

Evaluation of a new method for in-patient co-morbidity analysis based on KHIRI Pathology Group Set codes at the Kigali University Teaching Hospital

Verbeke F.^{a,b}, Murekatete C.^a, Tran Ngoc C.^a, Karara G.^a, Gasakure E.^a, Nyssen M.^b

Abstract

The Kigali Health Informatics Research Institute (KHIRI), a department of the Kigali University Teaching Hospital, one of the national referral hospitals in Rwanda, has developed a set of pathology grouping codes in an attempt to enable efficient evaluation of clinical activity in a typical sub-Saharan hospital. This KHIRI Pathology Grouping Set (KPGS) is a bi-classified grouping system, based on ICD-10 and ICPC-2 classification standards and constructed on ICD-10 chapters. KPGS provides a means for providing an analysis of hospital co-morbidity for hospital management purposes. This study evaluates both the consistency of ICD-10 and ICPC-2 mappings on KPGS as well as the clinical value of the defined groupings of clinical conditions.

Keywords

ICD-10; ICPC-2; 3BT; KPGS, clinical activities; monitoring; quality improvement; co-morbidity

Introduction

Measurement and evaluation of hospital clinical activity for hospital management purposes is a difficult task. It involves identification and classification of health conditions (such as complaints and diseases), clinical response (such as procedures and treatments) and clinical outcome. Moreover, classification must be based on internationally validated standards and should provide summary information based on clinical facts but useful for management purposes.

Today's most popular approach seems to be the usage of Diagnosis Related Groups (DRG), representing groupings of ICD-9/ICD-10 classified diagnoses into health management oriented groups. DRG's have proven to be useful in clinical settings mainly in the Western world, but the usability of these sophisticated but complex systems in developing countries, more particularly in Central Africa is at least questionable.

The Kigali Health Informatics Research Institute (KHIRI), a department of the Kigali University Teaching Hospital, one of the national referral hospitals in Rwanda, has developed an alternative set of pathology grouping codes in an attempt to enable efficient evaluation of clinical activity in a typical sub-Saharan hospital. This KHIRI Pathology Grouping Set (KPGS) is a bi-classified grouping system, based on ICD-10 and ICPC-2 classification standards. The KPGS groupings have been developed while keeping in mind that:

1. Groupings should in the first place be relevant to hospital management staff. Hospital management staff (department of statistics and

epidemiology) therefore participated from the beginning in the definition of KPGS entities.

2. Groupings should remain clinically meaningful and thus logical, representing morbidity entities relevant for hospital co-morbidity analysis
3. Groupings must be internationally comparable hence based on validated classification and coding schemes

KPGS was constructed starting from ICD-10 chapters. Sub-classifications in these chapters have been redeveloped in order to better respond to specific needs of CHUK hospital management staff. KPGS codes have been introduced for the first time at the CHUK in February 2009. They will be subject to continuous clinical validation and refinement in the future.

Purpose of the evaluation study:

Our paper presents the results of the following research and evaluation activities:

1. Presentation and documentation of KPGS
2. Evaluation of the extent to which the KPGS based hospital morbidity statistics based on ICD-10 codes remain consistent with those based on ICPC-2 codes. This activity evaluates both the usability of the 3BT as a classification entry-point and the accuracy of KPGS code mappings onto the ICD-10 and ICPC-2 classification systems.

^aKHIRI:
Kigali Health Informatics
Research Institute
Kigali University Teaching
Hospital (CHUK)

^bBISI:
Department of biostatistics and
medical informatics
Faculty of Medicine and Pharmacy
Vrije Universiteit Brussel,
Brussels, Belgium

Correspondence to:
dr. Frank Verbeke, BISI:
Department of Biostatistics and
Medical Informatics
Faculty of Medicine and Pharmacy
Vrije Universiteit Brussel
Laarbeeklaan 103, B-1090 Jette
(Brussels), Belgium
frank.verbeke@vub.ac.be

Referencing this article

Verbeke, F., Murekatete, C., Ngoc, C. T., Karara, G., Gasakure, E., & Nyssen, M. (2009). Evaluation of a new method for in-patient co-morbidity analysis based on KHIRI Pathology Group Set codes at the Kigali University Teaching Hospital [Electronic Version]. *Journal of Health Informatics in Developing Countries*, 3(2), 12-24, from <http://www.jhdc.org/index.php/jhdc/issue/view/8>

3. Evaluation of to what extent KPGS codes represent useful morbidity entities enabling a clinically comprehensible evaluation of hospital activity. This activity requires evaluation and feedback by clinicians of different clinical departments of KPGS-code co-morbidity statistics on the one hand. On the other hand, KPGS based morbidity analysis is to be compared with the ICD-10 code/chapter and ICPC-2 code based analysis that has been in use at the CHUK until today.

Methodology

Study site:

Situated in the capital of Rwanda, with a population of about 9 million inhabitants, the Kigali University Teaching Hospital is one of the national referral public hospitals of the country, and brings curative care to all inhabitants of the City of Kigali, with nearly 1 million inhabitants. It counted 425 beds on December the 31st 2008. On an annual basis, over 9.000 admissions, 90.000 consultations and 13.000 emergencies are dealt with. On December 31st, 2008, 93 physicians were employed: 38 specialists and 42 postgraduate trainees and 13 general practitioners.

The Kigali University Teaching Hospital started in 2000 with the early implementations of an electronic patient data management system. In a first phase, covering 2000 till 2005, all data, including names, pathology, outcome, length of stay were managed via Microsoft Access®. For the classification of diseases, 510 locally developed codes have been created. There was no link with national or international codes.

In 2005 the Kigali University Teaching Hospital stepped into a new era by starting the encoding of pathologies in both ICD-10 and ICPC-2, by using the Belgian 3BT (3B = Belgian Bilingual Bi-classified; T = Thesaurus) in its French version. The database was run under Microsoft Access®. All patient data were systematically converted into both ICD-10 and ICPC-2 codes.

In 2007 the hospital started implementing an ambitious ICT Master Plan, including the individual electronic patient record. The system manages all patients' administrative, financial and clinical data. A unique patient identification number is generated and a patient ID card printed. The unique patient file code is generated using alphabetic characters. Diagnoses and other important health conditions continue to be encoded under ICD-10 and ICPC-2. All data generated since January 1st, 2006 have been migrated from MS Access® into the used software, OpenClinic®.

All departments were present and functional during the 3 years study period, except for the gynaecology department that reopened in January 2008 after rehabilitation of the buildings. The full data set available to the validation program described in this paper therefore only covers one year of gynaecological activities.

Material and methods:

Step 1: As a starting point, all electronically available hospital health records from January 1st, 2006 until December 31st, 2008 have been extracted and anonymized from the existing OpenClinic® hospital information system database.

Step 2: Based on the 21 ICD-10 chapters, a set of 176 entities has been defined. Selection of these entities was based on clinical concepts that are particularly meaningful for clinical and financial management purposes at the CHUK. Every ICD-10 and ICPC-2 code has been mapped onto such a corresponding KPGS code.

Step 3: A new module was developed for the OpenClinic® hospital information system in order to extend the existing ICD-10 and ICPC-2 code based hospital co-morbidity statistics software making use of KPGS codes.

Step 4: KPGS-code co-morbidity statistics were computed on the full study dataset using the new module developed in Step 3. Two calculations were performed: one for ICD-10 based KPGS codes and one for ICPC-2 based KPGS codes. The results of both calculations have then been compared for the 10 most frequent pathology groups (KPGS codes associated to the greatest number of admissions) and the 10 most resource consuming pathology groups (KPGS codes with longest associated mean length of stay per admission).

Step 5: KPGS-code co-morbidity statistics were compared to equivalent ICD-10 and ICPC-2 based statistics and then presented to hospital clinicians for usability and clinical consistency evaluation.

Results

Step 1: The cleaning (removal of erroneous diagnostic codes, unidentifiable patients etc.) of the extracted dataset resulted in 30.557 ICD-10 codes and 30.412 ICPC-2 codes for a total of 25.466 hospital admissions and 23.454 patients. This has been the basis for all further research activities of this study.

Step 2: The development of the KPGS coding system has resulted in 3 tables:

Table 1: the list of all KPGS codes organized according to ICD-10 chapters

Table 2: a mapping table between ICD-10, ICPC-2 and KPGS

Table 1: Defined KPGS codes

01 CERTAIN INFECTIOUS AND PARASITIC DISEASES

01A INTESTINAL INFECTIOUS DISEASES
01B TUBERCULOSIS
01C CERTAIN ZOONOTIC BACTERIAL DISEASES
01D OTHER BACTERIAL DISEASES
01E INFECTIONS WITH A PREDOMINANTLY
SEXUAL MODE OF TRANSMISSION
01F OTHER SPIROCHAETAL DISEASES
01G OTHER DISEASES CAUSED BY CHLAMYDIAE

01H RICKETTSIOSES
 01I VIRAL INFECTIONS OF THE CENTRAL NERVOUS SYSTEM
 01J ARTHROPOD-BORNE VIRAL FEVERS AND VIRAL HAEMORRHAGIC FEVERS
 01K VIRAL INFECTIONS CHARACTERIZED BY SKIN AND MUCOUS MEMBRANE LESIONS
 01L VIRAL HEPATITIS
 01M HUMAN IMMUNODEFICIENCY VIRUS [HIV] DISEASE
 01N OTHER VIRAL DISEASES
 01O MYCOSES
 01P PROTOZOAL DISEASES
 01Q HELMINTHIASES
 01R PEDICULOSIS, ACARIASIS AND OTHER INFESTATIONS
 01S SEQUELAE OF INFECTIOUS AND PARASITIC DISEASES
 01T BACTERIAL, VIRAL AND OTHER INFECTIOUS AGENTS
 01U OTHER INFECTIOUS DISEASES
 01V MALARIA

02 NEOPLASMS

02A MALIGNANT NEOPLASMS, STATED OR PRESUMED TO BE PRIMARY, OF SPECIFIED SITES, EXCEPT OF LYMPHOID, HAEMATOPOIETIC AND RELATED TISSUE
 02B MALIGNANT NEOPLASMS OF ILL-DEFINED, SECONDARY AND UNSPECIFIED SITES
 02C MALIGNANT NEOPLASMS, STATED OR PRESUMED TO BE PRIMARY, OF LYMPHOID, HAEMATOPOIETIC AND RELATED TISSUE
 02D MALIGNANT NEOPLASMS OF INDEPENDENT (PRIMARY) MULTIPLE SITES
 02E IN SITU NEOPLASMS
 02F BENIGN NEOPLASMS
 02G NEOPLASMS OF UNCERTAIN OR UNKNOWN BEHAVIOUR

03 DISEASES OF THE BLOOD AND BLOOD-FORMING ORGANS AND CERTAIN DISORDERS INVOLVING THE IMMUNE MECHANISM

03A NUTRITIONAL ANAEMIAS
 03B HAEMOLYTIC ANAEMIAS
 03C APLASTIC AND OTHER ANAEMIAS
 03D COAGULATION DEFECTS, PURPURA AND OTHER HAEMORRHAGIC CONDITIONS
 03E OTHER DISEASES OF BLOOD AND BLOOD-FORMING ORGANS
 03F CERTAIN DISORDERS INVOLVING THE IMMUNE MECHANISM

04 ENDOCRINE, NUTRITIONAL AND METABOLIC DISEASES

04A DISORDERS OF THYROID GLAND
 04B DIABETES MELLITUS
 04C DISORDERS OF OTHER ENDOCRINE GLANDS
 04D NUTRITIONAL DEFICIENCIES
 04E OBESITY AND OTHER HYPERALIMENTATION
 04F METABOLIC DISORDERS

05 MENTAL AND BEHAVIOURAL DISORDERS

05A ORGANIC, INCLUDING SYMPTOMATIC, MENTAL DISORDERS

05B MENTAL AND BEHAVIOURAL DISORDERS DUE TO PSYCHOACTIVE SUBSTANCE USE
 05C SCHIZOPHRENIA, SCHIZOTYPAL AND DELUSIONAL DISORDERS
 05D MOOD [AFFECTIVE] DISORDERS
 05E NEUROTIC, STRESS-RELATED AND SOMATOFORM DISORDERS
 05F BEHAVIOURAL SYNDROMES ASSOCIATED WITH PHYSIOLOGICAL DISTURBANCES AND PHYSICAL FACTORS
 05G DISORDERS OF ADULT PERSONALITY AND BEHAVIOUR
 05H MENTAL RETARDATION
 05I DISORDERS OF PSYCHOLOGICAL DEVELOPMENT
 05J BEHAVIOURAL AND EMOTIONAL DISORDERS WITH ONSET USUALLY OCCURRING IN CHILDHOOD AND ADOLESCENCE
 05K UNSPECIFIED MENTAL DISORDER

06 DISEASES OF THE NERVOUS SYSTEM

06A INFLAMMATORY DISEASES OF THE CENTRAL NERVOUS SYSTEM
 06B SYSTEMIC ATROPHIES PRIMARILY AFFECTING THE CENTRAL NERVOUS SYSTEM
 06C EXTRAPYRAMIDAL AND MOVEMENT DISORDERS
 06D OTHER DEGENERATIVE DISEASES OF THE NERVOUS SYSTEM
 06E DEMYELINATING DISEASES OF THE CENTRAL NERVOUS SYSTEM
 06F EPISODIC AND PAROXYSMAL DISORDERS
 06G NERVE, NERVE ROOT AND PLEXUS DISORDERS
 06H POLYNEUROPATHIES AND OTHER DISORDERS OF THE PERIPHERAL NERVOUS SYSTEM
 06I DISEASES OF MYONEURAL JUNCTION AND MUSCLE
 06K OTHER DISORDERS OF THE NERVOUS SYSTEM
 06L OTHER PARALYTIC SYNDROMES

07 DISEASES OF THE EYE AND ADNEXA

07A DISORDERS OF EYELID, LACRIMAL SYSTEM AND ORBIT
 07B DISORDERS OF CONJUNCTIVA
 07C DISORDERS OF SCLERA AND CORNEA
 07D DISORDERS OF IRIS AND CILIARY BODY
 07E DISORDERS OF LENS
 07F DISORDERS OF CHOROID AND RETINA
 07G GLAUCOMA
 07H DISORDERS OF VITREOUS BODY AND GLOBE
 07I DISORDERS OF OPTIC NERVE AND VISUAL PATHWAYS
 07J DISORDERS OF OCULAR MUSCLES, BINOCULAR MOVEMENT, ACCOMMODATION AND REFRACTION
 07K VISUAL DISTURBANCES AND BLINDNESS
 07L OTHER DISORDERS OF EYE AND ADNEXA
 07M CATARACT

08 DISEASES OF THE EAR AND MASTOID PROCESS

08A OTITIS
 08B MASTOIDITIS

09 DISEASES OF THE CIRCULATORY SYSTEM

- 09A ACUTE RHEUMATIC FEVER
- 09B CHRONIC RHEUMATIC HEART DISEASES
- 09C HYPERTENSIVE DISEASES
- 09D ISCHAEMIC HEART DISEASES
- 09E PULMONARY HEART DISEASE AND DISEASES OF PULMONARY CIRCULATION
- 09F OTHER FORMS OF HEART DISEASE
- 09G CEREBROVASCULAR DISEASES
- 09H DISEASES OF ARTERIES, ARTERIOLES AND CAPILLARIES
- 09I DISEASES OF VEINS, LYMPHATIC VESSELS AND LYMPH NODES, NOT ELSEWHERE CLASSIFIED
- 09J OTHER AND UNSPECIFIED DISORDERS OF THE CIRCULATORY SYSTEM
- 09K HEART FAILURE
- 09L INTRACRANIAL HAEMORRHAGE
- 09M STROKE
- 09N TRANSIENT CEREBRAL ISCHAEMIC ATTACKS
- 09O PHLEBITIS AND THROMBOPHLEBITIS
- 09P VARICOSE VEINS
- 09Q OESOPHAGEAL VARICES
- 09R HAEMORRHOIDS

10 DISEASES OF THE RESPIRATORY SYSTEM

- 10A ACUTE UPPER RESPIRATORY INFECTIONS
- 10B INFLUENZA
- 10C PNEUMONIA
- 10D BRONCHITIS- BRONCHIOLITIS
- 10E OTHER DISEASES OF THE RESPIRATORY SYSTEM
- 10F BRONCHIOLITIS
- 10G EMPHYSEMA
- 10H OTHER CHRONIC OBSTRUCTIVE PULMONARY DISEASE
- 10I ASTHMA
- 10J BRONCHIECTASIS
- 10K OTHER DISEASES OF PLEURA

11 DISEASES OF THE DIGESTIVE SYSTEM

- 11A DISEASES OF ORAL CAVITY, SALIVARY GLANDS AND JAWS
- 11B DISEASES OF OESOPHAGUS, STOMACH AND DUODENUM
- 11C DISEASES OF APPENDIX
- 11D HERNIA
- 11E NONINFECTIVE ENTERITIS AND COLITIS
- 11F OTHER DISEASES OF INTESTINES
- 11G DISEASES OF PERITONEUM
- 11H DISEASES OF LIVER
- 11I DISORDERS OF GALLBLADDER, BILIARY TRACT AND PANCREAS
- 11J OTHER DISEASES OF THE DIGESTIVE SYSTEM
- 11K OESOPHAGITIS
- 11L GASTRO-OESOPHAGEAL REFLUX DISEASE
- 11M GASTROJEJUNAL ULCER
- 11N GASTRITIS AND DUODENITIS
- 11O PARALYTIC ILEUS
- 11P INTUSSUSCEPTION
- 11Q CIRRHOSIS
- 11R HEPATIC FAILURE
- 11S ALCOHOLIC LIVER DISEASE

12 DISEASES OF THE SKIN AND SUBCUTANEOUS TISSUE

- 12A INFECTIONS OF THE SKIN AND SUBCUTANEOUS TISSUE
- 12B DERMATITIS AND ECZEMA
- 12C PAPULOSQUAMOUS DISORDERS
- 12D URTICARIA AND ERYTHEMA
- 12E RADIATION-RELATED DISORDERS OF THE SKIN AND SUBCUTANEOUS TISSUE
- 12F DISORDERS OF SKIN APPENDAGES
- 12G OTHER DISORDERS OF THE SKIN AND SUBCUTANEOUS TISSUE

13 DISEASES OF THE MUSCULOSKELETAL SYSTEM AND CONNECTIVE TISSUE

- 13A OTHER JOINT DISORDERS
- 13B SYSTEMIC CONNECTIVE TISSUE DISORDERS
- 13C DORSOPATHIES
- 13D SOFT TISSUE DISORDERS
- 13E OSTEOPATHIES AND CHONDROPATHIES
- 13F OTHER DISORDERS OF THE MUSCULOSKELETAL SYSTEM AND CONNECTIVE TISSUE

14 DISEASES OF THE GENITOURINARY SYSTEM

140 DISEASES OF THE GENITOURINARY SYSTEM

15 PREGNANCY, CHILDBIRTH AND THE PUERPERIUM

- 15A PREGNANCY WITH ABORTIVE OUTCOME
- 15B OTHER COMPLICATIONS OF THE PREGNANCY, CHILDBIRTH AND THE PUERPERIUM

16 CERTAIN CONDITIONS ORIGINATING IN THE PERINATAL PERIOD

160 CERTAIN CONDITIONS ORIGINATING IN THE PERINATAL PERIOD

17 CONGENITAL MALFORMATIONS, DEFORMATIONS AND CHROMOSOMAL ABNORMALITIES

- 170 CONGENITAL MALFORMATIONS, DEFORMATIONS AND CHROMOSOMAL ABNORMALITIES

18 SYMPTOMS, SIGNS AND ABNORMAL CLINICAL AND LABORATORY FINDINGS, NOT ELSEWHERE CLASSIFIED

- 18A SYMPTOMS AND SIGNS INVOLVING THE CIRCULATORY AND RESPIRATORY SYSTEMS
- 18B SYMPTOMS AND SIGNS INVOLVING THE DIGESTIVE SYSTEM AND ABDOMEN
- 18C SYMPTOMS AND SIGNS INVOLVING THE SKIN AND SUBCUTANEOUS TISSUE
- 18D SYMPTOMS AND SIGNS INVOLVING THE NERVOUS AND MUSCULOSKELETAL SYSTEMS
- 18E SYMPTOMS AND SIGNS INVOLVING THE URINARY SYSTEM
- 18F SYMPTOMS AND SIGNS INVOLVING

COGNITION, PERCEPTION, EMOTIONAL
STATE AND BEHAVIOUR
18G SYMPTOMS AND SIGNS INVOLVING SPEECH
AND VOICE
18H GENERAL SYMPTOMS AND SIGNS
18I ABNORMAL FINDINGS ON EXAMINATION OF
BLOOD, WITHOUT DIAGNOSIS
18J ABNORMAL FINDINGS ON EXAMINATION OF
URINE, WITHOUT DIAGNOSIS
18K ABNORMAL FINDINGS ON EXAMINATION OF
OTHER BODY FLUIDS, SUBSTANCES AND
TISSUES, WITHOUT DIAGNOSIS
18L ABNORMAL FINDINGS ON DIAGNOSTIC
IMAGING AND IN FUNCTION STUDIES,
WITHOUT DIAGNOSIS
18M ILL-DEFINED AND UNKNOWN CAUSES OF
MORTALITY

19 INJURY, POISONING AND CERTAIN OTHER
CONSEQUENCES OF EXTERNAL CAUSES

190 OTHER INJURY, POISONING AND CERTAIN
OTHER CONSEQUENCES OF EXTERNAL
CAUSES
19A FRACTURES
19B BURNS AND CORROSIONS

20 EXTERNAL CAUSES OF MORBIDITY AND
MORTALITY

200 EXTERNAL CAUSES OF MORBIDITY AND
MORTALITY
21 FACTORS INFLUENCING HEALTH STATUS
AND CONTACT WITH HEALTH SERVICES

21A PERSONS ENCOUNTERING HEALTH
SERVICES FOR EXAMINATION AND
INVESTIGATION
21B PERSONS WITH POTENTIAL HEALTH
HAZARDS RELATED TO COMMUNICABLE
DISEASES
21C PERSONS ENCOUNTERING HEALTH
SERVICES IN CIRCUMSTANCES RELATED
TO REPRODUCTION
21D PERSONS ENCOUNTERING HEALTH
SERVICES FOR SPECIFIC PROCEDURES
AND HEALTH CARE
21E PERSONS WITH POTENTIAL HEALTH
HAZARDS RELATED TO SOCIOECONOMIC
AND PSYCHOSOCIAL CIRCUMSTANCES
21F PERSONS ENCOUNTERING HEALTH
SERVICES IN OTHER CIRCUMSTANCES
21G PERSONS WITH POTENTIAL HEALTH
HAZARDS RELATED TO FAMILY AND
PERSONAL HISTORY AND CERTAIN
CONDITIONS INFLUENCING HEALTH
STATUS

Table 2
Mapping sample
between KPGS codes
and ICD-10/ICPC-2
(first 4 KPGS chapters)

01 CERTAIN INFECTIOUS AND PARASITIC DISEASES	ICD-10	ICPC-2
01A INTestinal Infectious Diseases	A00-A09	D70, D73
01B TUBERCULOSIS	A15-A19	A70
01C CERTAIN ZOONOTIC BACTERIAL DISEASES	A20-A28	-
01D OTHER BACTERIAL DISEASES	A30-A49	N72, R71
01E INFECTIONS WITH A PREDOMINANTLY SEXUAL MODE OF TRANSMISSION	A50-A64	X70, X71, X73, X90, X91, X92, Y70, Y71, Y72, Y76
01F OTHER SPIROCHAETAL DISEASES	A65-A69	-
01G OTHER DISEASES CAUSED BY CHLAMYDIAE	A70-A74	F86
01H RICKETTSIOSES	A75-A79	-
01I VIRAL INFECTIONS OF THE CENTRAL NERVOUS SYSTEM	A80-A89	N70
01J ARTHROPOD-BORNE VIRAL FEVERS AND VIRAL HAEMORRHAGIC FEVERS	A90-A99	-
01K VIRAL INFECTIONS CHARACTERIZED BY SKIN AND MUCOUS MEMBRANE LESIONS	B00-B09	A71, A72, A74, A76, S03, S70, S71, S95
01L VIRAL HEPATITIS	B15-B19	D72
01M HUMAN IMMUNODEFICIENCY VIRUS [HIV] DISEASE	B20-B24	B90
01N OTHER VIRAL DISEASES	B25-B34	A75, A77, D71
01O MYCOSES	B35-B49	S74, S75, X72
01P PROTOZOAL DISEASES	B55-B64	-
01Q HELMINTHIASES	B65-B83	D96
01R PEDICULOSIS, ACARIASIS AND OTHER INFESTATIONS	B85-B89	S72, S73

01S SEQUELAE OF INFECTIOUS AND PARASITIC DISEASES	B90-B94	-
01T BACTERIAL, VIRAL AND OTHER INFECTIOUS AGENTS	B95-B97	-
01U OTHER INFECTIOUS DISEASES	B99	A78
01V MALARIA	B50-B54	A73
02 NEOPLASMS		
02A MALIGNANT NEOPLASMS, STATED OR PRESUMED TO BE PRIMARY, OF SPECIFIED SITES, EXCEPT OF LYMPHOID, HAEMATOPOIETIC AND RELATED TISSUE	C00-C75	D74, D75, D76, D77, K72, L71, N74, R84, R85, S77, T71, U75, U76, U77, W72, X75, X76, X77, Y77, Y78
02B MALIGNANT NEOPLASMS OF ILL-DEFINED, SECONDARY AND UNSPECIFIED SITES	C76-C80	A79
02C MALIGNANT NEOPLASMS, STATED OR PRESUMED TO BE PRIMARY, OF LYMPHOID, HAEMATOPOIETIC AND RELATED TISSUE	C81-C96	B72, B73, B74
02D MALIGNANT NEOPLASMS OF INDEPENDENT (PRIMARY) MULTIPLE SITES	C97	-
02E IN SITU NEOPLASMS	D00-D09	-
02F BENIGN NEOPLASMS	D10-D36	B75, D78, L97, N75, R86, S78, S79, S81, S82, T72, U78, X78, X79, X80
02G NEOPLASMS OF UNCERTAIN OR UNKNOWN BEHAVIOUR	D37-D49	F74, H75, N76, R92, T73, U79, X81, Y79
03 DISEASES OF THE BLOOD AND BLOOD-FORMING ORGANS AND CERTAIN DISORDERS INVOLVING THE IMMUNE MECHANISM		
03A NUTRITIONAL ANAEMIAS	D50-D53	B80, B81
03B HAEMOLYTIC ANAEMIAS	D55-D59	B78
03C APLASTIC AND OTHER ANAEMIAS	D60-D64	B82
03D COAGULATION DEFECTS, PURPURA AND OTHER HAEMORRHAGIC CONDITIONS	D65-D69	B83
03E OTHER DISEASES OF BLOOD AND BLOOD-FORMING ORGANS	D70-D77	B99
03F CERTAIN DISORDERS INVOLVING THE IMMUNE MECHANISM	D80-D89	-
04 ENDOCRINE, NUTRITIONAL AND METABOLIC DISEASES		
04A DISORDERS OF THYROID GLAND	E00-E07	T70, T81, T85, T86
04B DIABETES MELLITUS	E10-E14	T89, T90
04C DISORDERS OF OTHER ENDOCRINE GLANDS	E20-E35	T99
04D NUTRITIONAL DEFICIENCIES	E40-E64	T91
04E OBESITY AND OTHER HYPERALIMENTATION	E65-E68	T82, T83
04F METABOLIC DISORDERS	E15-E19, E70-E85, E87-E90	T87, T93

The full mapping table can be provided by the authors on request

Step 3: an extension to the OpenClinic® system was developed in Java® and can provide the following statistics for every KPGS code and per type of outcome:

- Relative Outcome Frequency (ROF): Relative number of admissions with this outcome compared to total number of admissions for the KPGS code
- Absolute Outcome Frequency (AOF): Number of admissions associated to the KPGS code
- Total length of stay for admissions associated to the KPGS code (TLOS)
- Average length of stay for admissions associated to the KPGS code (MLOS)
- Quartiles (1,2 and 3), Standard deviation and

Extremes for length of stay for admissions associated to the KPGS code (QLOS1-3, SDLOS, MinLOS, MaxLOS)

- Co-morbidity score (CS): this score reflects the mean number of registered diagnoses for admissions associated to the KPGS code (≥ 1)
- Corrected total length of stay (CTLOS): total length of stay divided by co-morbidity score (TLOS/CS).
- Corrected Median for length of stay (CMLOS): median for length of stay divided by co-morbidity score (MLOS/CS)

Step 4: KPGS morbidity analysis based on ICD-10 codes produced the following output:

Table 3a

ICD-10 code based KPGS morbidity analysis for top 10 most frequent pathology groups

KPGS	LABEL	# cases
19A	FRACTURES	2619
01A	INTESTINAL INFECTIOUS DISEASES	2439
15B	OTHER COMPLICATIONS OF THE PREGNANCY, CHILDBIRTH AND THE PUERPERIUM	2098
01V	MALARIA	1997
140	DISEASES OF THE GENITOURINARY SYSTEM	1759
10C	PNEUMONIA	1584
10A	ACUTE UPPER RESPIRATORY INFECTIONS	1552
01B	TUBERCULOSIS	1184
190	OTHER INJURY, POISONING AND CERTAIN OTHER CONSEQUENCES OF EXTERNAL CAUSES	976
160	CERTAIN CONDITIONS ORIGINATING IN THE PERINATAL PERIOD	930

Table 3b

ICD-10 code based KPGS morbidity analysis for top 10 most resource consuming pathology groups

KPGS	LABEL	# days
19A	FRACTURES	70386
01B	TUBERCULOSIS	29106
01A	INTESTINAL INFECTIOUS DISEASES	19867
140	DISEASES OF THE GENITOURINARY SYSTEM	19010
10C	PNEUMONIA	16725
190	OTHER INJURY, POISONING AND CERTAIN OTHER CONSEQUENCES OF EXTERNAL CAUSES	14721
04D	NUTRITIONAL DEFICIENCIES	14505
01V	MALARIA	14134
09F	OTHER FORMS OF HEART DISEASE	9108
02A	MALIGNANT NEOPLASMS, STATED OR PRESUMED TO BE PRIMARY, OF SPECIFIED SITES, EXCEPT OF LYMPHOID, HAEMATOPOIETIC AND RELATED TISSUE	9017

KPGS morbidity analysis based on ICPC-2 codes produced the following output:

Table 3c
ICPC-2 code based
KPGS morbidity
analysis for top
10 most frequent
pathology groups

KPGS	LABEL	# cases
19A	FRACTURES	2525
01A	INTESTINAL INFECTIOUS DISEASES	2440
01V	MALARIA	1996
140	DISEASES OF THE GENITOURINARY SYSTEM	1755
10C	PNEUMONIA	1694
01B	TUBERCULOSIS	1494
15B	OTHER COMPLICATIONS OF THE PREGNANCY, CHILDBIRTH AND THE PUERPERIUM	1294
10A	ACUTE UPPER RESPIRATORY INFECTIONS	1290
190	OTHER INJURY, POISONING AND CERTAIN OTHER CONSEQUENCES OF EXTERNAL CAUSES	1156
11J	OTHER DISEASES OF THE DIGESTIVE SYSTEM	944

Table 3d
ICPC-2 code based
KPGS morbidity
analysis for top
10 most resource
consuming pathology
groups

KPGS	LABEL	# days
19A	FRACTURES	67956
01B	TUBERCULOSIS	37034
01A	INTESTINAL INFECTIOUS DISEASES	19869
140	DISEASES OF THE GENITOURINARY SYSTEM	18751
190	OTHER INJURY, POISONING AND CERTAIN OTHER CONSEQUENCES OF EXTERNAL CAUSES	18135
10C	PNEUMONIA	17997
04D	NUTRITIONAL DEFICIENCIES	14474
01V	MALARIA	14126
11J	OTHER DISEASES OF THE DIGESTIVE SYSTEM	11774
10E	OTHER DISEASES OF THE RESPIRATORY SYSTEM	9185

For the top 5 KPGS codes, we then analyzed the co-morbidity statistics: for any of the 5 codes we listed the frequency of all other KPGS codes that had been associated to it within the context of one and the same admission episode. Co-morbidity was again analyzed twice based on the appropriate

underlying classification system (respectively ICD-10 and ICPC-2). Output was further divided in results for every type of clinical outcome of hospital admission (only outcomes improvement/recovery and death are shown in this paper)

Table 4a

Top 5 Co-morbidity
for top 5 KPGS
codes based on
ICD-10 (outcomes
improvement/recovery
and death)

Outcome: improvement/recovery			
19A	FRACTURES (CS=1,25, AOF=2501, ROF=96,19%)		
	190 OTHER INJURY, POISONING AND CERTAIN OTHER CONSEQUENCES OF EXTERNAL CAUSES	75	3,00%
	13E OSTEOPATHIES AND CHONDROPATHIES	9	0,36%
	11G DISEASES OF PERITONEUM	9	0,36%
	03E OTHER DISEASES OF BLOOD AND BLOOD-FORMING ORGANS	6	0,24%
	10K OTHER DISEASES OF PLEURA	4	0,16%
01B	TUBERCULOSIS (CS=1,26, AOF=868, ROF=71,32%)		
	04D NUTRITIONAL DEFICIENCIES	25	2,88%
	01V MALARIA	17	1,96%
	10C PNEUMONIA	17	1,96%
	09F OTHER FORMS OF HEART DISEASE	11	1,27%
	140 DISEASES OF THE GENITOURINARY SYSTEM	11	1,27%
01A	INTESTINAL INFECTIOUS DISEASES (CS=1,54, AOF=2206, ROF=90,71%)	D72	
	090 VOLUME DEPLETION	495	22,44%
	04D NUTRITIONAL DEFICIENCIES	144	6,53%
	01V MALARIA	133	6,03%
	10C PNEUMONIA	72	3,26%
	18H GENERAL SYMPTOMS AND SIGNS	56	2,54%
140	DISEASES OF THE GENITOURINARY SYSTEM (CS=1,21, AOF=1551, ROF=90,12%)	S72, S73	
	01V MALARIA	34	2,20%
	09C HYPERTENSIVE DISEASES	23	1,49%
	01A INTESTINAL INFECTIOUS DISEASES	20	1,29%
	09K HEART FAILURE	17	1,10%
	04B DIABETES MELLITUS	12	0,78%
01V	MALARIA (CS=1,45, AOF=1813, ROF=90,06%)		
	01A INTESTINAL INFECTIOUS DISEASES	133	7,34%
	11B DISEASES OF OESOPHAGUS, STOMACH AND DUODENUM	116	6,40%
	10C PNEUMONIA	96	5,30%
	11J OTHER DISEASES OF THE DIGESTIVE SYSTEM	80	4,41%
	090 VOLUME DEPLETION	58	3,20%

Outcome: death			
19A	FRACTURES (CS=1,60, AOF=52, ROF=2,06%)		
	06K OTHER DISORDERS OF THE NERVOUS SYSTEM	2	3,85%
	11J OTHER DISEASES OF THE DIGESTIVE SYSTEM	2	3,85%
	140 DISEASES OF THE GENITOURINARY SYSTEM	2	3,85%
	190 OTHER INJURY, POISONING AND CERTAIN OTHER CONSEQUENCES OF EXTERNAL CAUSES	2	3,85%
	21F PERSONS WITH POTENTIAL HEALTH HAZARDS RELATED TO FAMILY AND PERSONAL HISTORY AND CERTAIN CONDITIONS INFLUENCING HEALTH STATUS	1	1,92%
01B	TUBERCULOSIS (CS=1,30, AOF=395, ROF=25,83%)		
	01U OTHER INFECTIOUS DISEASES	16	4,05%
	10E OTHER DISEASES OF THE RESPIRATORY SYSTEM	9	2,28%
	11A DISEASES OF ORAL CAVITY, SALIVARY GLANDS AND JAWS	8	2,03%
	01V MALARIA	8	2,03%
	140 DISEASES OF THE GENITOURINARY SYSTEM	7	1,77%
01A	INTESTINAL INFECTIOUS DISEASES (CS=1,87, AOF=116, ROF=4,75%)	D72	
	090 VOLUME DEPLETION	24	20,69%
	04D NUTRITIONAL DEFICIENCIES	14	12,07%
	09J OTHER AND UNSPECIFIED DISORDERS OF THE CIRCULATORY SYSTEM	13	11,21%
	01U OTHER INFECTIOUS DISEASES	7	6,03%
	10C PNEUMONIA	6	5,17%
140	DISEASES OF THE GENITOURINARY SYSTEM (CS=1,76, AOF=144, ROF=8,39%)	S72, S73	
	09C HYPERTENSIVE DISEASES	9	6,25%
	09F OTHER FORMS OF HEART DISEASE	9	6,25%
	09K HEART FAILURE	7	4,86%
	01B TUBERCULOSIS	7	4,86%
	11H DISEASES OF LIVER	7	4,86%
01V	MALARIA (CS=1,64, AOF=110, ROF=5,46%)		
	01B TUBERCULOSIS	8	7,27%
	10C PNEUMONIA	8	7,27%
	10E OTHER DISEASES OF THE RESPIRATORY SYSTEM	7	6,36%
	090 VOLUME DEPLETION	5	4,55%
	140 140 DISEASES OF THE GENITOURINARY SYSTEM	4	3,64%

Step 6: based on the same dataset, co-morbidity analysis has been performed directly on ICD-10 and ICPC-2 codes. For the ICD-10 and ICPC-2 codes, code grouping was performed based on the first 3 characters of the code as this is the actual method

at the CHUK for hiding irrelevant diagnostic details (ICPC-2 codes only consisting of 3 characters, there was no impact whatsoever on the statistics). The results were then compared to the results obtained in tables 3a to 4b

Table 5a

ICD-10 code based morbidity analysis for top 10 most frequent pathology groups

KPGS	LABEL	# cases
A08	ACUTE GASTROENTEROPATHY	1540
B50	PLASMODIUM FALCIPARUM MALARIA, UNSPECIFIED	1064
J18	BRONCHOPNEUMONIA, UNSPECIFIED	828
O80	SIMPLE UNCOMPLICATED DELIVERY	738
B54	UNSPECIFIED MALARIA	698
E86	VOLUME DEPLETION	683
S72	FEMUR FRACTURE, UNSPECIFIED	598
D63	ANEMIE ASSOCIATED TO OTHER CHRONIC DISEASES, NOT SPECIFIED ELSE-WHERE	584
A09	DIARRHEA AND GASTROENTERITIS OF PRESUMED INFECTIOUS ORIGIN	570
J18	PNEUMONIA, UNSPECIFIED	515

Table 5b

ICD-10 code based morbidity analysis for top 10 most resource consuming pathology groups

KPGS	LABEL	# days
S72	FEMUR FRACTURE, UNSPECIFIED	16868
A08	ACUTE GASTROENTEROPATHY	11838
A16	TUBERCULOSIS OF LUNG, WITHOUT MENTION OF BACTERIOLOGICAL OR HISTOLOGICAL CONFIRMATION	8998
E41	NUTRITIONAL MARASMUS	8831
J18	BRONCHOPNEUMONIA, UNSPECIFIED	8438
B50	PLASMODIUM FALCIPARUM MALARIA, UNSPECIFIED	7846
J18	PNEUMONIA, UNSPECIFIED	5532
A19	MILIARY TUBERCULOSIS, UNSPECIFIED	4939
E86	VOLUME DEPLETION	4821
J18	PNEUMONIA, UNSPECIFIED	515

Table 5c

ICPC-2 code based morbidity analysis for top 10 most resource consuming pathology groups

KPGS	LABEL	# days
A70	TUBERCULOSIS	37034
L75	FRACTURE: FEMUR	33738
R81	PNEUMONIA	17997
L76	FRACTURE: OTHER	17541
D70	GASTROINTESTINAL INFECTION	15855
T91	VITAMIN/NUTRITIONAL DEFICIENCY	14474
A73	MALARIA	14126
L73	FRACTURE: TIBIA/FIBULA	12801
D99	DISEASE DIGESTIVE SYSTEM OTHER	11719
R99	RESPIRATORY DISEASE OTHER	6982

Conclusions

1. The proposed system for hospital management oriented grouping of clinical conditions based on electronic patient records (KPGS) was successfully implemented in the CHUK. KPGS-codes have been integrated into existing co-morbidity analysis software (OpenClinic ®) at the hospital site. The KPGS is now available for routine use by hospital management staff.
2. Every ICD-10 and ICPC-2 code was mapped onto 1 single KPGS code, enabling direct usage of structured information on in-patients' clinical conditions coming from routine registration procedures. No modification to the existing clinical registration process has been necessary.
3. Whether ICD-10 or ICPC-2 based, KPGS groupings show a remarkable consistency for all major clinical conditions analysed on the 3-year dataset at the CHUK site (tables 4a – 4d). In the first place, this consistency reflects the good quality of the 3BT thesaurus that was used, enabling users to simultaneously classify clinical conditions in ICD-10 and ICPC-2 based on a common clinical thesaurus that has been adapted to the local Central African setting. On the other hand, the study results provide evidence that the proposed KPGS-mapping on ICD-10 and ICPC-2 is of sufficient quality to be used in routine hospital morbidity. Occasionally the low level of granularity present in ICPC-2 is reflected in KPGS-mapping: no KPGS-ICPC-2 mapping exists for 43 KPGS codes (e.g. 01C, 01F, 01H, 01J...) meaning that in those cases the KPGS-code provides a level of detail that is not available in ICPC-2. In practice this was of little or no influence on our study results, for the simple reason that, although ICD-10 provides the appropriate coding level, quite often the necessary diagnostic resources to confirm this detailed clinical condition are unavailable at the hospital.
4. Co-morbidity analysis of the top 5 clinical conditions (tables 5a and 5b) also shows a surprisingly high level of consistency, although we can see that in these results the higher level of detail provided by ICD-10 shows up more clearly. For KPGS codes 01B (Tuberculosis), 01A (Intestinal infectious diseases), 140 (Genito-urinary diseases) and 01V (Malaria), co-morbidity statistics are nearly identical whether they have been based on ICD-10 or ICPC-2 classification. For KPGS code 19A (Fractures) small differences can be attributed to detailed KPGS-code mappings not being available in ICPC-2 (e.g. 11G, Peritoneal diseases replaced in ICPC-2 by the more general code 11J, Other diseases of the digestive system).
5. Compared to direct ICPC-2 and ICD-10 codes based morbidity analysis, KPGS delivers a more comprehensive and logical approach for routine interpretation of co-morbidity statistics by both hospital management staff and hospital clinicians, hiding irrelevant levels of detail and differential diagnostic uncertainty for the user (e.g. 3 different tuberculosis related codes present in table 5b). On the other hand, this makes the KPGS approach less useful for detailed research statistics in

very specific clinical domains. Therefore it is important that ICD-10 and ICPC-2 remain the base registration level and that information at this level remains accessible for later research purposes.

6. As KPGS codes were defined at the hospital management level, it seems evident that in the future ICD-10 based KPGS grouping should be used for management purposes. It provides a complete coverage of all defined KPGS entities. ICPC-2 based registration should however remain in place, not only for purely academic reasons but also to further review future KPGS and ICPC classification modifications and to enable international standardized comparison of source data with other similar institutions.

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