U.S. Department of Veterans Affairs

Targeting Home and Community Based Care to Veterans at Greatest Need: Incorporating CAN into GEC High Needs High Risk v2

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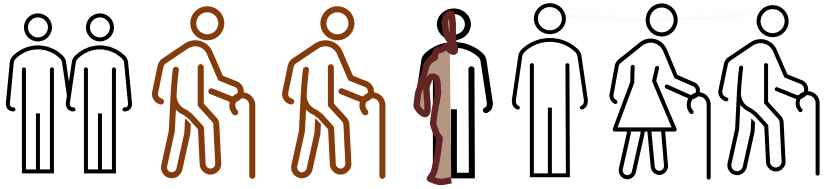
High Need High Risk Version 2 (HNHR2)

Modeled to identify LTI risk, also identifies high cost, hospital use, and death



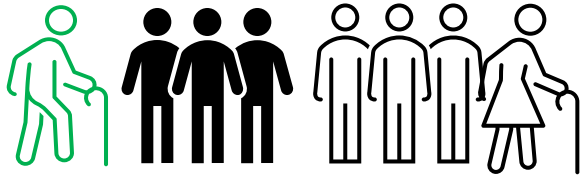
Less than 30% of Veterans entering nursing homes receive help to remain in the community prior to NH placement

1% of Veterans reside long term in institutions

High Need High Risk v2 uses VA and Medicare diagnoses, demographics, health care use, and risk measures for frailty to identify the 1% who will enter a NH long term.

HNHRv2 identifies in 4% of VA users nearly 40% of new long term institutionalization; 19% of new spending, 22% of deaths

For every 8 Veterans identified at High Risk, in the next 2 years 3 will die, and 1 will enter a NH long term



HNHR2 Background: RECAP

I. Over 90% of Americans prefer to stay in their homes as they age instead of nursing homes

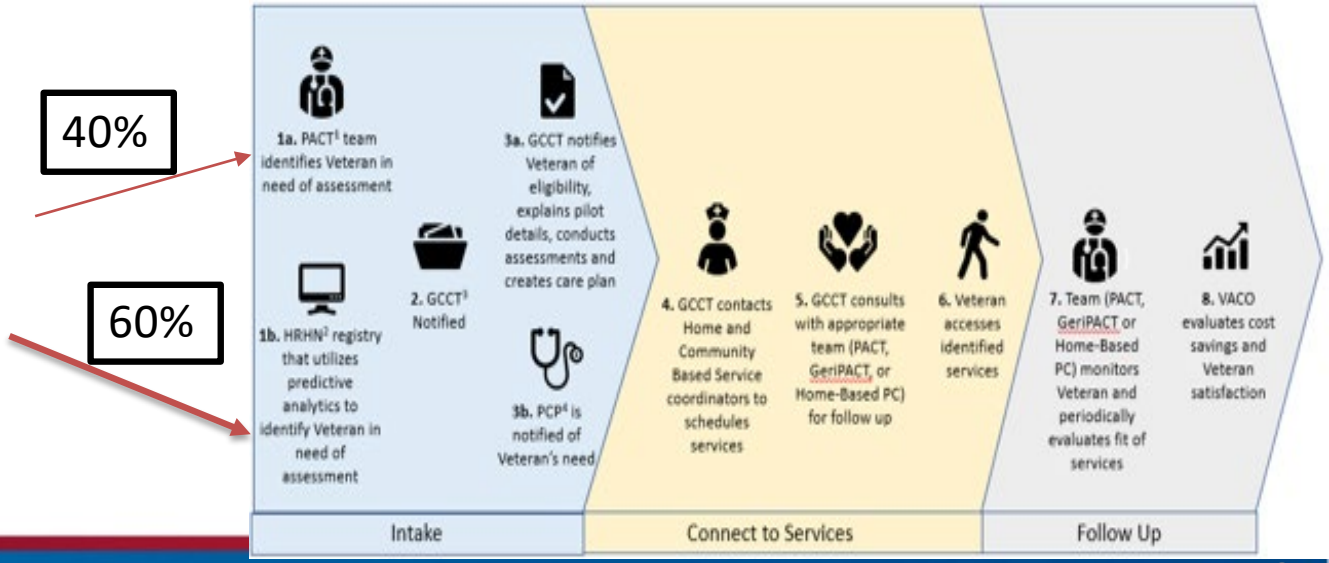
RECAP Pilot Goal: Honor Veteran preference for care in the home and prevent unnecessary nursing home care

II. Between 2017 and 2037, it is projected:

A.# VHA enrollees > 85years old will increase by 70.5% (n = 434,235)

B.# CNH beds will increase by additional 8,080 beds/year (2019 Long-stay CNH=9,627)

HNHR2 identified Veterans to augment usual clinical referral pathways for Non-Institutional Care

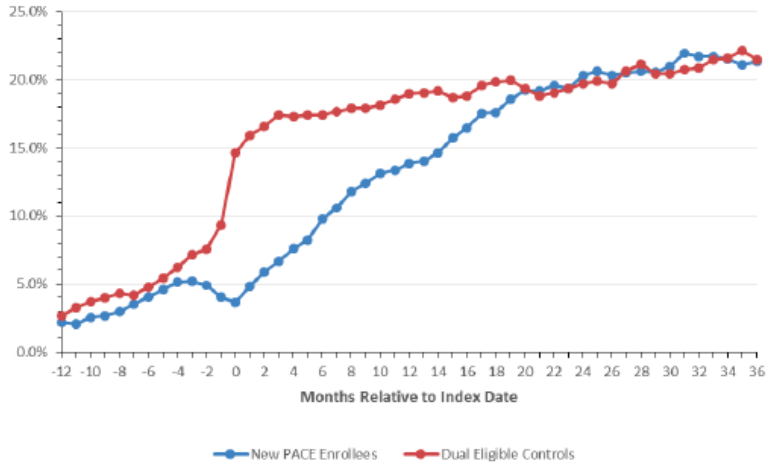


Delay in Nursing Home Months, not prevention

Massachusetts PACE study* (2007-2013)

Matched incident cohort PACE & HCBS community controls;

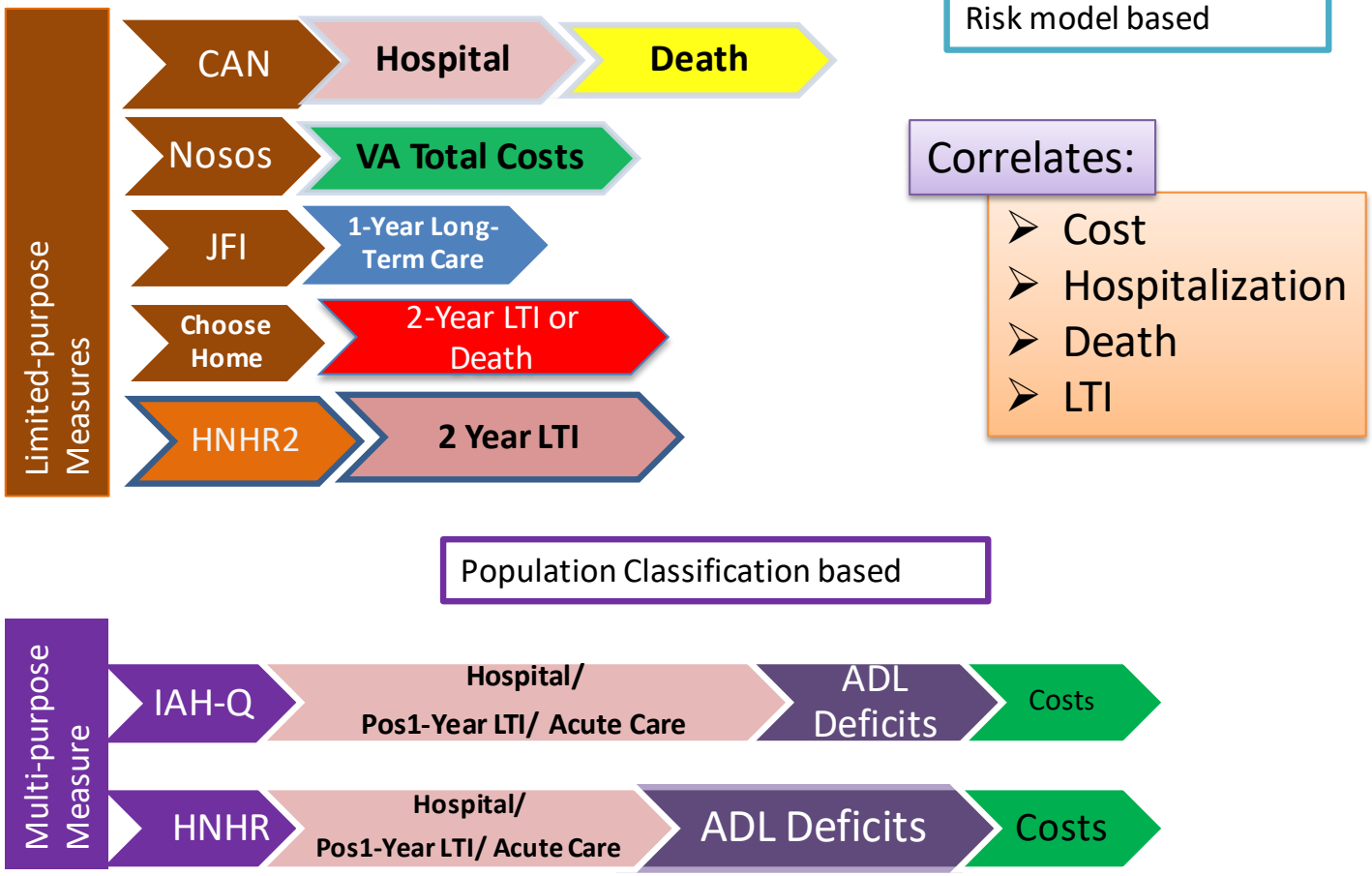
- 28% reduction (4.8 months/100) in NF residency
- 38% reduction in NF residency per patient.
- Cost of avoided NH months over 9% of LTSS spend



	PACE Enrollees	Matched LTSS Controls
N (F/U months)	3,456 (111,970)	3,456 (115,698)
Total NH months	15,629	21,732
Mean NH Months/NH resident	13.3	21.2
Mean NH months/beneficiary	4.5	6.3

*JEN Associates, 2016

Current VA Risk Tools



Limits of Current Tools

- Impact is determined by the % of actual LTI identified.
- Positive predictive value (PPV) for LTI is low.
- Efficiency of ADLs and JFI identify groups with high and low risks for LTI but most don't experience LTI
- Efficiency of HCBS is determined by PPV

High PPV doesn't always equal high impact.

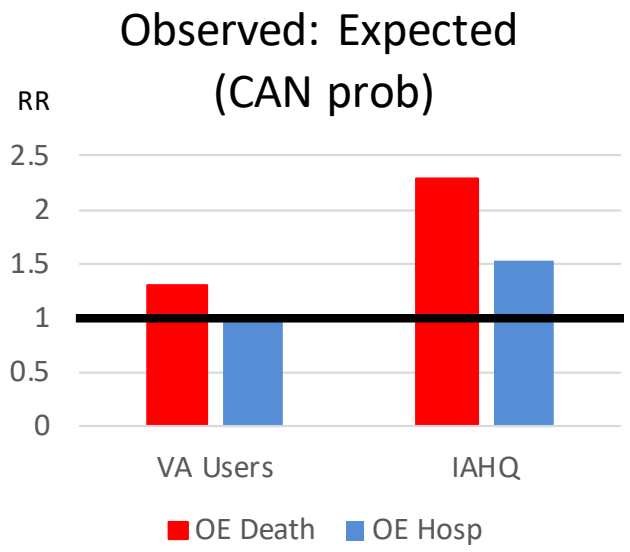
- LTI Prevalence is low (~ 1%)

Positive Predictive Value (PPV)= % of identified high risk who experience LTI

Full Population Risk Rules
Under-predict Events in Higher-risk Sub-Populations

Example CAN and IAH-Q:
Within IAH-Q Population, CAN Under-predicts Death and Hospitalization FY 2016

Pop	N	CAN: Expected deaths	Observed Deaths	CAN: Expected VA Hospital-izations	Observed VA Hosp
VA users	6.3M	140,581	185,417	550,204	546,283
IAH-Q	452,247	35,501	81,533	100,083	153,647



Target Population

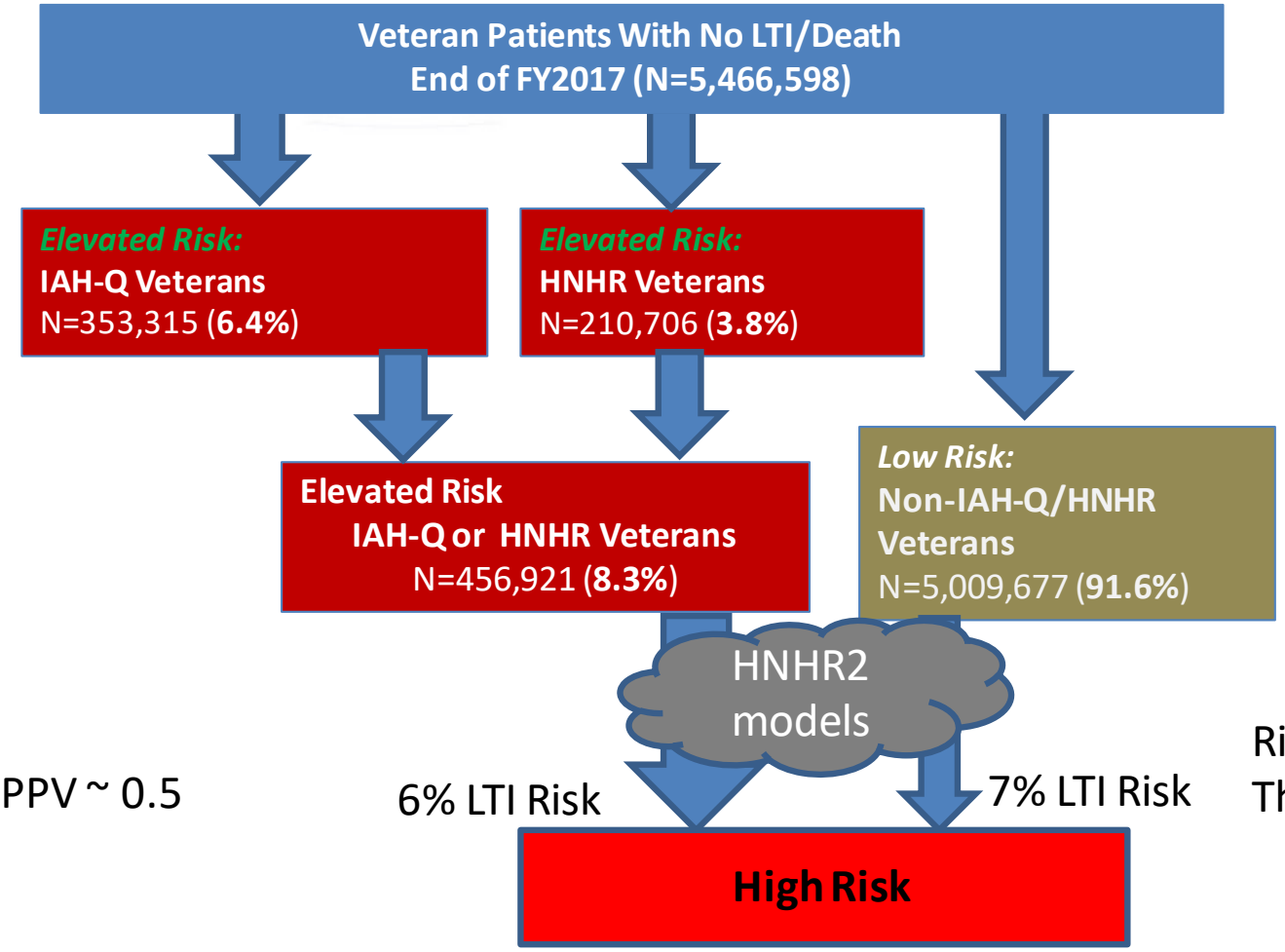
- All FY17 Veteran VA users with 1+ Face to Face VA Diagnosis age 17-110, VA costs >$0 alive at the end of year.

Exclusions:

- CNH+SVH+CLC utilization >90 days during index year,
- Patients with any Residential History File (RHF)-defined LTI episode during index year
- Patients in VA inpatient/outpatient hospice or in CLC/SVH/CNH on first day of FY.
- **Outcome** is 2-year Residential History File -defined LTI

Total Vets in model data	5,466,598
Total LTI in model data	62,056
Total death in model data	371,607
Total death not LTI	309,551

Approach to High Risk LTI Identification



Targets:
NNS ~ 8
Death/LTI PPV ~ 0.5

Risk Thresholds

"Choose-Home" ➔ VA HNHR2…

Model	Threshold: high risk, not high risk, (LTI only in some models)	Model chosen population based on threshold	Model identified LTI 2yr	Sensitivity % LTI	Positive Predictive Value (Death & LTI)	Number Needed to Screen for 1 LTI
Modlel 0 VA data only, VA LTI predict 2-yr death or LTI	0.5 (PPV for LTI or death)	66,913	3,986	0.06	0.49	16.8
Model 1. CH model with 1-year look-back, VA data only, RHF LTI, predicting LTI	0.07	118,061	14,340	0.23	0.5	8.2
Model 2. Add 2 part model stratification to CH model	.07/.07	157,158	18,761	0.3	0.47	8.4
Model 3a. Add other covariates and expand ICD code list for Dx	.07; .07	157,818	18,719	0.3	0.46	8.4
Model 3b. Add VA JFI	.07/.07	158,153	18,788	0.31	0.47	8.4

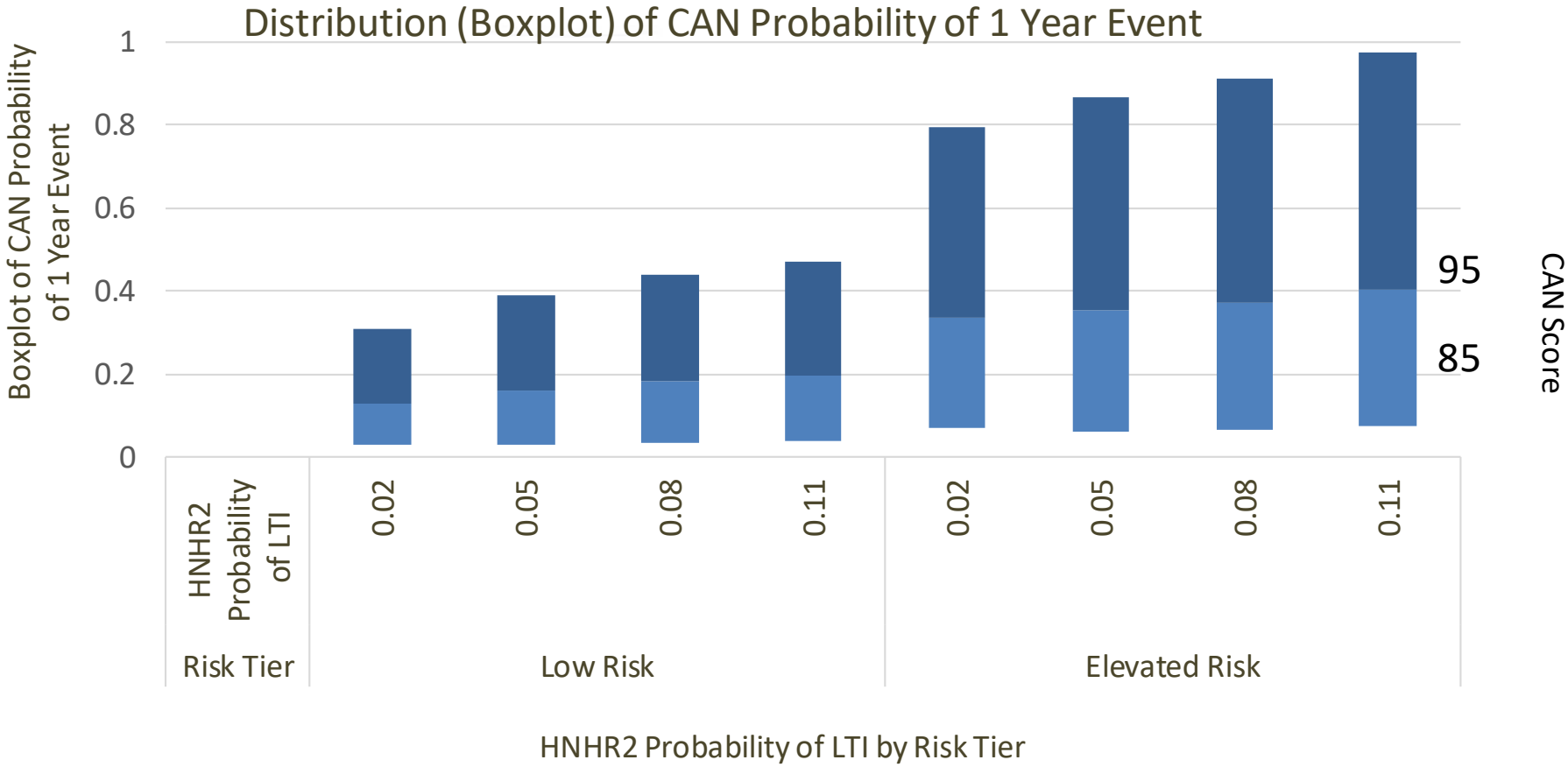
+Medicare DX → HNHR2 Production

Model	Threshold: high risk, not high risk, (LTI only in some models)	Model chosen population based on threshold	Model identified LTI 2yr	Sensitivity % LTI	Positive Predictive Value (Death & LTI)	Number Needed to Screen for 1 LTI
Model 4 Add in MC data for medical comorbidities (1-year look-back) and use JFI MCVA	.07; .07	161,955	20,615	0.33	0.48	8.1
Model 5a. 2-year lookback, 6-month lagged IAHQ and JFI; used 1-year IAHQ indicators from GCF.	.07;.07	162,835	21,099	0.34	0.47	7.7
Model 5b. Add VAMC fixed effects	.07;.07	162,998	21,106	0.34	0.47	7.7
Model 5b. Add VAMC fixed effects –split threshold	.06;.07	183,624	22,705	0.37	0.46	8.1
Model 6. Above, w Max JFI prior 12 mo.	.06;.07	183,386	22,703	0.37	0.46	8.1

Segments w Split Thresholds raises sensitivity ~ 25% w same NNS/PPV

CAN Does Not Discriminate Risk of LTI

In Both Low and Elevated Risk Tiers



Little Overlap in HNHR2 and CAN

Logistic regression model predicting Long-Term Institutionalization
Covariates: CAN probability of 1 year event, Missing CAN
Elevated Risk. Low Risk populations
Prediction of CAN LTI Model: Thresholds for High Risk: .05/.07

(N, % Risk of LTI in Cell) (Cell N)	HNHR2: High Risk Tier	HNHR2: Not High Risk Tier
CAN Probability of LTI: High Risk	(LTI=6,906, 12.6%) (N=54,945)	(LTI=3800, 3%) (N=126,592)
CAN Probability of LTI: Not High Risk	(LTI=15,817, 12.3%) (N=128,566)	(LTI=35,533, 0.7%) (N=5,156,495)

Full Population vs. ER/LR Population

Single Population

Predicted Probability	N	2 Year Long-Term Institution	Sensitivity	PPV	NNS
.00	5,466,598	62,056			
.02	370,748	15,988	.26	.25	23.2
.03	211,546	10,819	.17	.30	19.6
.04	142,854	8,208	.13	.33	17.4

Stratified Population

Predicted Probability	N	2 Year Long-Term Institution	Sensitivity	PPV	NNS
.03/.05	484,548	23,579	0.38	0.25	20.6
.04/.06	381,932	19,350	0.32	0.27	19.7
.05/.07	181,537	10,706	0.17	0.32	17.0
.06/.08	88,102	6,019	0.10	0.37	14.6

HNHR2 Models for Elevated Risk (ER) & Low Risk (LR)

Diagnoses

	Elevated Risk (LTI=22,426 of N=456,921)			Low Risk (LTI=39,630 of N=5,009,677)		
Variable	Estimate	Std Err	P Value	Estimate	Std Err	P Value
Intercept	-6.8343	0.0753	<.0001	-11.3877	0.0491	<.0001
Cancer	-0.1714	0.0165	<.0001	-0.1806	0.0154	<.0001
Congestive Heart Failure	0.0168	0.0152	0.2682	0.0977	0.0152	<.0001
Dementia	0.8746	0.0166	<.0001	1.5352	0.0139	<.0001
Diabetes	0.1891	0.0150	<.0001	0.2793	0.0112	<.0001
Fracture	0.1689	0.0241	<.0001	0.4755	0.0329	<.0001
Head Injury	-0.0578	0.0335	0.0846	0.1526	0.0423	0.0003
Malnutrition	0.1001	0.0219	<.0001	0.5876	0.0318	<.0001
Multiple Sclerosis	0.3804	0.0630	<.0001	0.9303	0.0668	<.0001
Obesity	0.1515	0.0197	<.0001	0.1433	0.0230	<.0001
Parkinsons'/ Huntington	0.4819	0.0258	<.0001	1.0135	0.0226	<.0001
Pressure Ulcer	0.3050	0.0213	<.0001	0.6027	0.0266	<.0001
Schizophrenia	0.3469	0.0276	<.0001	0.7998	0.0285	<.0001
Spinal Cord Injury (SCI)	0.0374	0.0387	0.3342	0.4025	0.0530	<.0001
Seizure	0.2216	0.0231	<.0001	0.4458	0.0276	<.0001
Sepsis	0.00115	0.0175	0.9477	0.2194	0.0284	<.0001
Stroke	0.3442	0.0176	<.0001	0.6405	0.0195	<.0001

HNHR2 ER & LR Models (cont'd)

		Elevated Risk (LTI=22,426 of N=456,921)			Low Risk (LTI=39,630 of N=5,009,677)		
	Variable	Estimate	Std Err	P Value	Estimate	Std Err	P Value
Risk Measures	JFI (VA + Medicare DXs)	0.00814	0.00535	0.1282	0.0342	0.00303	<.0001
	CAN Probability 1Year Event	0.2584	0.0372	<.0001	1.0041	0.0457	<.0001
	Missing CAN	0.1746	0.0416	<.0001	0.4416	0.0235	<.0001
Utilization Measures	Adjusted VA Cost ($10,000)	0.0251	0.000997	<.0001	0.0504	0.00167	<.0001
	Acute Hospital Stay	0.1345	0.0161	<.0001	0.0616	0.0185	0.0009
	LTI in prior year	0.7197	0.0426	<.0001	1.2502	0.0871	<.0001
	Medicare SNF in prior year	0.4048	0.0180	<.0001	0.4962	0.0419	<.0001
Behavior Measures	Substance Use Disorder	0.0952	0.0194	<.0001	0.2308	0.0205	<.0001
	Amputation	0.2243	0.0473	<.0001	0.4005	0.0923	<.0001
	Homeless	0.4323	0.0299	<.0001	0.7603	0.0290	<.0001
Socio-Demographic Measures	Age	0.0401	0.000794	<.0001	0.0851	0.000539	<.0001
	Male	0.1285	0.0400	0.0013	0.1277	0.0304	<.0001
	Married	-0.4984	0.0153	<.0001	-0.6877	0.0111	<.0001
	VA Priority 1	0.0650	0.0159	<.0001	0.0475	0.0130	0.0003
	Rural	0.0425	0.0173	0.0141	0.0955	0.0124	<.0001

HNHR2 Model Calibration

HNHR2 Model Calibration on *Elevated*/ Low Risk Populations

- Model ***discrimination better in low risk population*** (c-statistic *.89* vs .77)
- Model ***sensitivity better in elevated risk population*** **(.59** vs .27, at 6% threshold)
- Impact of risk factors possibly higher in low-risk populations

Variable	Elevated Risk OR	Low Risk OR	Relative Odds Ratio
Dementia	2.4	**4.64**	1.94
MS	1.46	**2.54**	1.73
Parkinson's	1.62	**2.76**	1.7
Pressure ulcer	1.36	**1.83**	1.34
Schizophrenia	1.42	**2.25**	1.57
P (event) CAN	1.3	**2.73**	2.1
Malnutrition	1.1	**1.8**	1.62

Differential impact of Prior NH Use

- Long-Term Institutionalization (LTI) in the prior 12-24 months: Odds ratio larger for Low Risk population
- Medicare Skilled Nursing Facility (SNF) benefit used in 0-24 months prior: Odds ratio significant and similar for Elevated and Low Risk populations

Variable	Elevated Risk Odds Ratio	Low Risk Odds Ratio	Relative Odds Ratio
Prior LTI	2.05	3.49	1.7
Prior SNF	1.5	1.64	1.1
Priority 1	1.07	1.05	.98
Married	.61	.50	.82
Homeless	1.54	2.14	1.39

HNHR2 Model Results: Diagnoses

Comorbidity variables

	ELEVATED RISK			LOW RISK		
Variable	OR	N	%	OR	N	%
Amputation	1.251	7,085	1.60%	1.493	4,436	0.10%
Cancer	0.842	142,377	31.20%	0.835	465,138	9.30%
CHF	1.017 NS	182,595	40.00%	1.103	296,049	5.90%
Dementia	2.398	79,198	17.30%	4.642	121,250	2.40%
Diabetes	1.208	244,142	53.40%	1.322	1,291,938	25.80%
Fracture	1.184	29,521	6.50%	1.609	29,393	0.60%
Head injury	0.944 NS	18,730	4.10%	1.165	51,275	1.00%
Malnutrition	1.105	41,825	9.20%	1.8	24,819	0.50%
Multiple sclerosis	1.463	4,634	1.0%	2.535	16,225	0.3%
Morbid obesity	1.164	81,497	17.80%	1.154	256,345	5.10%
Parkinson's/ Huntington's	1.619	19,216	4.20%	2.755	46,402	0.90%
Schizophrenia	1.415	25,082	5.50%	2.225	83,526	1.70%
Spinal Cord Injury (SCI)	1.038 NS	13,259	2.90%	1.496	22,127	0.40%
Seizure	1.248	37,556	8.20%	1.562	80,850	1.60%
Sepsis	1.001 NS	94,117	20.60%	1.245	57,993	1.20%
Stroke	1.411	69,188	15.10%	1.897	101,704	2.00%
Substance Use Disorder	1.100	100,606	22.00%	1.26	442,070	8.80%
Pressure ulcer	1.357	39,106	8.60%	1.827	36,690	0.70%

Demographic and Utilization Variables

	ELEVATED RISK			LOW RISK		
Variable	OR	N/ mean(std)	%	OR	N/ mean(std)	%
Age	1.041	70.87	12.26	1.089	60.37	16.47
Adjusted Total VA Cost ($10,000)	1.025	$4.02	$6.13	1.052	$0.82	$1.65
JFI (VA & Medicare DX)	1.008	7.02	1.66	1.035	3.26	1.89
CAN 1Year Probability of event	1.295	0.30 (90)	0.23	2.729	0.08 (55)	0.09
Acute Hospital Stay	1.144 NS	239,463	52.40%	1.064	1,737,226	34.70%
Male	1.137	435,189	95.20%	1.136	4,572,366	91.30%
Married	0.607	240,737	52.70%	0.503	2,785,465	55.60%
VA Priority 1	1.067	172,786	37.80%	1.049	1,656,361	33.10%
Homeless	1.541	28,459	6.20%	2.139	158,635	3.20%
Prior Long-Term Inst.	2.054	4,614	1.00%	3.491	1,514	0.00%
Prior SNF	1.499	66,025	14.40%	1.642	12,957	0.30%
Missing CAN	1.191	11,762	2.60%	1.555	304,013	6.10%
Rural	1.043	152,548	33.40%	1.1	1,737,226	34.70%

5-Fold Cross Validation: FY2017

Thresholds (elevated risk=0.7/ low risk=0.7)

Variable	Mean	Std Dev	Median	Min	Max
Sensitivity	0.34	.002	.34	.339	.343
PPV	.47	.0008	.471	.471	.472
NNS	7.71	.031	7.72	7.66	7.73

Thresholds (elevated risk=0.6/ low risk=0.7)

Variables	Mean	Std Dev	Median	Min	Max
Sensitivity	.366	.0015	.366	.364	.368
PPV	.458	.0006	.458	.4577	.459
NNS	8.07	.026	8.07	8.03	8.09

Multi-temporal performance consistency:
FY13-15 calibrated model predicting FY16-18 outcomes
FY14-16 calibrated model predicting FY17-19 outcomes

From Model to Production

- Current Data lags:
  - VA data– DSS/Fee
    Death out of VA facility
  - Medicare dx data—6-7 months
  - RHF (MDS):3-9 months
- IAHQ and HNHR flags
- Prior year LTI/SNF flags sensitive to timing
- Non-identification of recent LTI

- Extended dx look back period to 2 years for IAHQ;
- Kept 1Y for JFI– used 12-month max score.
- Used GCF IAHQ flag in addition to lagged dx
- 12 month buffer around prior LTI (months 13-24)

Impact of extended look-back was to improve sensitivity, allowing a reduction in elevated risk threshold, increasing model sensitivity from 0.34 to 0.37, while maintaining a NNS of 8

Production Model Estimates OUT-OF-RANGE of Research Model Confidence Interval

Elevated Risk Model (Independence-At-Home-Qualified OR At Risk of HBPC) (11/31)				
Model Covariate	**OddsRatio Prod <CI**	**Lower CI**	**Upper CI**	**OddsRatio Prod > CI**
LTI in prior year	2.05	2.2	2.62	
Pressure Ulcer	1.35	1.48	1.59	
JFI	1.01	1.08	1.1	
Schizophrenia	1.41	1.47	1.65	
Malnutrition	1.1	1.16	1.27	
Fracture	1.18	1.22	1.34	
Dementia		2.23	2.38	2.39
SNF in prior year		**1.35**	**1.45**	**1.49**
Acute Hospitalization in prior year		1	1.08	1.14
Obesity		**0.92**	**0.99**	**1.16**
CAN Probability of 1 Year Event		**0.82**	**0.95**	**1.29**

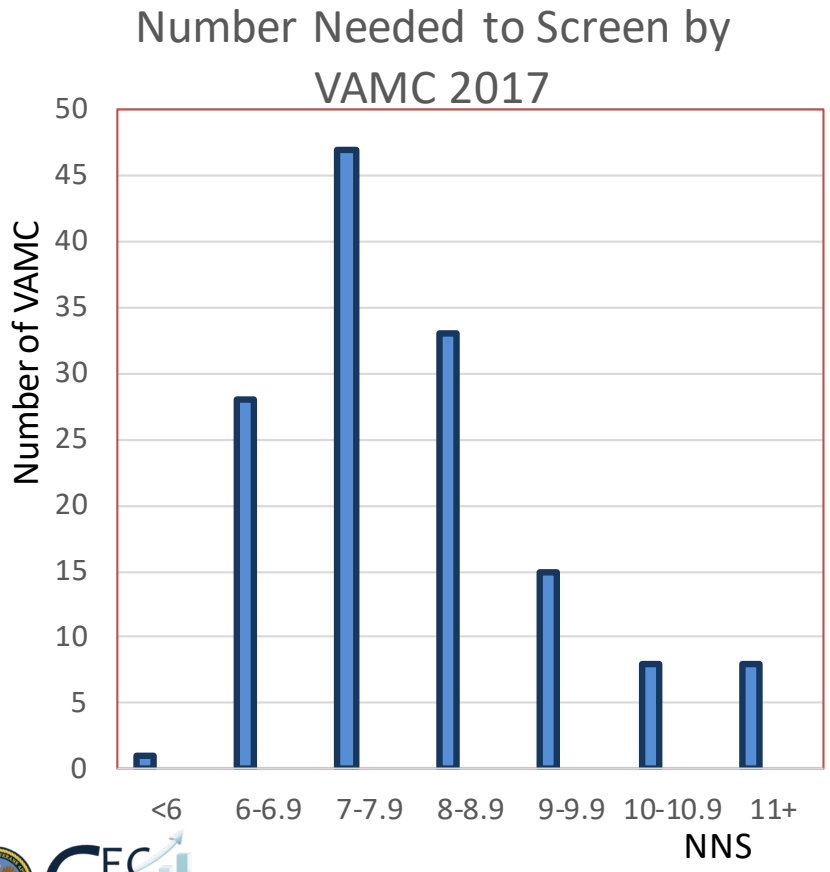
Production: c-stat=.767
Research: c-stat=.769

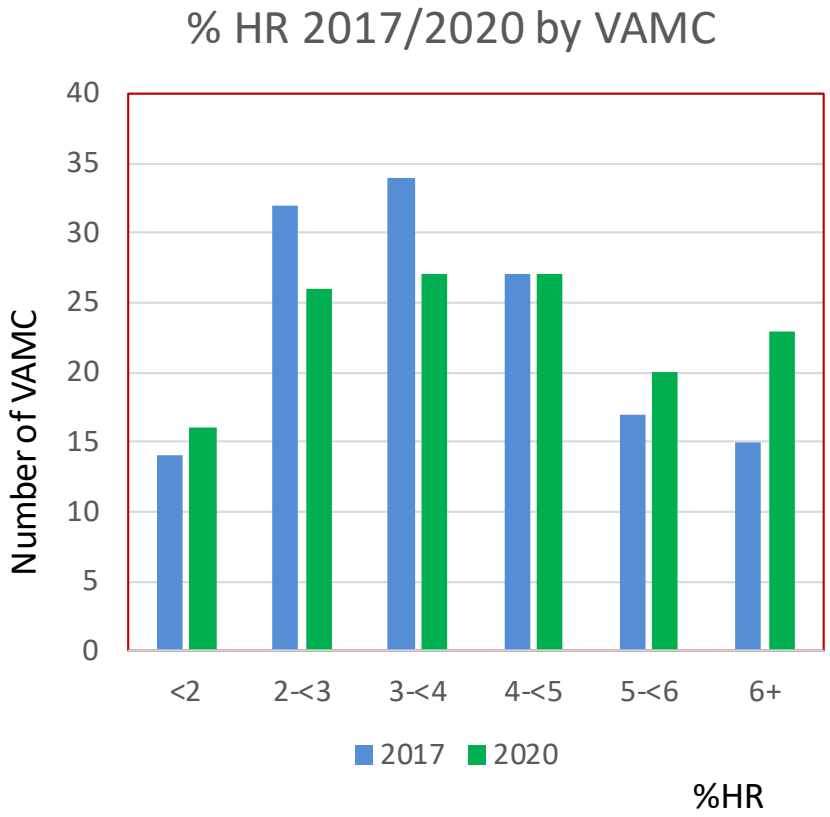
Low Risk Model (16/31)				
Model Covariate	**OddsRatio Prod <CI**	**Lower CI**	**Upper CI**	**OddsRatio Prod > CI**
CAN Probability of 1 Year Event	**2.73**	**3.16**	**3.8**	
Amputation	**1.49**	**1.72**	**2.1**	
SCI	**1.5**	**1.68**	**2.04**	
SNF in Prior Year	**1.64**	**1.76**	**2.08**	
Schizophrenia	2.23	2.3	2.59	
Parkinsons/ Huntington	2.76	2.82	3.1	
Missing CAN	1.56	1.6	1.76	
LTI in prior year	3.49	3.53	4.73	
Strok	1.9	1.92	2.09	
Pressure Ulcer	1.82	1.83	2.04	
Substance Use Disorder		**1.14**	**1.25**	**1.26**
Obesity		**0.87**	**0.94**	**1.15**
Sepsis		**0.96**	**1.15**	**1.25**
Fracture		**1.3**	**1.54**	**1.61**
Dementia		**4.3**	**4.56**	**4.64**
Head Injury		**0.74**	**0.88**	**1.17**

Production: c-stat= .885
Research: c-stat=.878

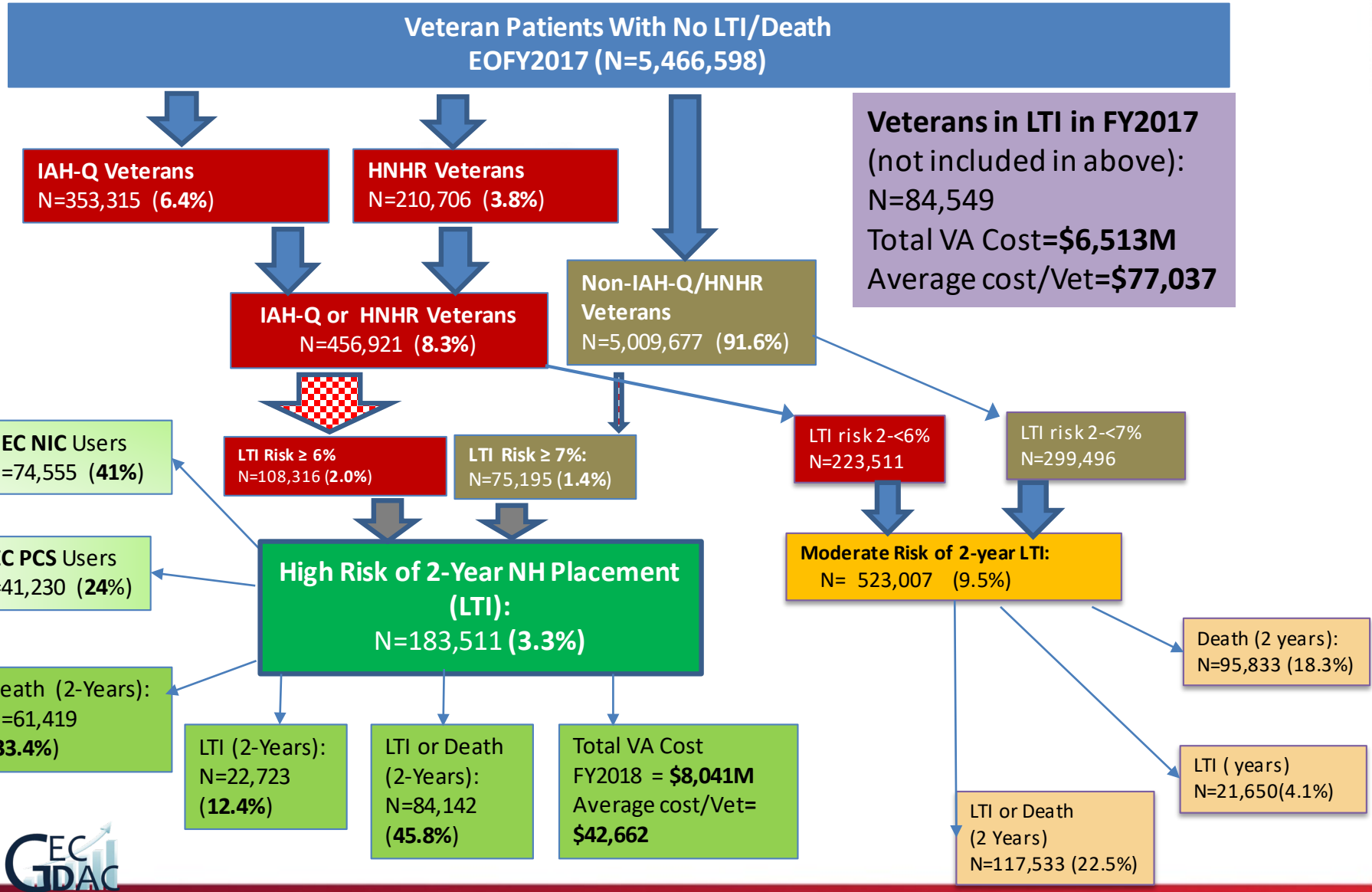
VAMC Variations 2017/2020

- VAMC Variations in FY2017 and FY2020 in:
  - % High Risk
  - Number Needed to Screen (NNS)





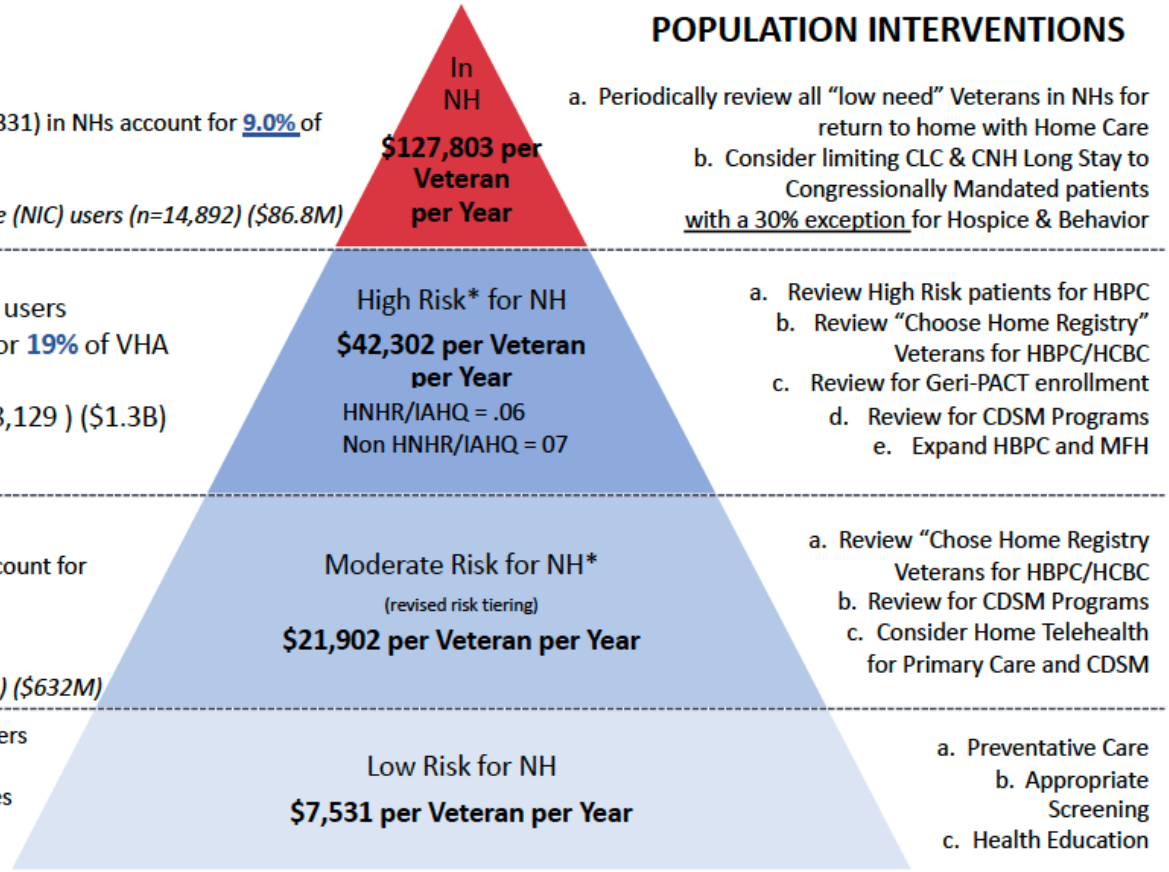
HNHR2 Population, Stratification, Outcomes



Geriatrics & Extended Care Data Analysis Center

GEC Pyramid in FY2019

VA Nursing Home (NH) Risk Populations based on **FY19** VHA Users, Population Associated Expenditures & Interventions

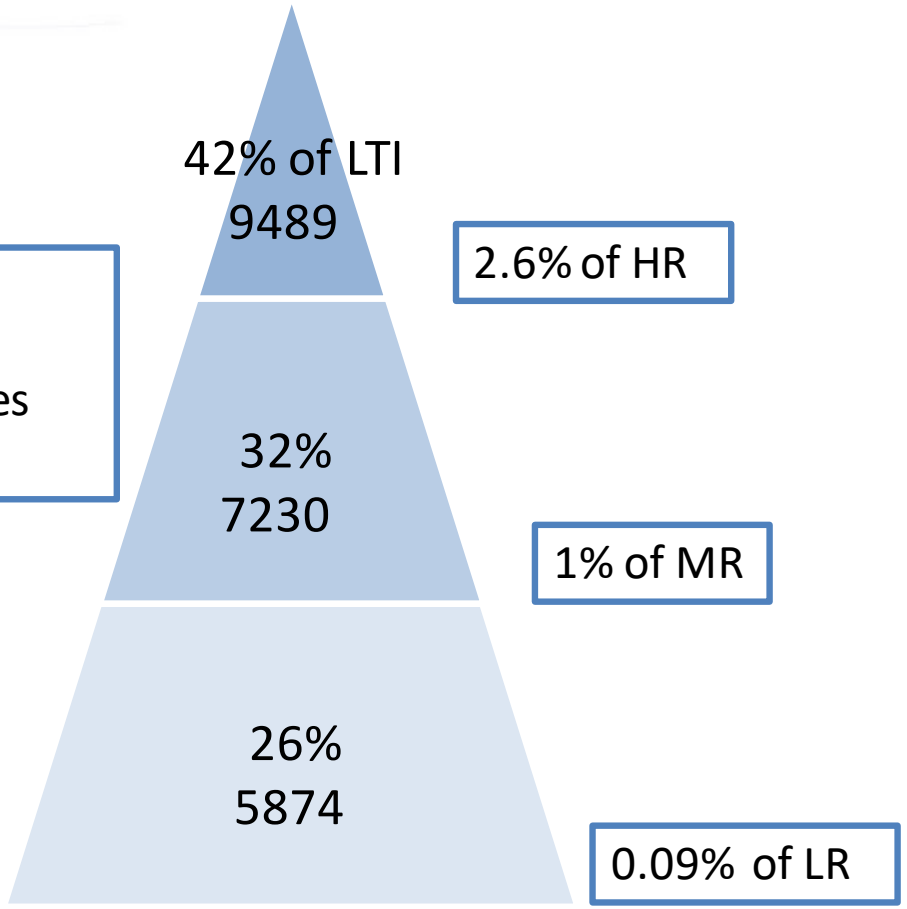


NEW LTI in FY19: 42% from High Tier

But 26% came from the Low Risk Tier

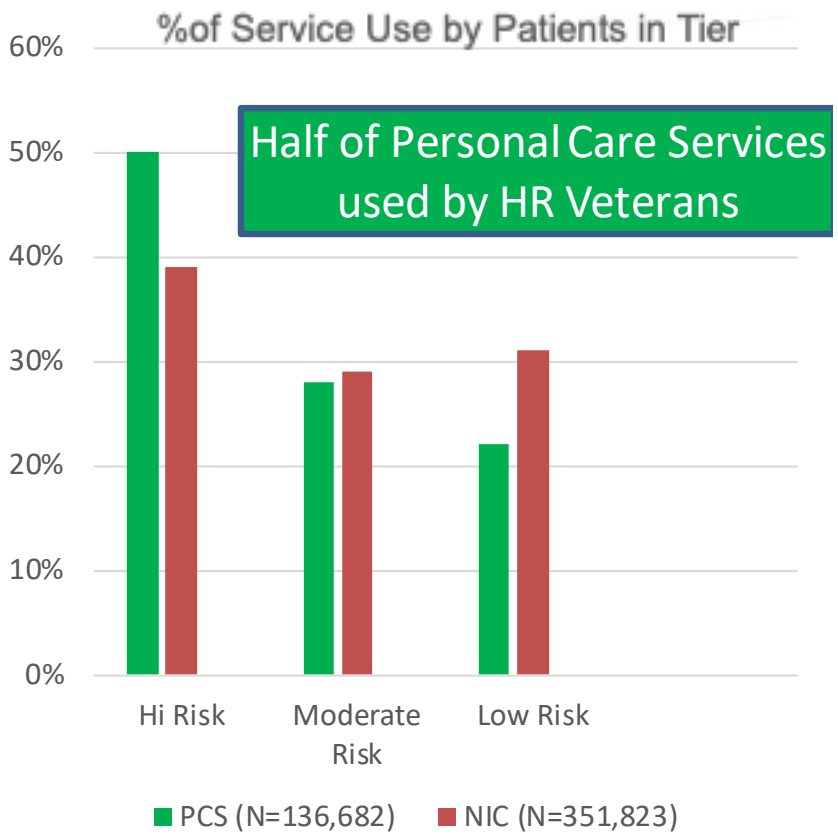
New LTI 2019: 22,594

65% Non-Institutional Care Services
22% Personal Care Services



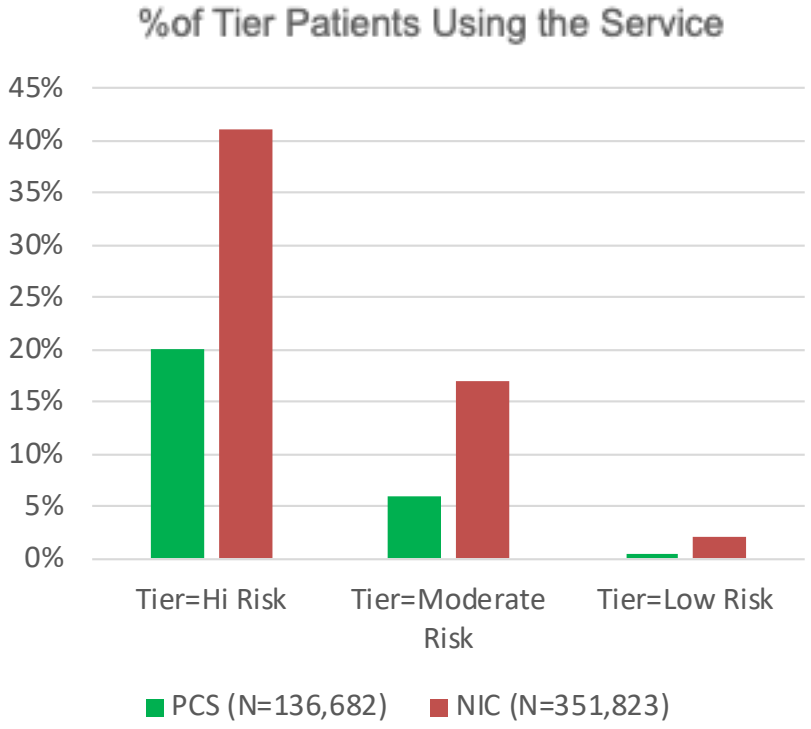
Non-Institutional Care Allocated Along LTI Risk Gradient

But ONLY a Minority of High Risk receive HCBS



Half of Personal Care Services used by HR Veterans

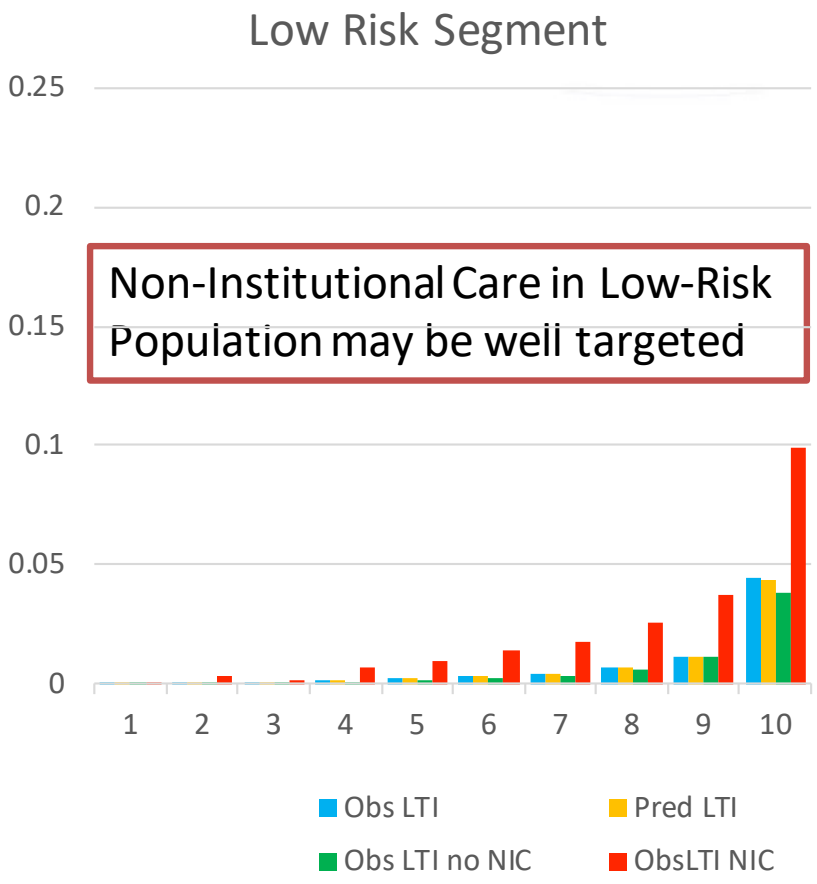
Need more Services, not reallocating current services

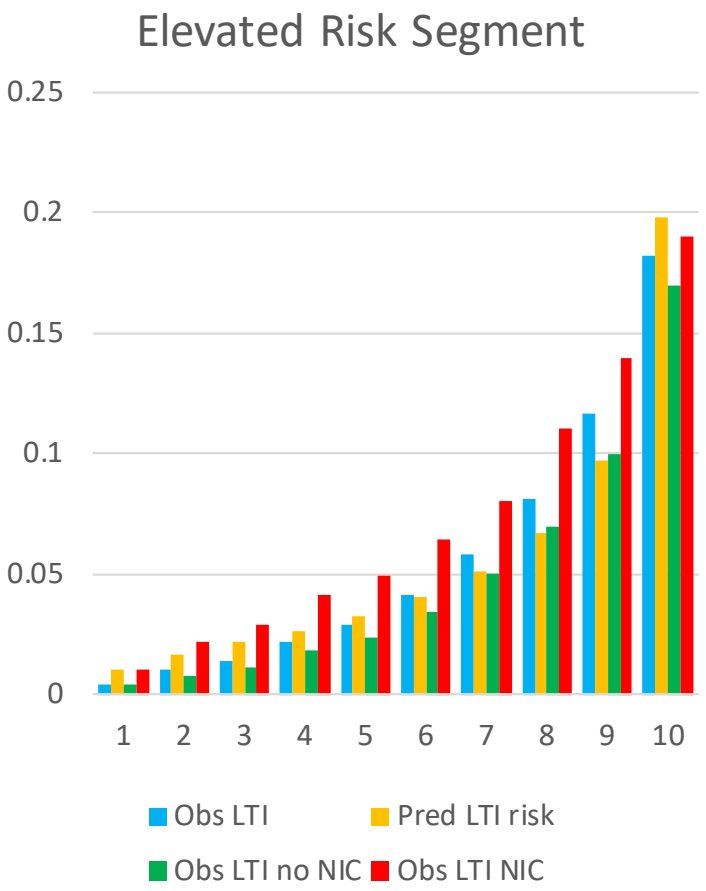


PCS= Personal Care Services NIC=Non-Institutional Care

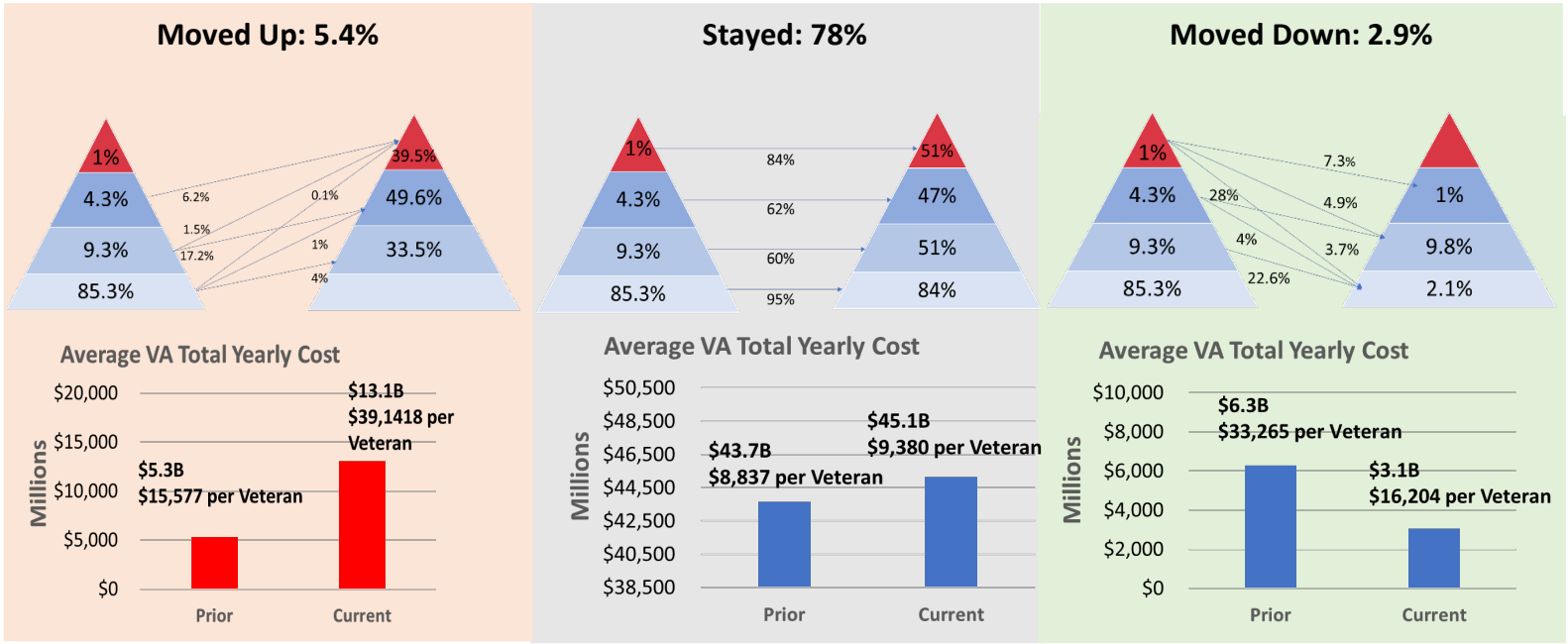
FY2017 Risk Deciles with FY2018-19 LTI

Receipt of Non-Institutional Care Indicates High LTI Risk





Transitions between Pyramid Tiers 2013-2017

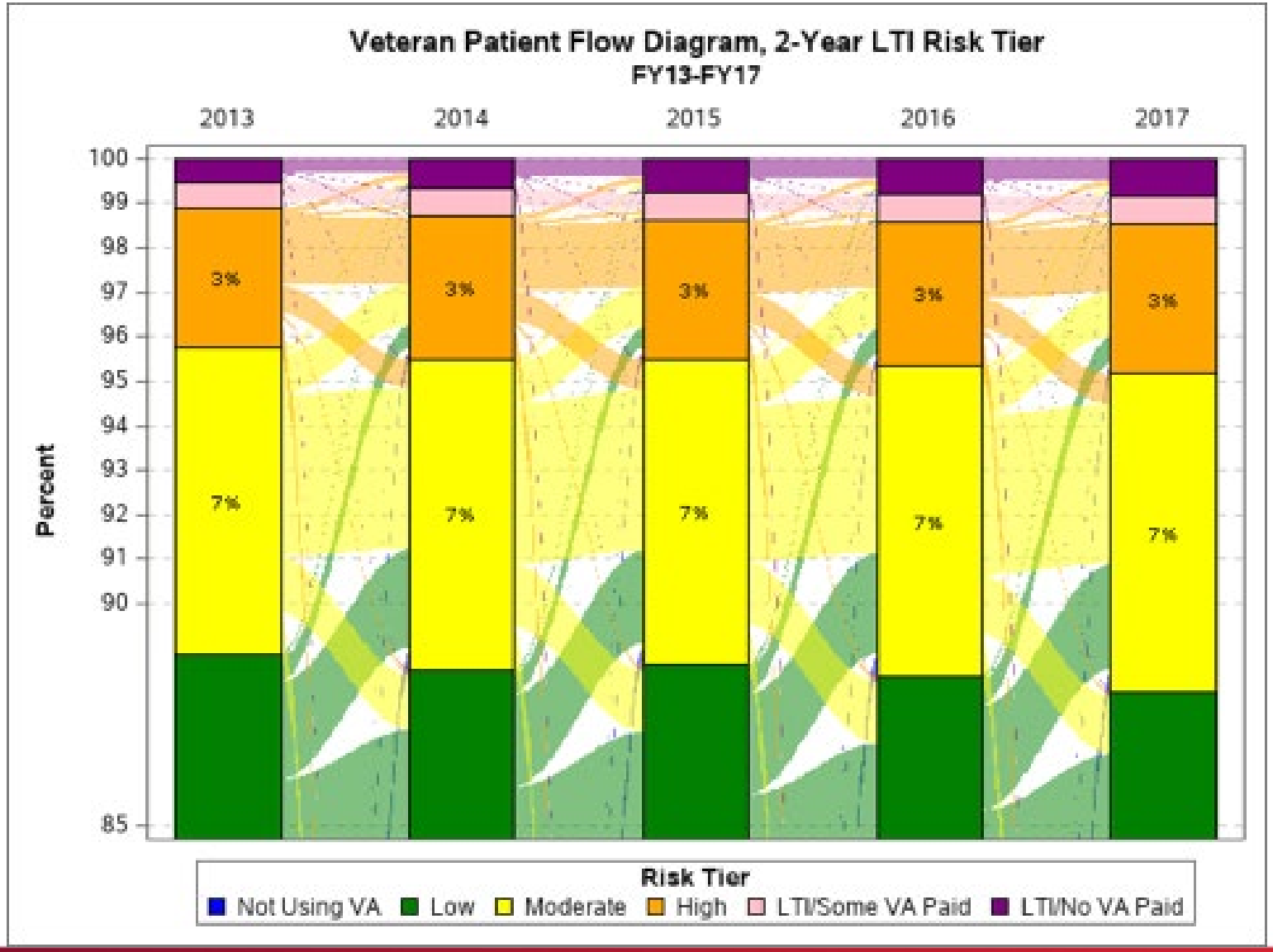


- In NH - $86,184 per Veteran per year
- High Risk for NH - $40,774 per Veteran per year
- Moderate Risk for NH - $20,175 per Veteran per year
- Low Risk for NH - $7,058 per Veteran per year

*FY 2013-2017 (13.7% do not transition, either due to death or no VA use)

~15% of LTI Vets transition to lower community tiers– over half to HR tier

Annual Movement between Tiers appears to be stable, with a large share of MR Tier Veterans rising to HR, and a smaller share of LR Veterans rising to HR.



HNHR2 identifies Veterans at High Risk of Hospitalization

Modeled and estimated to predict LTI; Nevertheless, HNHRv2 identifies Veterans at High Risk of Hospitalization

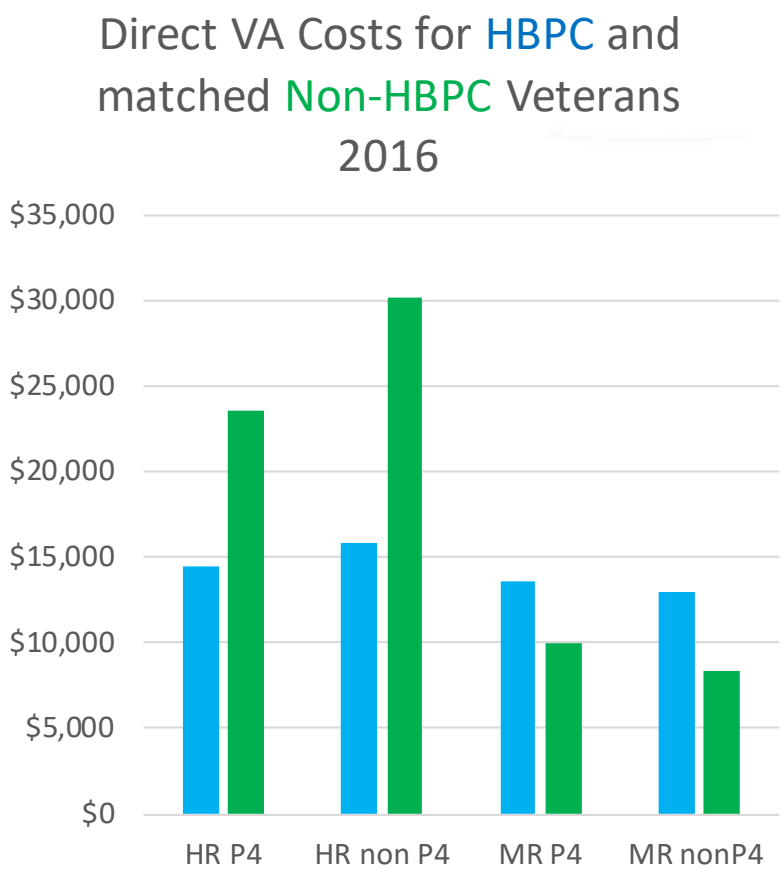
	N (% of VA users)	1 Yr Hosp	Sensitivity (% Hosp)	PPV (Hosp)
VA users	5,466,598	710823		
HR (6,7)	183,511 (3.3%)	80552	11.3%	0.44
IAHQ	456,921 (8%)	187993	26.4%	0.41
IAHQ 3%	239,742 (4.3%)	114357	61%/ 16%*	0.48
IAHQ 6%	108,316 (1.9%)	55693	30%/ 7.8%	0.51
IAHQ 7%	87,789 (1.6%)	45751	24%/ 5.3%	0.52
IAHQ 9%	60,456 (1.1%)	32023	17%/ 4.5%	0.53

FY2017 Risk, FY2018 hospitalization

CAN 97 = .41 PPV

*% IAHQ hospitalizations/% all hospitalizations

HNHR2 As Risk Stratification



- Targeting non-IAHQ Veterans for HBPC
  - HBPC cost effective for IAHQ Veterans (IAH Demo)
  - Non-IAHQ HR appears to be a subgroup where there are also cost savings

    (Direct, VA total)

HR=High Risk Tier MR=Medium Risk Tier P4=Priority Grp 4

Future Issues

Limitations

- Misses 60% of new LTI
- Outlier small area performance
- Misses family supports, social determinants, actual function
- Misses episodic clinical assessments
  - Outcome proxy: NIC
  - Process measures: MDS/OASIS
- Logistic model deals poorly with missing data and relatively rare events
- Unstable NH behavior for 2020-21

Next Steps

- Added measures:
  MDS, OASIS, ADI, health factors
- Better model structure:
  Machine learning (e.g.,XG Boost)
  Latent class models
- Adding NIC as clinical assessment proxy

Take Aways

- **HNHR2 is a useful risk stratification tool for LTI, hospitalization, death, and cost**
- **Multi-part estimation of a logistic risk model can improve model performance**
- **Current CMS-VHA arrangements allow incorporation of Medicare data into Operational analytic tools, although requires attention to data lags.**