

POPULATION HEALTH ANALYTICS

An Introduction to the ACG System and Main Markers

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THE JOHNS HOPKINS ACG° SYSTEM Celebrating Decades of Impact on Population Health Research and Practice



THE POPULATION-BASED CASE-MIX SYSTEM WITH THE LARGEST FOOTPRINT IN THE WORLD.

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MAIN APPLICATIONS & USES



KEY MARKERS & MODELS IN THE ACG SYSTEM

Aggregated Diagnostic Groups – ADGs

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- Adjusted Clinical Groups ACGs
- Resource Utilisation Bands RUBs
- Expanded Diagnosis Clusters EDCs
- Pharmacy Based Markers Rx-MGs
- Patient Need Groups PNGs
- Predictive Models

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- Other Markers Including
 - Frailty Markers, Chronic Condition count
 - Active Ingredient Count
 - Laboratory Markers
 - Emergency Department Classification



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ACG SYSTEM RISK MARKERS

Diagnosis	Pharmacy	Lab	Diagnosis and Pharmacy	Utilization and Resource Use	Coordination
 ADGs ACGs RUBs EDCs MEDCs Chronic Condition Count Frailty Cal-SSA Pregnant Pregnancy without delivery Delivered Low birth weight Dx (POS/Procedure codes to remove rule- out/provisional)	 RxMGs Active Ingredient Count Rx Concomitant Opioid User Chronic Opioid User Days Supply Quantity 	 Diabetes Mellitus Dyslipidemia Kidney Disease Deficiency Anemia 	 Condition markers Pharmacy adherence Opioid markers MMS Place of Service Type of Bill Code Revenue Code Procedure Code Service Begin Date / Service End Date Nex Fill Date Rx Fill Date Rx Days Supply 	 All Cause Inpatient Hospitalization Count Inpatient Hospitalization Count Unplanned Inpatient hospitalization Count Readmission 30 Day Count Unplanned Readmission 30 Day Count Inpatient Hospitalization Days Observation Stay Observation Days Emergency Visit Count Outpatient Visit Count Outpatient Visit Count Dialysis Service Marker Nursing Service Marker Cancer Treatment Marker Mechanical Ventilation Psychotherapy Service Marker Emergency Department Visit Classification 	 Management Visit Count Generalist Visit Count Majority Source of Care Unique Provider Count Specialty Count Generalist Seen Risk of Poor Coordination Care Density Provider ID Provider Specialty Provider Specialty Provider Standard Specialty

 ADGs are unique to the ACG System and are at the heart of the principle of the Johns Hopkins work and the ACG System

AGGREGATED DIAGNOSES GROUPS (ADGS)

THE BUILDING BLOCKS

- ADGs classify diagnoses into a limited number of clinically meaningful, but not diseasespecific, morbidity groups. (For example, "chronic unstable")
- Each ADG is homogenous with respect to specific clinical criteria and their demand on healthcare services
- Patients with multiple diagnoses can be assigned to one or more ADGs

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- There are 32 ADGs and all diseases map to one or more of these 32 ADGs
- ADGs form the basis of actuarial cells called Adjusted Clinical Groups (ACGs)

"The clustering of morbidity is a better predictor of health services resource use than the presence of specific diseases".

AGGREGATED DIAGNOSES GROUPS (ADG)



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- Examples of the ADGs and how they are constructed
- Full list available in circulated material
- Eight of the ADGs are classified as 'major'

No.	ADG	Duration	Severity	Aetiology	Diagnostic Certainty	Expected Need for Specialist Care	Example
I	Time Limited: Minor	Acute	Low	Medical, non-infectious	High	Unlikely	Noninfectious Gastroentritis
2	Time Limited: Minor-Primary Infections	Acute	Low	Medical, infectious	High	Unlikely	Croup
3	Time Limited: Major	Acute	High	Medical, non-infectious	High	Likely	Phlebitis of lower limb
4	Time Limited: Major-Primary Infections	Acute	High	Medical, infectious	High	Likely	Hepatitis
5	Allergies	Recurrent	Low	Allergy	High	Possibly	Allergic Rhinitis
6	Asthma	Recurrent or Chronic	Low	Mixed	High	Possibly	Asthma
7	Likely to Recur: Discrete	Recurrent	Low	Medical, non-infectious	High	Unlikely	Gout, backache
8	Likely to Recur: Discrete-Infections	Recurrent	Low	Medical, infectious	High	Unlikely	Chronic Tonsillitis
9	Likely to Recur: Progressive	Recurrent	High	Medical, non-infectious	High	Likely	Adult Onset Type II Diabetes w/Ketoacidosis
10	Chronic Medical: Stable	Chronic	Low	Medical, non-infectious	High	Unlikely	Adult-Onset Type I Diabetes
П	Chronic Medical: Unstable	Chronic	High	Medical, non-infectious	High	Likely	Sickle cell anaemia
12	Chronic Specialty: Stable-Orthopedic	Chronic	Low	Anatomic/Musculoskeletal	High	Likely: Orthopaedics	Cervical Spondylosis Without Myelopathy

ACGS – THE CONCEPT

ADGs are used to develop an ACG "Tree"

Patient-centric measure of health status based on:

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- Commonly occurring combinations of ADGs
- Age
- Gender
- One ACG per person per time period
- I06 ACGs (only 92 active at a given time)



- ACGs avoid basing "patient complexity" on specific procedures or hospitalisations and thus patterns of practice.
- Unit of analysis is the patient and not visit or service.
- Person-focused: Captures longitudinal, multi-episode dimension of health care.
- Complexity is more than merely summing organ system-based diagnosis codes.
- Each ACG includes individuals with:

I. A similar pattern of morbidity

2. Similar <u>expected</u> resource use

CAPTURING THE ESSENCE OF AN INDIVIDUAL'S HEALTH STATUS



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ADJUSTED CLINICAL GROUPS (ACG)



ACG Code	ACG Desription	Freq %	Normalized Weight
0100	Acute Minor, Age 1	0.39	0.35192
0200	Acute Minor, Age 2 to 5	1.08	0.32808
1500	Psychosocial, w/ Psychosocial Unstable, w/ Psychosocial Stable	0.26	0.63709
1600	Preventive/Administrative	5.89	0.24436
1711	Pregnancy, 0-1 ADGs, Delivered	0.11	0.23787
1761	Pregnancy, 6+ ADGs, no Major ADGs, Delivered	0.06	1.42326
1762	Pregnancy, 6+ ADGs, no Major ADGs, Not Delivered	0.06	1.72110
2800	Acute Major/Likely to Recur	1.73	0.67646
3900	2-3 Other ADG Combinations, Males Age 18 to 34	1.02	0.64744
4000	2-3 Other ADG Combinations, Females Age 18 to 34	1.19	0.70861
4100	2-3 Other ADG Combinations, Age 35+	12.76	0.89682
4510	6-9 Other ADG Combinations, Age 1 to 5, no Major ADGs	0.07	1.12811
4520	6-9 Other ADG Combinations, Age 1 to 5, 1+ Major ADGs	0.05	0.90349
5030	10+ Other ADG Combinations, Age 1 to 17, 2+ Major ADGs	0.01	1.71235
5040	10+ Other ADG Combinations, Age 18+, 0-1 Major ADGs	0.43	3.90740
5050	10+ Other ADG Combinations, Age 18+, 2 Major ADGs	0.62	4.01776
5060	10+ Other ADG Combinations, Age 18+, 3 Major ADGs	0.60	3.94284
5070	10+ Other ADG Combinations, Age 18+, 4+ Major ADGs	0.49	4.04358
5110	No Diagnosis or Only Unclassified Diagnosis or Non-Users (1 input file)	0.02	0.38306
5200	Non-Users (2 input files)	2.88	0.12804
5311	Infants: 0-5 ADGs, no Major ADGs, Low Birth Weight	0.01	0.21481
5342	Infants: 6+ ADGs, 1+ Major ADGs, Normal Birth Weight	0.01	0.83360
9900	Invalid Age or Date of Birth	0.00	1.15076

Please refer to the spreadsheet to be circulated for the complete list: 'ACG Labels'



RESOURCE UTILISATION BANDS

- RUBs group together a number of ACGs
- There are five RUBs:
 - RUB 5 Very high
 - RUB 4 High
 - RUB 3 Moderate
 - RUB 2 Low
 - RUB I Healthy users
 - (RUB 0 Non-users)
- RUBs are a collapsed version of the ACG categories and as such describe the <u>current</u> morbidity profile of individuals and the population
- RUBs do not reflect how the morbidity burden of an individual may change over the next year
- RUBs are interesting to explore how the morbidity burden of a population is distributed and how this varies between different GP Practices and to help understand differences in 'case-mix' between different populations
- Resource Utilisation Bands = resources you would **expect** an individual to use based on their morbidity profile
- Resource Utilisation Bands \neq actual resource use in the past year



Patient Characteristics	ACG System Outputs	Cost & Activity
Age/Sex:	ACG-0900:	Total Cost: £300
49/Female	Chronic Medical, Stable	GP Visits:
		ED Attendances: 0
Conditions:	ADGs:	Hospital Admissions: 0
Diabetes mellitus	10, Chronic Medical: Stable	

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MEDIUM COMPLEXITY PATIENT WITH DIABETES HEALTH ANALYTICS

Patient Characteristics	ACG System Outputs	Cost & Activity
Age/Sex: 49/Female Conditions: Diabetes mellitus Disorders of Lipid Metabolism Peripheral Neuropathy Otitis Media Gastroesophageal Reflux Acute sprain Joint disorder Bursitis Arthropathy	ACG-3600: Acute Minor/Acute Major/Likely Recur/Eye & Dental ADGS: 01 - Time Limited: Minor 07 - Likely to Recur: Discrete 08 - Likely to Recur: Discrete Infections 10 - Chronic Medical: Stable 22 - Injuries/Adverse Effects: Major 26 - Signs/Symptoms: Minor 27 - Signs/Symptoms: Uncertain	Total Cost: £1,700 GP Visits: 6 ED Attendances: 1 Hospital Admissions: 0

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HIGH COMPLEXITY PATIENT WITH DIABETES

Patient Characteristics	ACG System Outputs	Cost & Activity
Age/Sex:51/FemaleConditions:Diabetes mellitusIschemic Heart DiseaseHypertensionDisorders of Lipid MetabolismLow Back PainPeripheral NeuropathyCerebrovascular DiseaseCOPDAcute Lower Respiratory Tract InfectionAllergic RhinitisGingivitisOtitis MediaHearing LossChronic Cystic Disease of the BreastTobacco UseAbdominal PainSinusitis, Sleep Apnea, Contusions and Abrasions, Headache, Cough, Fatigue	ACG - 5070: 10+Other ADG Combinations, Age >17, 4+ Major ADGs 01 - Time Limited: Minor 02 - Time Limited: Minor- Primary Infections 03* - Time Limited: Major 04* - Time Limited: Major-Primary Infections, Allergies 05 - Likely to Recur: Discrete 07 - Likely to Recur: Discrete- Infections 08 - Likely to Recur: Progressive 09* - Chronic Medical: Stable 10 - Chronic Medical: Unstable Chronic 11* - Specialty: Stable - Orthopedic 12 - Chronic Specialty: Unstable - Orthopedic 16* - Chronic Specialty: Unstable - Chronedic 17 - Injuries/Adverse Effects: Minor 22* - Psychosocial:Time Limited, Minor 23 - Signs/Symptoms: Minor 30 - See/Reassure 31 - Prevention/Administrative	Total Cost: £25,000 GP Visits: 20 ED Attendances: 3 Hospital Admissions: 2

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EXPANDED DIAGNOSTIC CLUSTERS (EDC)

Expanded Diagnosis Clusters (EDCs): Groups of clinically similar diagnoses



284 groups that can be combined into 27 Major EDC categories of clinical conditions

- EDCs are groups of clinically similar diagnoses
- There are 284 groups that can be combined into 27 Major EDC categories of clinical conditions. For example:

Major EDCs (MEDC)	Code	EDC Description
Cardiovascular	CAR04	Congenital heart disease
Cardiovascular	CAR05	Congestive heart failure
Endocrine	END04	Thyroid disease
Endocrine	END06	Type 2 diabetes, w/o complication
Hematologic	HEM02	Iron deficiency, other deficiency anemias
Malignancies	MAL03	High impact malignant neoplasms
Malignancies	MAL04	Malignant neoplasms, breast
Musculoskeletal	MUS02	Acute sprains and strains
Musculoskeletal	MUS03	Degenerative joint disease
Psychosocial	PSY01	Anxiety, neuroses
Psychosocial	PSY02	Substance use
Respiratory	RESO4	Emphysema, chronic bronchitis, COPD
Respiratory	RES05	Cough

MEDC MEDC No. of EDCs Code ADM Administrative 4 ALL Allergy 5 CAR Cardiovascular 15 DEN Dental 4 EAR Ear, Nose, Throat 12 Endocrine END 7 EYE Eye 15 FRE **Female Reproductive** 14 GAS Gastrointestinal/Hepatic 14 GSI **General Signs and Symptoms** 8 GSU **General Surgery** 13 GTC Genetic 2 GUR Genito-urinary 24 HEM Hematologic 9 INF Infections 9 Malignancies MAL 17 Musculoskeletal 17 MUS Neonatal NEW 5 NUR Neurologic 23 NUT Nutrition 4 PSY Psychosocial 18 REC Reconstructive 4 REN Renal 6 RES Respiratory 13 RHU Rheumatologic 5 SKN Skin 20 **Toxic Effects and Adverse Events** тох 4

Please refer to the spreadsheet 'ACG Labels' for the complete list

- The Rx-MGs provide a medication-based approach for describing the morbidity profile of an individual or population that complements the use of diagnosis data
- The Rx-MG assignment methodology evaluates each unique active ingredient/route of administration combination along with four clinical dimensions of medication use:
 - Primary organ system affected by the medication

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- Morbidity differentiation, which refers to whether the medication is used to relieve symptoms or treat a specific disease
- Expected duration of targeted diseases as time-limited or chronic
- Severity of illness, which refers to the long-term stability of the targeted diseases
- There are 84 Rx-MGs. As an example:

Rx-MG	THREE COMMON INGREDIENT- ROUTES	RX-MG DESCRIPTION
Endocrine/Metabolic/ Chronic Medical	testosterone topical testosterone injectable fludrocortisone oral	long-term disturbances in endocrine systems, including inborn errors of metabolism
Endocrine/Metabolic/ Diabetes With Insulin	insulin glargine subcutaneous insulin aspart subcutaneous insulin lispro subcutaneous	type 1 or 2 diabetes treated with insulin
Endocrine/Metabolic/ Diabetes Without Insulin	metformin oral sitagliptin oral glipizide oral	type 2 diabetes
Endocrine/Metabolic/ Hypothyroidism	levothyroxine oral thyroid desiccated oral liothyronine oral	hypothyroidism

 Primary use in the UK is to identify individuals who are taking medication associated with a condition but do not have a diagnosis recorded in their record



The Patient Need Groups methodology allows segmentation and stratification of the population, using available markers and predictive models from the ACG system. There are three components:

Component 1: Patient Need Groups

Eleven (11) mutually exclusive population segments based on an individual's range of morbidities, conditions and care needs.

These segments are an extension of ACG's patient-centric methodology and the anchor of the PNG feature:

Component 2: Care Modifiers

An optional feature of the PNG tool, Care Modifiers are individual traits with opportunities for intervention. These offer actionable data points within each segment.

Component 3: Risk Stratification

An optional feature of the PNG tool, population segments can be stratified by predicted total cost risk level, allowing for nuanced understanding.



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ligh	Frailty	11 Frailty	Adults aged 65 and older with evidence of <u>2 or more frailty concepts</u>
Î	High Complexity; Multi-Morbidity	10 Multi-Morbidity, High Complexity	Multi-morbidity with <u>high complexity</u> (major and unstable chronic conditions)
	Dominant Chronic	09 Dominant Major Chronic Condition	Somatic condition with high impact on health, without treatment the condition is progressive and unstable over time
	Dominant Chronic	08 Dominant Psychiatric/Behavioral Condition	<u>Psychiatric condition with high impact on health</u> , without treatment the condition is progressive and unstable over time
	Pregnancy	07 Pregnancy, High Complexity	Pregnancy with or without delivery among women with high morbidity burden
		06 Pregnancy, Low Complexity	Pregnancy with or without delivery among women with low morbidity burden
		05 Multi-Morbidity, Medium Complexity	Multi-morbidity with moderate complexity conditions
	moderate needs	04 Multi-Morbidity, Low Complexity	Multi-morbidity with low complexity conditions
	Healthy	03 Low Need Adult	Adults aged 18 and older with acute morbidity and no more than one low complexity condition
		02 Low Need Child	Children aged 0 to 17 with <u>acute morbidity</u> and no more than one low complexity condition
ow		01 Non-User	Individuals who have <u>no diagnosis</u>

The "color coded" groupings of PNGs which can be nested together to form larger segments when appropriate

RISK FACTORS IN THE JOHNS HOPKINS MODELS



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Concurrent risk

- Age-gender
- Local ACG concurrent
- Reference ACG concurrent
- Concurrent risk (regression-based)

Predictive cost risk

- Predicted cost
- Rank probability
- Reference probability
- Persistent high user
- High risk unexpected pharmacy cost

Hospitalization risk

- Inpatient admission
- Injury
- Readmission
- ICU
- Extended stay



Thank You



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