

WHAT IS THE IMPACT OF HEALTH LITERACY ON MEDICAL CARE COSTS IN AN INTEGRATED HEALTH CARE SYSTEM?



Jolie Haun PhD EdS

Nitin Patel MPH

Douglas D. Bradham DrPH, MA, MPH

Robert R. Campbell JD PhD MPH

Dustin D. French PhD

William Lapcevic MSST MPH

This material is the result of work supported with resources and the use of facilities at the James A. Haley Veterans' Hospital. Content does not represent the views of the Department of Veterans Affairs or the United States Government.

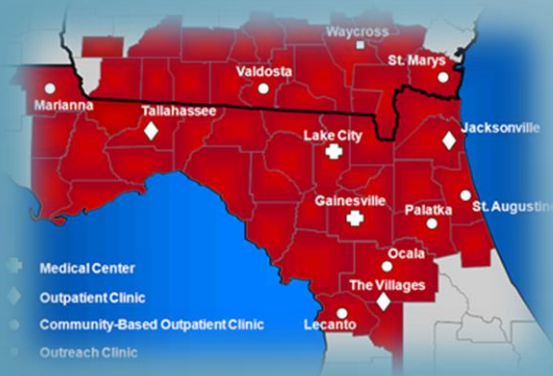
RESEARCH OBJECTIVE

*Evaluate the
association between
veteran health literacy
and health care costs
over a 3-year period.*

re·search¹ /rɪˈsɜːtʃ,
[plural] 1 serious st-
discover new facts
research into +
student

METHODS

- *Generalized Linear Model*
- 112,417 => **92,574** Veterans from NF/SG VHS region
- 2007-2009 Costs
- Adjustments for factors
- CPRS, Medical SAS, DSS-NDE, DCG-HCC Data



RESULTS

- 94% males
- 85% White; 98% Not Hispanic/Latino
- 42% w/ moderate or catastrophic disability
- Age:
 - 18% <55
 - 28% 55-64
 - 24% 65-74
 - 23% 75-84
 - 07% >85



TABLE 1. RELATIVE COST INCREASE ESTIMATES & CONFIDENCE INTERVALS FOR FACTORS ASSOCIATED WITH VA MEDICAL AND PHARMACY COSTS, BASE AND INTERACTION MODEL (N= 92,574)

	Relative Increases in Cost (\$) from 2007 to 2009							
	2007		2008		2009		2007-2009	
	Base	Interaction	Base	Interaction	Base	Interaction	Base	Interaction
Variables	Estimate (95% CI)		Estimate (95% CI)		Estimate (95% CI)		Estimate (95% CI)	
Health Literacy	Adequate (Reference)							
Inadequate	1.24 ^{**} (1.21-1.27)	1.68 ^{**} (1.42-1.99)	1.32 ^{**} (1.28-1.36)	1.58 ^{**} (1.31-1.91)	1.50 ^{**} (1.46-1.54)	2.32 ^{**} (1.92-2.80)	1.30 ^{**} (1.27-1.33)	2.05 ^{**} (1.76-2.39)
Marginal	1.10 ^{**} (1.08-1.12)	1.14 [*] (1.02-1.28)	1.14 ^{**} (1.12-1.17)	1.42 ^{**} (1.26-1.61)	1.17 ^{**} (1.15-1.20)	1.83 [*] (1.61-2.07)	1.12 ^{**} (1.10-1.14)	1.42 ^{**} (1.28-1.57)
Gender	Female (Reference)							
Male	0.86 ^{**} (0.84-0.88)	0.86 ^{**} (0.83-0.88)	0.83 ^{**} (0.81-0.85)	0.83 ^{**} (0.80-0.85)	0.80 ^{**} (0.78-0.82)	0.81 ^{**} (0.78-0.83)	0.84 ^{**} (0.82-0.86)	0.85 ^{**} (0.83-0.87)
Marital Status	Married (Reference)							
Divorced	1.14 ^{**} (1.12-1.16)	1.14 ^{**} (1.13-1.16)	1.13 ^{**} (1.11-1.15)	1.12 ^{**} (1.10-1.14)	1.18 ^{**} (1.16-1.20)	1.17 ^{**} (1.15-1.19)	1.15 ^{**} (1.13-1.16)	1.14 ^{**} (1.13-1.16)
Other	1.12 ^{**} (1.10-1.14)	1.10 ^{**} (1.08-1.12)	1.13 ^{**} (1.10-1.15)	1.10 ^{**} (1.08-1.12)	1.12 ^{**} (1.10-1.15)	1.13 ^{**} (1.11-1.16)	1.12 ^{**} (1.10-1.13)	1.11 ^{**} (1.09-1.13)
Priority Code	No service-connected disability (Reference)							
Catastrophically disabled	2.04 ^{**} (2.01-2.08)	2.06 ^{**} (2.02-2.10)	1.92 ^{**} (1.88-1.96)	1.90 ^{**} (1.86-1.94)	1.99 ^{**} (1.95-2.02)	2.00 ^{**} (1.96-2.04)	1.86 ^{**} (1.83-1.89)	1.87 ^{**} (1.84-1.90)
Medicaid assistance/low income	1.57 ^{**} (1.54-1.59)	1.57 ^{**} (1.54-1.60)	1.57 ^{**} (1.54-1.59)	1.57 ^{**} (1.54-1.6)	1.60 ^{**} (1.57-1.63)	1.61 ^{**} (1.58-1.64)	1.55 ^{**} (1.53-1.57)	1.55 ^{**} (1.53-1.58)
Moderate disability	1.24 [*] (1.22-1.26)	1.23 [*] (1.20-1.25)	1.26 [*] (1.24-1.29)	1.25 [*] (1.22-1.27)	1.30 [*] (1.28-1.33)	1.29 [*] (1.26-1.32)	1.26 [*] (1.24-1.28)	1.25 ^{**} (1.23-1.27)
Race	Non-minority (Reference)							
Minority	0.97 [*] (0.95-0.99)	0.96 [*] (0.94-0.99)	1.02 (0.99-1.04)	1.01 (0.98-1.04)	1.03 (1.01-1.05)	1.03 (1.01-1.06)	1.01 (1.00-1.03)	1.00 (0.99-1.02)
Ethnicity	Not Hispanic or Latino (Reference)							
Hispanic or Latino	1.09 [*] (1.04-1.14)	1.10 [*] (1.05-1.15)	1.03 (0.99-1.08)	1.01 (0.96-1.06)	1.03 (0.99-1.08)	1.03 (0.98-1.08)	1.05 [*] (1.01-1.09)	1.03 (0.99-1.08)
Age	≥85 (Reference)							
<55	1.64 [*] (1.59-1.68)	1.65 ^{**} (1.60-1.70)	1.66 ^{**} (1.62-1.72)	1.69 ^{**} (1.63-1.75)	1.56 ^{**} (1.51-1.61)	1.71 ^{**} (1.65-1.77)	1.63 ^{**} (1.59-1.67)	1.70 ^{**} (1.65-1.76)
55-64	1.62 [*] (1.58-1.66)	1.63 [*] (1.59-1.69)	1.64 [*] (1.60-1.69)	1.68 [*] (1.62-1.73)	1.54 [*] (1.50-1.58)	1.69 [*] (1.63-1.75)	1.61 ^{**} (1.57-1.65)	1.69 [*] (1.64-1.73)
65-74	1.40 [*] (1.36-1.43)	1.41 [*] (1.37-1.45)	1.42 [*] (1.38-1.46)	1.44 [*] (1.39-1.49)	1.25 [*] (1.22-1.29)	1.37 [*] (1.33-1.42)	1.37 [*] (1.34-1.40)	1.43 [*] (1.39-1.47)
75-84	1.12 [*] (1.09-1.15)	1.12 [*] (1.09-1.16)	1.16 [*] (1.12-1.19)	1.18 [*] (1.14-1.22)	1.03 [*] (1.00-1.06)	1.09 [*] (1.05-1.13)	1.11 [*] (1.08-1.13)	1.14 [*] (1.11-1.17)
DCG	2.09 [*] (2.07-2.11)	2.17 [*] (2.15-2.20)	2.02 [*] (2.00-2.03)	2.10 [*] (2.08-2.12)	2.01 [*] (1.99-2.03)	2.08 [*] (2.06-2.11)	2.35 [*] (2.32-2.37)	2.46 [*] (2.44-2.49)
Disease Status	(Reference="no disease")							
Cerebral	1.21 ^{**} (1.16-1.25)	1.22 ^{**} (1.17-1.27)	1.26 ^{**} (1.21-1.31)	1.27 ^{**} (1.21-1.33)	1.27 ^{**} (1.21-1.32)	1.26 ^{**} (1.21-1.32)	1.14 ^{**} (1.11-1.17)	1.13 ^{**} (1.10-1.16)
Heart	1.21 ^{**} (1.19-1.22)	1.21 ^{**} (1.19-1.22)	1.29 ^{**} (1.27-1.31)	1.30 ^{**} (1.28-1.32)	1.18 ^{**} (1.16-1.19)	1.19 ^{**} (1.17-1.21)	1.16 ^{**} (1.15-1.18)	1.18 ^{**} (1.16-1.19)
Vascular	1.17 [*] (1.14-1.19)	1.20 [*] (1.17-1.24)	1.24 [*] (1.21-1.27)	1.26 [*] (1.22-1.29)	1.18 [*] (1.15-1.21)	1.19 [*] (1.15-1.22)	1.12 [*] (1.11-1.14)	1.13 [*] (1.11-1.16)
Cancer	1.24 [*] (1.22-1.26)	1.24 ^{**} (1.21-1.26)	1.31 [*] (1.29-1.34)	1.34 [*] (1.31-1.37)	1.37 [*] (1.34-1.39)	1.36 ^{**} (1.33-1.39)	1.21 [*] (1.19-1.22)	1.21 [*] (1.19-1.23)
Diabetes	1.25 [*] (1.23-1.26)	1.26 [*] (1.24-1.28)	1.26 [*] (1.24-1.28)	1.28 [*] (1.26-1.30)	1.24 [*] (1.23-1.26)	1.25 [*] (1.23-1.27)	1.21 [*] (1.19-1.22)	1.21 [*] (1.20-1.23)
Arrhythmias	1.13 [*] (1.11-1.16)	1.12 [*] (1.10-1.15)	1.21 [*] (1.18-1.24)	1.22 [*] (1.19-1.25)	1.29 [*] (1.26-1.31)	1.30 [*] (1.27-1.33)	1.13 [*] (1.12-1.15)	1.12 [*] (1.11-1.14)

**=p-value<0.0001,*=p-value<0.05

**TABLE 1 CONT.
INTERACTIONS
BY HEALTH
LITERACY
LEVEL**

	2007	2008	2009	2007-2009
	Interaction	Interaction	Interaction	Interaction
HL by Age				
Inadequate				
<55	1.08 (0.97-1.2)	1.16 [*] (1.03-1.31)	0.79 ^{**} (0.70-0.89)	0.93 (0.84-1.03)
55-64	0.99 (0.91-1.08)	0.89 [*] (0.81-0.98)	0.75 [*] (0.68-0.82)	0.83 [*] (0.77-0.89)
65-74	1.12 [*] (1.03-1.23)	0.98 (0.89-1.08)	0.80 [*] (0.72-0.88)	0.90 [*] (0.83-0.97)
75-84	1.00 (0.93-1.08)	1.00 (0.92-1.09)	0.98 (0.90-1.06)	0.97 (0.91-1.04)
Marginal				
<55	0.97 (0.89-1.05)	0.89 [*] (0.82-0.97)	0.72 ^{**} (0.66-0.78)	0.88 [*] (0.82-0.94)
55-64	0.95 (0.89-1.02)	0.92 [*] (0.86-1.00)	0.73 [*] (0.68-0.79)	0.87 [*] (0.81-0.92)
65-74	0.94 (0.88-1.01)	0.94 (0.87-1.01)	0.73 ^{**} (0.68-0.79)	0.88 [*] (0.83-0.94)
75-84	1.01 (0.95-1.08)	0.92 [*] (0.86-0.99)	0.87 [*] (0.81-0.93)	0.94 (0.89-1.00)
HL by Gender				
Inadequate, Male	0.94 (0.81-1.10)	1.06 (0.90-1.26)	1.10 (0.93-1.30)	1.02 (0.89-1.17)
Marginal, Male	1.03 (0.94-1.13)	0.93 (0.84-1.03)	0.86 (0.78-0.96)	0.94 (0.86-1.03)
HL by Marital Status				
Inadequate				
Divorced	0.83 ^{**} (0.78-0.89)	1.00 (0.93-1.08)	0.92 [*] (0.85-1.00)	0.91 [*] (0.86-0.97)
Other	1.05 (0.99-1.13)	1.22 ^{**} (1.13-1.31)	0.96 (0.90-1.04)	1.06 (1.00-1.12)
Marginal				
Divorced	1.03 (0.99-1.08)	1.04 (0.99-1.09)	1.09 [*] (1.04-1.15)	1.05 [*] (1.01-1.10)
Other	1.07 [*] (1.02-1.12)	1.03 (0.98-1.09)	0.97 (0.92-1.03)	1.01 (0.97-1.06)
HL by Priority Code				
Inadequate				
Catastrophically disabled	0.93 (0.86-1.00)	1.07 (0.98-1.16)	0.85 [*] (0.78-0.93)	0.91 [*] (0.85-0.98)
Medicaid assistance/low income	0.95 (0.88-1.03)	0.97 (0.89-1.05)	0.87 [*] (0.80-0.94)	0.91 [*] (0.85-0.97)
Moderate disability	1.06 (0.97-1.16)	1.24 ^{**} (1.12-1.37)	1.03 (0.93-1.13)	1.05 (0.97-1.14)
Marginal				
Catastrophically disabled	0.98 (0.92-1.03)	1.03 (0.97-1.09)	1.02 (0.96-1.08)	1.01 (0.96-1.06)
Medicaid assistance/low income	0.97 (0.93-1.02)	0.98 (0.93-1.03)	0.98 (0.93-1.04)	0.99 (0.95-1.03)
Moderate disability	1.10 [*] (1.04-1.16)	1.07 [*] (1.01-1.13)	1.07 [*] (1.01-1.14)	1.06 [*] (1.01-1.11)
HL by Race				
Inadequate, minority	1.05 (0.97-1.12)	1.00 (0.93-1.08)	1.01 (0.93-1.09)	1.02 (0.96-1.09)
Marginal, minority	1.06 [*] (1.00-1.11)	1.08 [*] (1.01-1.15)	1.01 (0.95-1.07)	1.06 [*] (1.00-1.11)
HL by Ethnicity				
Inadequate, Hispanic or Latino	0.94 (0.80-1.10)	1.20 [*] (1.00-1.43)	1.02 (0.85-1.22)	1.05 (0.91-1.22)
Marginal, Hispanic or Latino	1.03 (0.90-1.17)	1.07 (0.93-1.24)	1.07 (0.93-1.24)	1.10 (0.98-1.24)
HL by Chronic Conditions				
Inadequate, Cerebral	0.89 (0.77-1.03)	0.80 [*] (0.69-0.94)	1.02 (0.87-1.19)	0.96 (0.88-1.05)
Marginal, Cerebral	1.01 (0.91-1.12)	1.07 (0.95-1.20)	0.97 (0.86-1.09)	1.04 (0.97-1.11)
Inadequate, Heart	0.98 (0.92-1.04)	0.92 [*] (0.87-0.99)	0.91 [*] (0.86-0.98)	0.87 [*] (0.83-0.92)
Marginal, Heart	1.01 (0.97-1.06)	0.96 (0.92-1.01)	0.96 (0.91-1.01)	0.94 [*] (0.90-0.97)
Inadequate, Vascular	0.77 ^{**} (0.71-0.85)	0.90 [*] (0.82-0.99)	0.95 (0.87-1.05)	0.92 [*] (0.86-0.98)
Marginal, Vascular	0.90 [*] (0.85-0.97)	0.94 [*] (0.87-1.01)	0.95 (0.89-1.03)	0.96 (0.92-1.01)
Inadequate, Cancer	1.00 (0.92-1.08)	0.82 ^{**} (0.76-0.90)	0.95 (0.87-1.03)	0.92 [*] (0.87-0.98)
Marginal, Cancer	1.02 (0.96-1.09)	0.93 [*] (0.87-0.99)	1.04 (0.98-1.11)	1.01 (0.96-1.05)
Inadequate, Diabetes	0.93 [*] (0.88-0.98)	0.85 ^{**} (0.80-0.90)	0.98 (0.92-1.04)	0.94 [*] (0.89-0.98)
Marginal, Diabetes	0.95 [*] (0.91-0.99)	0.95 [*] (0.91-0.99)	0.95 [*] (0.91-0.99)	0.97 (0.94-1.01)
Inadequate, Arrhythmias	1.00 (0.92-1.09)	0.94 (0.86-1.02)	0.87 [*] (0.79-0.94)	0.96 (0.90-1.02)
Marginal, Arrhythmias	1.05 (0.99-1.11)	0.97 (0.91-1.03)	0.99 (0.93-1.06)	1.07 [*] (1.02-1.12)
HL by DCG Score				
Inadequate	0.79 ^{**} (0.77-0.81)	0.79 ^{**} (0.77-0.81)	0.79 ^{**} (0.77-0.81)	0.76 ^{**} (0.73-0.78)
Marginal	0.90 ^{**} (0.87-0.92)	0.90 ^{**} (0.88-0.92)	0.91 [*] (0.89-0.93)	0.87 [*] (0.85-0.89)

**=p-value<0.0001, *=p-value<0.05



RESULTS

- *Being minority, younger than 85 years of age, female, divorced, disabled, Medicaid/low income, and having chronic conditions was associated with increased health care costs.*



RESULTS

Health literacy level was associated with increased health care costs:

Adequate = 83%

\$4,598 - \$6,295



Marginal = 12%

\$6,023 - \$8,851



Inadequate = 5%

\$7,870 - \$12,352



17% = 15,874 Veterans

TABLE 2. OBSERVED AVERAGE COST PER PERSON BY HEALTH LITERACY AND CARE SETTING

		Cost (\$) from 2007 to 2009: Inpatient, Outpatient and Pharmacy			
Variables	n (%)	2007 mean (sd)	2008 mean (sd)	2009 mean (sd)	2007-2009 mean (sd)
TOTAL Cost					
Adequate	76,700 (83)	4,598 (10,847)	5,695 (13,784)	6,295 (16,140)	16,587 (30,578)
Marginal	10,935 (12)	6,023 (13,796)	7,977 (18,307)	8,851 (20,219)	22,852 (39,322)
Inadequate	4,939 (5)	7,870 (19,561)	10,350 (25,053)	12,352 (24,252)	30,573 (48,781)
Inpatient					
Adequate	11,010 (12)*	14,976 (26,046)	18,528 (30,906)	25,058 (40,559)	26,853 (45,812)
Marginal	2,177 (2)*	18,500 (32,860)	23,047 (35,754)	28,453 (41,227)	34,087 (52,481)
Inadequate	1,278 (1)*	20,770 (44,081)	26,065 (52,400)	30,028 (41,966)	37,906 (61,840)
Outpatient					
Adequate	76,700 (83)	3,864 (7,175)	4,441 (7,657)	4,428 (6,879)	12,732 (17,114)
Marginal	10,935 (12)	4,651 (7,041)	5,633 (8,986)	5,782 (8,822)	16,065 (19,959)
Inadequate	4,939 (5)	5,853 (9,940)	6,883 (9,155)	8,036 (11,345)	20,764 (23,370)
Pharmacy					
Adequate	74,787 (81)*	1,049 (4,113)	1,061 (4,082)	1,041 (3,647)	3,032 (7,827)
Marginal	10,704 (12)*	1,217 (3,088)	1,337 (3,859)	1,582 (5,094)	4,006 (8,219)
Inadequate	4,879 (5)*	1,704 (7,106)	1,882 (15,117)	2,672 (7,336)	6,075 (18,481)

*Sample sizes vary due to variation in use of inpatient and pharmacy services. Thus these values represent sample size for three-year timeframe.

**TABLE 3. THREE YEAR
PREDICTED COSTS BY RISK
SCENARIOS**

	HEALTH LITERACY					
	ADEQUATE		MARGINAL		INADEQUATE	
	Base Model	Interaction Model	Base Model	Interaction Model	Base Model	Interaction Model
Male aged 55-64 years old, married, not disabled or service connected, non-minority, not Hispanic, with no chronic conditions and mean comorbidity score	\$8,254	\$6,530	\$9,248	\$8,864	\$10,719	\$12,178
% difference between base and interaction model	-21%		-4%		14%	
Male aged 55-64 years old, <u>divorced</u> , not disabled or service connected, non-minority, not Hispanic, with no chronic conditions and mean comorbidity score	\$9,479	\$7,466	\$10,621	\$10,691	\$12,310	\$12,699
% difference between base and interaction model	-21%		<1%		3%	
Male aged 55-64 years old, <u>divorced, moderately disabled</u> , non-minority, not Hispanic, with no chronic conditions and mean comorbidity score	\$11,926	\$9,324	\$13,362	\$14,122	\$15,487	\$16,730
% difference between base and interaction model	-22%		6%		8%	
Male aged 55-64 years old, <u>divorced, moderately disabled, minority</u> , not Hispanic, with no chronic conditions and mean comorbidity score	\$12,076	\$9,367	\$13,530	\$14,978	\$15,682	\$17,227
% difference between base and interaction model	-22%		11%		10%	
Male aged 55-64 years old, <u>divorced, moderately disabled, minority, Hispanic</u> , with no chronic conditions and mean comorbidity score	\$12,634	\$9,647	\$14,155	\$17,035	\$16,407	\$18,606
% difference between base and interaction model	-24%		20%		13%	
Male aged 55-64 years old, <u>divorced, moderately disabled, minority, Hispanic, heart and diabetes conditions</u> and mean comorbidity score	\$17,691	\$13,801	\$19,822	\$22,263	\$22,975	\$21,759
% difference between base and interaction model	-22%		12%		-5%	
Male aged 55-64 years old, <u>divorced, moderately disabled, minority, Hispanic, heart and diabetes conditions and upper quartile comorbidity score (0.74)</u>	\$19,953	\$19,972	\$22,355	\$24,794	\$25,912	\$23,759
% difference between base and interaction model	<1%		11%		-8%	

WHAT DO SCENARIOS TELL US?

- *Scenarios confirm influencing factors on cost, including impact of low health literacy.*
- *Scenarios inform research questions and points of leverage for improvements in patient-centered care.*



SO WHAT?

- Veterans' with low health literacy for a 3-year period, was $\approx$ **\$138 million** more than those with adequate health literacy in the NF/SG region.
- Large-scale data illustrate financial impacts within integrated healthcare system.



FINAL THOUGHTS

- *Improving health literacy in integrated healthcare systems such as the VA has great potential for economic savings.*
- *Ongoing assessment at population level provides compelling support for investing in research, policy, and practice.*



DON'T FORGET
STUDY LIMITATIONS!
Selection bias, can't
confirm causality,
subject to inaccurate
and missing data...

THANK YOU



This material is the result of work supported with resources and the use of facilities at the James A. Haley Veterans' Hospital. Content does not represent the views of the Department of Veterans Affairs or the United States Government.

