrankungen an Hirnnerven und peripheren Nerven mit komplexer Diagnose, außer bei Para- / Tetraplegie, ohne schwere CC oder ohne komplexe Diagnose, mit äußerst schweren oder schweren CC außer bei Para- / Tetrapl. oder ohne schwere CC bei Para- / Tetrapl."*.)

[15] An example of this case is G-DRG-2007 G07B:
"Appendectomy With Peritonitis With Catastrophic or Severe CC or Minor Small Intestine and Colon Procedures Without Catastrophic CC, Age > 2 Years". (The original label was: *"Appendektomie bei Peritonitis mit äußerst schweren oder schweren CC oder kleine Eingriffe an Dünn- und Dickdarm ohne äußerst schwere CC, Alter > 2 Jahre"*.)

[16] Examples of this case are: Medicare DRG 509 version 23: *"Full Thickness Burn W/O Skin Grft or Inh Inj W/O CC or Sig Trauma"*, or AR-DRG-5.2 I12C: *"Infect/Inflam Bone and Joint W Misc Musc Sys and Conn Tiss Proc W/O Cat or Sev CC"*.

[17] An example of this case is AR-DRG-5.2 G44C: *"Other Colonoscopy, Sameday"*: The term "sameday" is not used in G44A and G44B:
G44A: *"Other Colonoscopy W Catastrophic or Severe CC"*.
G44B: *"Other Colonoscopy W/O Catastrophic or Severe CC"*.

[18] For instance G-DRG-2007 A13A: *"Beatmung > 95 und < 250 Stunden mit hochkomplexem Eingriff oder intensivmedizinischer Komplexbehandlung > 1104 Punkte oder mit bestimmter OR-Prozedur und komplizierenden Prozeduren, mit intensivmedizinischer Komplexbehandlung > 1104 Punkte"*.

[19] For instance AR-DRG-5.2 H06Z: *"Other Hepatobiliary and Pancreas OR Procedures"* (identical with G-DRG-2007 H06Z: *"Andere OR-Prozeduren an hepatobiliärem System und Pankreas"*), or: G-DRG-2007 I44C: *"Various Knee Endoprothesis Procedures"* (original label: *"Verschiedene Endoprotheseneingriffe am Kniegelenk"*).

[20] For instance G-DRGs-2007 B17A, B17B, B17C and B07Z concern *"Peripheral and Cranial Nerve and Other Nervous System Procedures"*. G-DRGs B17A, B17B, B17C, B06A, B06B, B03Z concern *"Procedures for Cerebral Palsy, Muscular Dystrophy, Neuropathy"*. The problem lies in the fact that the themes of the Base G-DRGs B07 and B06 and parts of B03 are put together in B17 by the use of the conjunction "or".

Better DRG labels?

To get better DRG labels, it could be of help:

- To use logical brackets (as it was done in the AR-DRG system).
- To split up complex DRGs for clinical homogeneity.[21]
- To construct patient classification systems for the use within "cushioned" remuneration systems. (For instance: define for each DRG combined per diem and per case rates[22] or create systems in which more than one group can be assigned to each case.[23])

Conclusion

A DRG system should not only be useful for statisticians, but it should also serve as a basis for discussions between clinicians and managers. Thus it is necessary to make sure that DRG labels are compehensible. This is especially important when DRG systems are strongly optimised with regard to statistical performance (as it was done with the G-DRG system).

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[21] To get more transparency, one could define two level DRG systems: the first level would consist of "clinical DRGs". On the second level, these could be collapsed into "economical DRGs". The latter would have similar costs but it would be accepted that they are not too strictly clinically homogenous. – An example of a two level system (of rehabilition patient categories) are the TAR-FIM classes in conjunction with the nursing cost categories of the TAR system. Cf. Fischer et al. [TAR und Reha-PCS, 2006]: 18 ff.

[22] Such a system is used by the Austrian LDFs ("Leistungsbezogene Diagnosen-Fallgruppen").

[23] This was realised e. g. with LDF (partially), Disease Staging, SQLape, HRG4 (partially: "unbundled HRGs").