



Maximize the Usage of Current Modeling Tools to Determine More Accurate Patient Selection

Innovative Strategies in Predictive Modeling
February 13, 2007
Linda Dunbar PhD

Background

- Diagnosis-based predictive models are well beyond the proof of concept stage as a means to identify high risk cases for care management, especially those cases that have yet to become costly.
- Never-the-less, even the best models also include a substantial number of false positives (cases predicted to be high risk that don't become high risk).
- False positives can be expensive, tying up critical case finding resources and potentially leading to unnecessary interventions.
- This presentation explores how other data can increase the case finding "yield" of predictive models especially in difficult populations such as Medicaid enrollees and also shows *how that information provides useful clinical context for case identification and planning.*

Goals of this Presentation

1. To discuss approaches for the integration of multiple data sources into a comprehensive care management assessment and patient selection tool.
2. To present the success of a real-world program of integration of multiple data sources at Johns Hopkins HealthCare.
 - To discuss the roles and workflows necessary for the success of such programs.



Johns Hopkins University (JHU)

Johns Hopkins Health System (JHHS)

Johns Hopkins HealthCare (JHHC)

Care Management

- Care Management
- Outcomes Research
- Utilization Management
- Referral Management
- Outreach
- Disease Management
- Pharmacy Management
- Health Education

Operations

- Claims Mgmt.
- Customer Service
- Enrollment Mgmt.
- Systems Mgmt.
- Reporting
- Decision Support

Network Management

- Contracting
- Credentialing
- Provider Relations
- Provider Education
- Fee Schedules

Organizational Support Services

- Training/Performance Improvement
- Client Relations
- Human Resources
- Business Development
- Finance



**US FAMILY
HEALTH PLAN**
Caring for our Uniformed Services Family



23,000

116,000

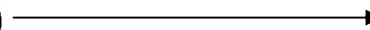


**PRIORITY
PARTNERS**

A MANAGED CARE ORGANIZATION FROM JOHNS HOPKINS
AND THE MARYLAND COMMUNITY HEALTH SYSTEM



JOHNS HOPKINS
EMPLOYER HEALTH PROGRAMS



56,000

Care Management Programs

End Stage Renal Disease

Behavioral Health

HIV/AIDS

Substance Use

Guided Care

End of Life Care

Partners with Mom

Rehabilitation

Cardiovascular/Diabetes

Complex Medical Needs

TeleWatch

Children with Special Needs



Historical Population Case Finding

- Financial prioritization:
 - Prior period healthcare expenditures
 - Medical Loss Ratio of certain populations
- Referrals to individual case managers from:
 - Utilization management staff
 - Providers: Multiple points of contact in CM department
 - Local Health Department in the State of Maryland
 - Outreach department
- Result:
 - Case managers using individual discretion to determine caseloads
 - Often acute episode follow-up; no clear ongoing need for intervention

Motivation for Change

- Published literature
 - Increasing Evidence that threshold-based models are inadequate for case finding and can lead to misallocation of resources, inefficiencies, and missed opportunities (Cousins MS, Shickle LM, Bander JA (2002), An introduction to predictive modeling for disease management risk stratification, Disease Management, 5(3), 157-67.)
 - Evidence that Adjusted Clinical Groups Predictive Model (ACG-PM) and similar predictive models perform better than threshold-based models (ACG Virtual Library: Version 5.0 (December 2001) ACG Software Documentation/Users Manual. www.acg.jhsph.edu.)
- Internal population analysis
 - Higher sensitivity and positive predictive value for ACG-PM versus “threshold-based” selection
- Pilot studies: “clinical cogency” of ACG-PM
 - Older Adults with multi-morbidity
 - Substance abuse with multi-morbidity and complex needs

Older Adults with High ACG Scores

- Care Management for Older adults
 - In response to rising costs and multiple healthcare needs
- Care Management interventions must be accurately targeted to older adults with two characteristics:
 - At high risk for healthcare expenditures
 - Clinical needs could be mitigated by clinical intervention
- The ability of ACG-PM risk scores to predict older persons' use of and costs of healthcare have been validated, however the clinical features of persons with high ACG-PM scores have not been described.*

Sources: Reid et al., Med Care, 2001.
Reid et al., Health Serv Res, 2002.
Adams et al., Health Care Financ Rev, 2002.

Selection Algorithm Older Adults

USFHP currently enrolled
Age \geq 65 at Wyman Park Medical Center
n=826



Classified top 18% as high-risk
n = 150



Analyzed administrative data
(demographics, use and costs of services)
Conducted a supplemental
survey of high-risk enrollees
(Sociodemographics, general health, bed disability days)

Demographic and Social Characteristics of Older Adults

Demographic and Social Characteristics of High- and Low-risk Enrollees			
Demographics	<i>Low-risk, n = 676</i>	<i>High-risk, n = 150</i>	<i>p value</i>
Age, years	74.4	76.0	0.015
Age group			0.051
65-74 years	56.8%	48.6%	
75-84 years	36.2%	40.7%	
85+ years	7.0%	10.7%	
Female sex	57.4%	54.7%	0.541
White race	43.0%	54.7%	0.038

Source: Sylvia et al., Disease Management, 2006.

Clinical Characteristics of Older Adults

<i>Disease Prevalence</i>	<i>Low-risk n = 645</i>	<i>High-risk n = 150</i>	<i>p value</i>
Ischemic heart disease	15.3%	51.3%	< 0.001
Congestive heart failure	2.2%	29.3%	< 0.001
Hypertension	74.6%	88.0%	< 0.001
Diabetes	7.1%	26.0%	< 0.001
Osteoarthritis	30.4%	44.7%	< 0.001
COPD	7.0%	22.0%	< 0.001
Depression	4.8%	15.3%	< 0.001
Dementia	4.7%	12.0%	< 0.001
Parkinson's Disease	1.9%	4.0%	0.113
Number of chronic conditions (of the list of nine above)	1.48	2.93	< 0.001

Clinical Characteristics of High-risk Survey Respondents

Clinical Characteristics of High Risk Older Adults	
	Survey Respondents, n = 120
Health status ^a : general health	
Excellent	2.5%
Very good	20.2%
Good	34.5%
Fair	36.1%
Poor	6.7%
Functional ability ^a	
Difficulty in performing at least one of five ADLs ^b	36.3%
Difficulty in performing at least one of seven IADLs ^c	58.1%
Any bed disability days in the past 6 months	38.7%
Any restricted activity days in the past 6 months	52.3%

^a Data available only for survey respondents.

^b Activities of Daily living (ADLs): bathing, dressing, eating, getting in and out of chairs, toileting.

^c Instrumental Activities of Daily Living (IADLs): using the telephone, doing housework, taking medications, getting to places beyond a walking distance, preparing meals, shopping, managing money.

Use of Services in Older Adults

<i>Use of Services</i>	<i>Low-risk, n = 676</i>	<i>High-risk, n = 150</i>	<i>p value</i>
Mean hospital admissions per year	0.13	1.13	<0.001
Mean hospital days per year	0.51	7.34	<0.001
Mean total expenditures per year	\$3,726	\$22,185	<0.001

Results of Study in Older Adults

- Older persons with high ACG-PM scores:
 - Have a higher prevalence of chronic disease
 - Considerable functional disability
 - Suboptimal general health
 - At risk for generating high healthcare expenditures
 - Clinical features appear amenable to clinical interventions (such as disease and case management) designed to optimize health and functional status and to contain healthcare costs

ACG-PM to Select Medicaid Enrollees with Substance Use Problems (SUP)

- All Claims for the determined time period inputted into the ACG grouper software
- ACG grouper software assigned a probability score to every enrollee that represented their probability of being in the top 5% of high utilizers in the next year(s)
- Algorithm using diagnoses and ACG-PM score used to select enrollees for intervention

Selection Algorithm

Substance Use

Medicaid currently enrolled,
Age \geq 21, geographic criteria
n=14,624



Positive for substance use using ICD-9
and CPT criteria, exclusions removed
n=3123

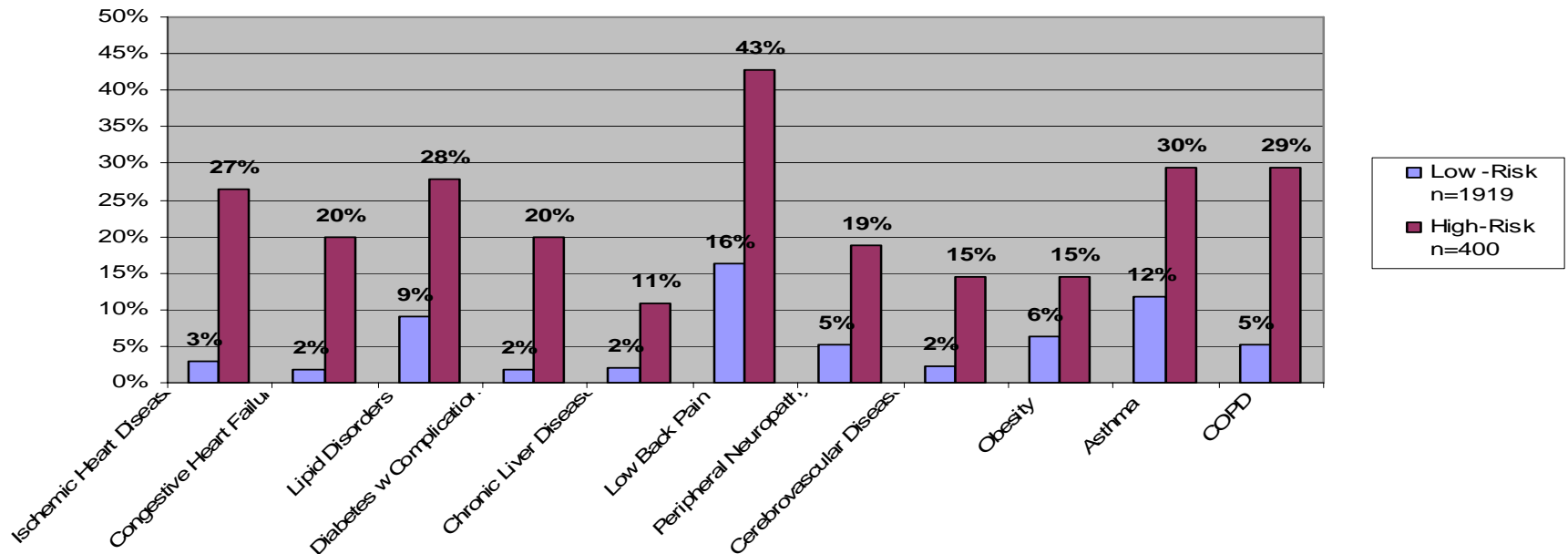


Ranking on ACG-PM Score
Top 400 chosen for intervention

ACG-PM range = 0.39 to 1.00

High-risk SUP Enrollees had a Higher Prevalence of Selected High Cost Medical Conditions than Low-risk SUP Enrollees

Disease Prevalence of Selected Medical Conditions
 $p < 0.001^{1,2,3}$

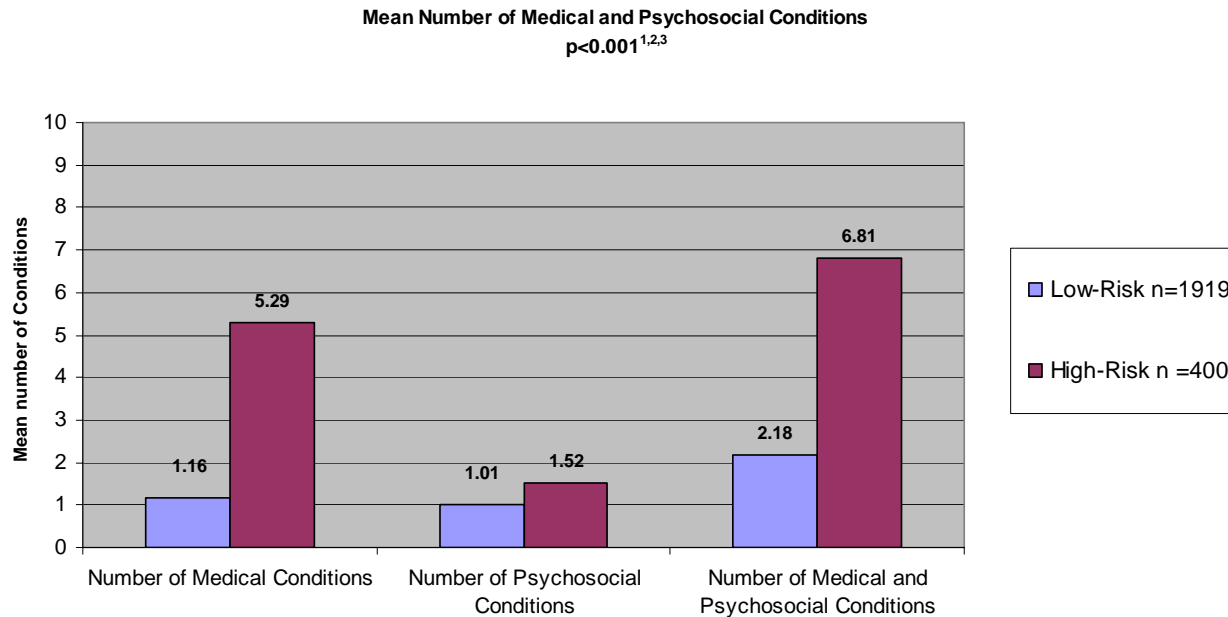


¹ 52 chronic medical conditions and 7 psychological conditions using Expanded Diagnostic Clusters (EDCs, which are part of the ACG toolkit). These conditions were chosen because of their high cost and amenability to intensive clinical intervention

² p calculated using chi-square

³ n=1919 represents number of members disease categories were assigned for out of the total n=2085.

High-risk SUP Enrollees had More Medical and Psychosocial Conditions than Low-risk SUP Enrollees

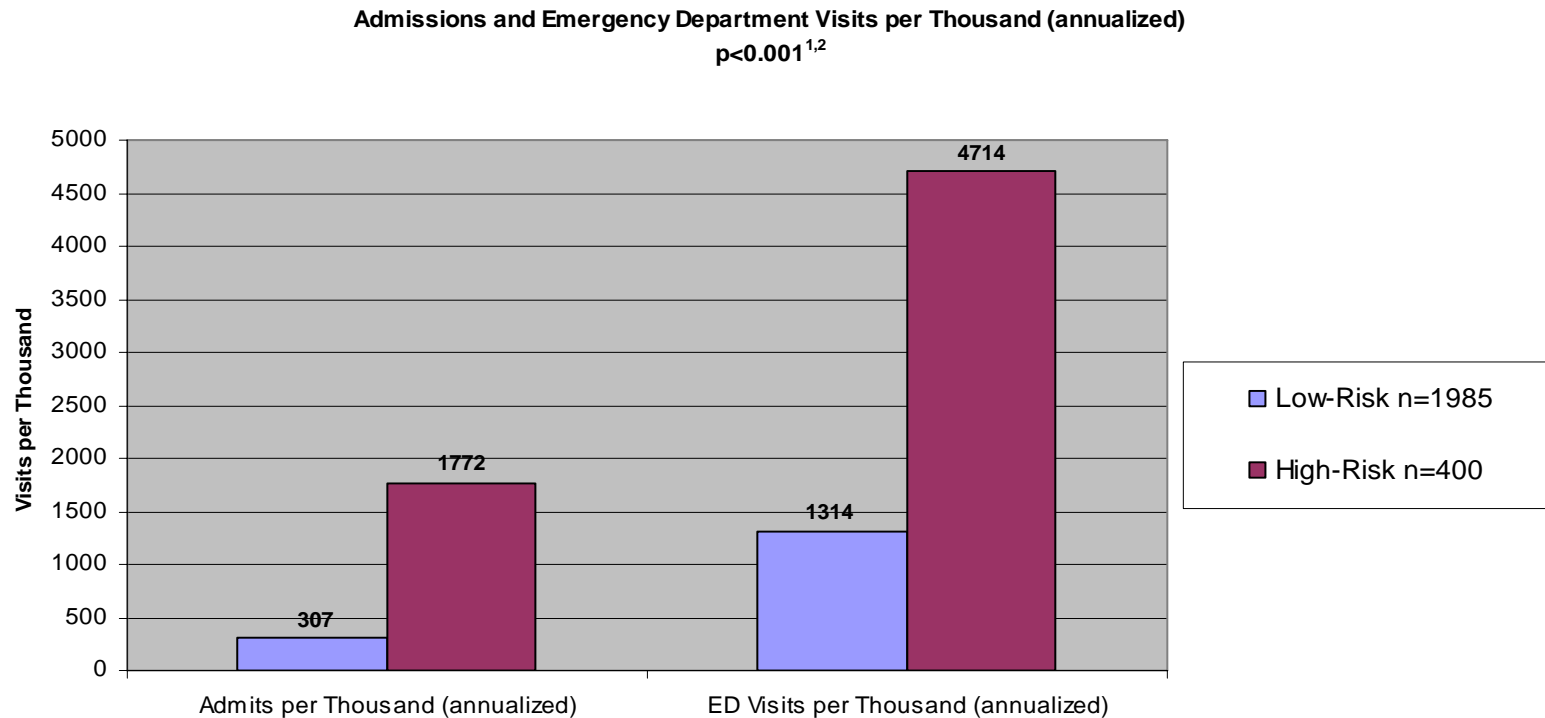


¹ 52 chronic medical conditions and 7 psychological conditions were analyzed using Expanded Diagnostic Clusters (EDCs, which are part of the ACG toolkit). These conditions were chosen because of their high cost and amenability to intensive clinical intervention

² p calculated using Mann-Whitney-U (non-parametric). Did not meet assumption of equal variances necessary for t-test.

³ n=1919 represents number of members disease categories were assigned for out of the total n=2085.

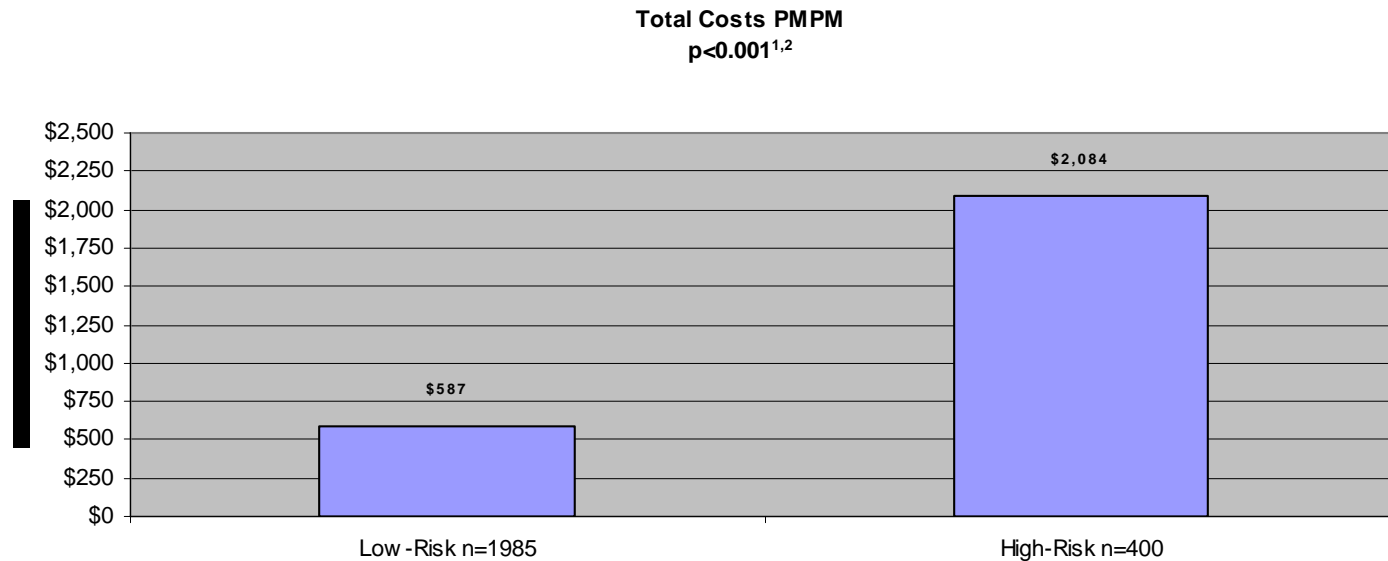
High-risk SUP Enrollees had More Admissions and ED Visits than Low-risk SUP Enrollees



¹ p calculated using Mann-Whitney-U (non-parametric). Did not meet assumption of equal variances necessary for t-test.

² n=1985 represents number of members claims data available for out of the total n=2085.

High-risk SUP Enrollees had Higher Total Costs than Low-risk SUP Enrollees



¹ p calculated using Mann-Whitney-U (non-parametric). Did not meet assumption of equal variances necessary for t-test.

² n=1985 represents number of members claims data available for out of the total n=2085.

Characteristics of the SUP/High ACG-PM Enrollees

- Compared to low-risk SUP enrollees, high-risk SUP enrollees identified by ACG-PM
 - Had higher prevalence of 52 chronic medical conditions
 - Had a higher average number of medical conditions
 - More hospital admissions
 - More hospital days
 - More ER visits
 - Higher pharmacy costs
 - Higher total Costs

Integrating ACG-PM into Daily Operations

- Intensive staff education
- Disseminating information: ACG files available to all who have been trained
- Enhancements to Decision Support and IT systems
- Clinical screener role
- Clinical screener toolkit

Decision Support/IT Systems

General Info | Enrollment Info | **Screening** | HRA | Screening Status | Contacts | Referrals | Print

Case Manager:

High Utilizer:

Begin Date	End Date	ID Source
9/9/2004		acgPM Score >= .3

Inclusion Criteria (ID'd from claims):

Criteria	Date Added
Cardiovascular Disease	4/21/2003 7:09:00 AM
HBP	11/7/2003 8:51:00 AM

Diagnosis Criteria Met (ID'd from claims):

Date Stamp	DX Code	Diagnosis
4/15/2003 10:31:00 AM	401.1	BENIGN HYPERTENSION
4/15/2003 10:31:00 AM	401.9	HYPERTENSION NOS
4/15/2003 10:31:00 AM	I12.9	ANGINA PECTORIS MEDIANOS

DM Program Enrollment:

Program	CaseMgr	Status	StatusDate
DM SCREENING	Not Assigned	Inactive	

Claims Data

Claims | acgPM | EDC

Adjusted Clinical Groups - Predictive Score

BeginPdDate	EndPdDate	ACGPMScore
1/1/2003	12/31/2003	0.42
1/1/2002	12/31/2002	0.62
1/1/2001	12/31/2001	0.42

Close

Save Member Info | Find Existing Member | Lookup New Member | Open QBF | Add To Current Group

Form View

Decision Support/IT Systems

General Info | Enrollment Info | Screening | HRA | Screening Status | Contacts | Referrals | Print

Case Manager:

High Utilizer:

Begin Date	End Date	ID Source
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4/15/2003 10:31:00 AM	401.1	BENIGN HYPERTENSION
4/15/2003 10:31:00 AM	401.9	HYPERTENSION NOS
4/15/2003 10:31:00 AM	413.9	ANGINA PECTORIS, NEC/MOS

DM Program Enrollment:

Program	CaseMgr	Status	StatusDat
DM SCREENING	Not Assigned	Inactive	

Claims Data

Claims | acgPM | EDC

Expanded Diagnostic Clusters

Major

BeginPdDt	EndPdDt	MajorEDC
1/1/2003	12/31/2003	MUSCULOSKELETAL
1/1/2003	12/31/2003	NEUROLOGIC
1/1/2003	12/31/2003	UNASSIGNED
1/1/2002	12/31/2002	ADMINISTRATIVE
1/1/2002	12/31/2002	CARDIOVASCULAR
1/1/2002	12/31/2002	FEMALE REPRODUCTIVE
1/1/2002	12/31/2002	GASTROINTESTINAL/HEPATIC
1/1/2002	12/31/2002	GENERAL SURGERY

(Note: Click on a major category to view the associated minor categories)

Minor

- Cardiac Arrhythmia
- Cardiomyopathy
- Cardiovascular Signs and Symptoms
- Congestive Heart Failure
- Heart Murmur

Close

Save Member Info | Find Existing Member | Lookup New Member | Open QBF | Current Group

Form View NUM

Clinical Screener: A New Nursing Role for Johns Hopkins HealthCare

- Registered Nurse
- Managed care and clinical experience
- Proactive screening of enrollees identified by ACG-PM as potential high utilizers
- Continued screening members referred by traditional sources
- Complete Care Management Assessment and make referral to appropriate program

Clinical Screener Toolkit

- ACG-PM: Predictive Modeling
- Diagnoses
- Utilization
- Clinical indicators: lab and radiology results
- Clinical assessment: telephone contact
- Disease/case management amenability assessment

ACG Lookup Database



The image shows a software window titled "Search Historical ACG". It features three search tabs: "Search by Last Name", "Search by Mem ID", and "Search by acgPM". The "Search by acgPM" tab is selected. Below the tabs are three dropdown menus. The first dropdown is labeled "Choose acgPM Lower" and has the value "0.8". The second dropdown is labeled "Choose acgPM Upper" and has the value "1". The third dropdown is labeled "Choose ACG Period" and has the value "1/1/2004".

Search Method	Lower Bound	Upper Bound	ACG Period
Search by Last Name			
Search by Mem ID			
Search by acgPM	0.8	1	1/1/2004

ACG Lookup Database

Pd Begin	Pd End	PCP	Aid Code	Aid Code Desc	County	Zip
1/1/2002	12/31/2002	CHASE BREXTON HEALTH SERVICE:	BC316	SSI	BALTIMORE CITY,MD	21229
4/1/2002	3/31/2003	CHASE BREXTON HEALTH SERVICE:	EC011	SSI	BALTIMORE CITY,MD	21229
7/1/2002	6/30/2003	CHASE BREXTON FULL RISK (H)	BC497	SSI	BALTIMORE CITY,MD	21229
10/1/2002	9/30/2003	CHASE BREXTON FULL RISK (H)	BC497	SSI	BALTIMORE CITY,MD	21229
1/1/2003	12/31/2003	CHASE BREXTON FULL RISK (H)	BC497	SSI	BALTIMORE CITY,MD	21229
4/1/2003	3/31/2004	CHASE BREXTON FULL RISK (H)	BC497	SSI	BALTIMORE CITY,MD	21229
7/1/2003	6/30/2004	CHASE BREXTON FULL RISK (H)	BC497	SSI	BALTIMORE CITY,MD	21229
10/1/2003	9/30/2004	CHASE BREXTON FULL RISK (H)	BC497	SSI	BALTIMORE CITY,MD	21229
1/1/2004	12/31/2004	CHASE BREXTON	BC497	SSI	BALTIMORE CITY,MD	21229

Record: 1 of 1

ACG Lookup Database

Priority Partners ACG Lookup

emos | Historical ACG | Historical Admits/Visits | Historical Flags | Current EDC | Current Address

Pd Begin	Pd End	Major EDC	MEDC_Desc
1/1/2004	12/31/2004	END	Endocrine
1/1/2004	12/31/2004	GSU	General Surgery
1/1/2004	12/31/2004	INF	Infections
1/1/2004	12/31/2004	MUS	Musculoskeletal
1/1/2004	12/31/2004	NUR	Neurologic
1/1/2004	12/31/2004	PSY	Psychological
1/1/2004	12/31/2004	RES	Respiratory
1/1/2004	12/31/2004	SKN	Skin
1/1/2004	12/31/2004	UDC	Unassigned

EDC Detail

EDC_Code	EDC_Desc
PSY01	Anxiety, Neuroses
PSY02	Substance Use
PSY06	Family and Social Problems

Record: 1 of 1

Form View NUM

Referral from Screener to Disease/Case Manager

Member Contacted: Yes

Date Member Contacted: 1/11/2005

Member Consent to CM: Yes

IP Utilization:

AcgPM Score: 0.94

multiple admits and OP surgical procedures for wound debridement. See IDX for clinical details.

EDC Descriptors:

car03 - Ischemic Heart Disease (excl AMI)
car05 - Congestive Heart Failure
car06 - Cardiac Valve Disorders
car07 - Cardiomyopathy
car09 - Cardiac Arrhythmia
car10 - Generalized Atherosclerosis
car11 - Disorders of Lipoid Metabolism
car12 - AMI
gsu11 - Peripheral Vascular Disease
nur05 - Cerebrovascular Disease
res04 - Emphysema, Chronic Bronchitis, COPD

ED Utilization:

1 ER visit for swollen legs in 7-04.

Member Referred to: Complex Medical Team

Date Referred: 1/11/2005

General Comments:

Referral Source Notified: Yes

Referral from Screener to Disease/Case Manager

Yale Social Isolation Responses:

1. Are you married? Divorced, Widowed, Never married
2. Who were you living with before you came/went to the hospital? Lives alone
3. Is there someone you can count on for help and support when you need it? Yes, 1 or more local adults
4. Emergency contact status: Yes, emergency contact name/number given or listed in medical record WITHIN 410 area code

YSI Comments:

Member lives alone but has a daughter who visits daily.

Instrumental Activities of Daily Living Responses:

Q1. Because of a health or physical problem, how much difficulty do you have doing these activities without the assistance of another person or a special device:

- | | | | |
|--------------------------------|----------------------------|--|----------------------------|
| A. Bathing | <u>Some difficulty</u> | H. Doing housework | <u>A lot of difficulty</u> |
| B. Dressing | <u>Some difficulty</u> | I. Taking medications | <u>Some difficulty</u> |
| C. Eating | <u>Some difficulty</u> | J. Getting to places beyond walking distance | <u>A lot of difficulty</u> |
| D. Getting in or out of chairs | <u>Some difficulty</u> | K. Preparing your own meals | <u>Some difficulty</u> |
| E. Walking across a small room | <u>A lot of difficulty</u> | L. Shopping | <u>A lot of difficulty</u> |
| F. Using the toilet | <u>Some difficulty</u> | M. Managing money like keeping track of expenses or paying bills | <u>Some difficulty</u> |
| G. Using the telephone | <u>Some difficulty</u> | | |
-

Referral from Screener to Disease/Case Manager

Q2. In the past 6 months, how many days did you stay in bed for more than one-half day because of illness or injury? 10

Q3. In the past 6 months, not counting the days you spent in bed, how many days did you cut down on things you usually do because of illness or injury? 50

Q4. On a Scale of 0 (No Burden at all) to 5 (Very High Burden),
How great a BURDEN is:

A. Taking Medications as Recommended	<u>2</u>	C. Following Dietary Recommendations	<u>3</u>
B. Visiting Health Care Providers	<u>4</u>	D. Following Exercise Recommendations	<u>N/A</u>

Q5. On a Scale of 0 (Not Confusing at all) to 5 (Very Confusing),
How CONFUSING is:

A. Taking Medications as Recommended	<u>1</u>	C. Following Dietary Recommendations	<u>2</u>
B. Visiting Health Care Providers	<u>1</u>	D. Following Exercise Recommendations	<u>N/A</u>

Q6. Many people cannot do everything their health care providers recommend.
How often do you:

A. Take your medications as recommended	<u>4 - Most of the time</u>	C. Follow exercise recommendations	<u>N/A</u>
B. Keep your health care appointments	<u>4 - Most of the time</u>	D. Follow dietary recommendations	<u>2 - Sometimes</u>

Building a Better Mousetrap:

Improving current risk adjustment models

- **Develop a sequenced process by using one or more of the *risk scores* to define a large at-risk group; then ,for this larger group, identify the *care management opportunities* for each patient.**
 - The Diagnosis-Rx-PM with a total health care costs model, which is one of the several new ACG predictive models.
 - Combines the old ACG-PM score, the new Rx-PM score, and prior costs in order to cover need, demand, and supply.
 - Model has superior performance to any of the individual models alone
 - An excellent 1st step screener
 - Consideration of a generous cut-point; perhaps the tangent to the ROC curve (i.e., where True Positive rates are maximized while minimizing False Positive rates)
 - Disease-specific cut-points when it makes sense
 - For Medicaid, determine if the use of program eligibility (SSI specifically) adds to the predictive performance of the combined model

Positive Predictive Value and Sensitivity at Top 5% Predicting Cost

	PPV	Sensitivity	Area Under ROC Curve
RX only model no Mental Health (MH)	45.09%	45.11%	.835
RX-DX-PM model no MH	46.44%	46.48%	.883
RX only model with MH	46.08%	46.08%	.850
RX-DX-PM model with MH	47.85%	47.85%	.889

Medicaid population results, 2005

Building a Better Mousetrap: Care Management Opportunities Measures

Excessive Demand	Low ACG-PM score with (a) high total health care costs or (b) high numbers of physician visits. (Top quartile for high and the bottom quartile for low)
Polypharmacy	2+SD (or top quartile) above the mean within the patient's ACG category for number of therapeutic classes.
Excessive specialist use	2+SD (or top quartile) above the mean within the patient's ACG category for specialist visit charges.
Excessive referrals (doctor shopping?)	2+SD (top quartile) above the mean within the patient's ACG category for the number of specialist types seen.
Excessive ED use	2+SD above the mean within the patient's ACG category for ED visit charges.
Excessive radiology/imaging use	2+SD above the mean within the patient's ACG category for imaging study charges.

Building a Better Mousetrap: Care Management Opportunities Measures

No PCP No medical home	No visits made during the year to a primary care provider
Low primary care visits	Lowest quartile for primary care visits (count) within the patient's ACG category
Poor continuity of care	Lowest quartile for the Modified-Modified Continuity Index (MMCI)
Specialist is the majority of care	Plurality of visits (using E&M codes) were made to a specialist physician
Avoidable hospitalization	1+ hospitalizations that could have been avoided had appropriate primary care been delivered (ACSC)
High coordination of care need	3+ chronic conditions & (substance abuse, schizophrenia, or bipolar disorder)
Possible access barriers	Low utilization (lowest quartile for patient's ACG) with high PM risk (highest quartile)

Ultimate Goal: Moderate the acuity and cost for members

- Identification and assessment of patients with high Care Management needs
- Case Managers must be provided with an actionable list of needs, such as
 - Lack of primary care and medical home
 - Low continuity of care
 - Overuse/underuse of services
 - Polypharmacy
 - Quality of care gaps
- Focus on modifying psycho-social drivers of morbidity
 - Patient Activation Measure (knowledge and skills for self-management)
 - Deficits in Chronic disease self-management
 - Mental health/ substance use
 - Homelessness

Questions

- Contact information

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