Duke University School of Medicine

A Cross-Sectional Study of GPT4Based Plain Language Translation of Clinical Notes to Improve Patient Comprehension of Disease Course and Management

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Motivations

Personal experience

Clinical experience

Met Dr. Engelhard

3rd year research & manuscript

Background

- 9 in 10 U.S. adults struggle with limited health literacy (HL) associated with higher rates of [1-6]
  - Hospital admissions, readmissions
  - Medication nonadherence
  - Healthcare cost
  - All-cause mortality

- HL rates are 2-3x lower in marginalized populations, disproportionally affects [7, 8]
  - Older adults
  - Racial and ethnic minorities
  - Limited English proficiency
  - Limited educational opportunity

- 21st Century Cures Act mandates all health documents be made available to patients in their EHRs
- 71% patients report accessing EHRs to read clinical notes, majority reading discharge summary notes (DSNs)[9, 10]
- Clinical notes have a very low level of readability , hindering patients' ability to engage in shared decision-making [10]
- Use of GPT to improve EHR readability and empower patients, especially those with historically low HL, to be agents of their own care

“

Does GPT-based plain language translation of DSNs improve patient comprehension of disease course and management?

And does this affect marginalized populations to a greater degree?

Methods: DSN Selection & Translation

- DSN Selection
  - PACE to access DSNs
  - CAP, ADHF, DKA, AIS
  - Manually deidentified each DSN

- DSN Translation
  - Prompt engineering → most readable and comprehensive translation
  - ”Can you provide a detailed summary to give to a patient with low HL?”

Standardized set of 8 DSNs
Patients randomly assigned 4 DSNs each

Methods: Patient Recruitment & Questionnaire

- Patient Recruitment
  - MyChart to enroll 553 patients from 12/2023 to 2/2024
  - Enhanced enrollment for race and ethnicity (#White = #Black, Hispanic)
  - Inclusion criteria: 18+ years old, able to read English, no diagnosis of cognitive impairment, DUHS appointment scheduled within 2 months of enrollment

- Questionnaire Workflow
  - Part A: Demographics, HL screening
  - Part B: After reading each DSN patients answered questions assessing objective comprehension, subjective comprehension, confidence, time spent

Primary Outcomes

Objective comprehension

1-point MCQ

Subjective comprehension

5-point Likert scale

Confidence

3-point Likert scale

Time spent

in seconds

Statistical Analysis

- Comprehension scores were calculated by summing all items:
  - Objective comprehension: 4 points
  - Subjective comprehension: 16 points
  - Confidence: 8 points

- Used generalized estimating equations with an unstructured covariance matrix to quantify relationships between predictors and outcomes

- Separate models were fitted to quantify:
  - Effect of translation on each primary outcome
  - Effect of DSN diagnosis on each primary outcome
  - Effect of demographics and HL on each primary outcome

- Used interaction terms to quantify differential effects of translation between groups

Results

Demographics, language proficiency, and health literacy of patient population

Characteristic	Category	No. (%)
Gender	Female	411 (74)
	Male	139 (25)
	Non-binary	3 (1)
Age	65+	240 (43)
	45-64	222 (40)
	18-44	91 (6)
Race	White	362 (65)
	Black	175 (32)
	Asian, Native American	16 (3)
Ethnicity	Non-Hispanic	540 (98)
	Hispanic	13 (2)
Education Level	Above Bachelors	201 (36)
	Bachelors Degree	194 (35)
	Below Bachelors	158 (29)
English Proficiency	Native Proficiency	359 (65)
	Medium Proficiency	186 (34)
	Low Proficiency	8 (1)
Another Language	No	463 (84)
	Yes	90 (16)
Health Info Confidence	Very Confident	390 (71)
	Somewhat Confident	159 (29)
	Not Confident	4 (1)
Medical Form Confidence	Very Confident	496 (90)
	Somewhat Confident	55 (10)
	Not Confident	2 (0.4)
Health Knowledge	Very Confident	152 (27)
	Somewhat Confident	318 (58)
	Not Confident	83 (15)

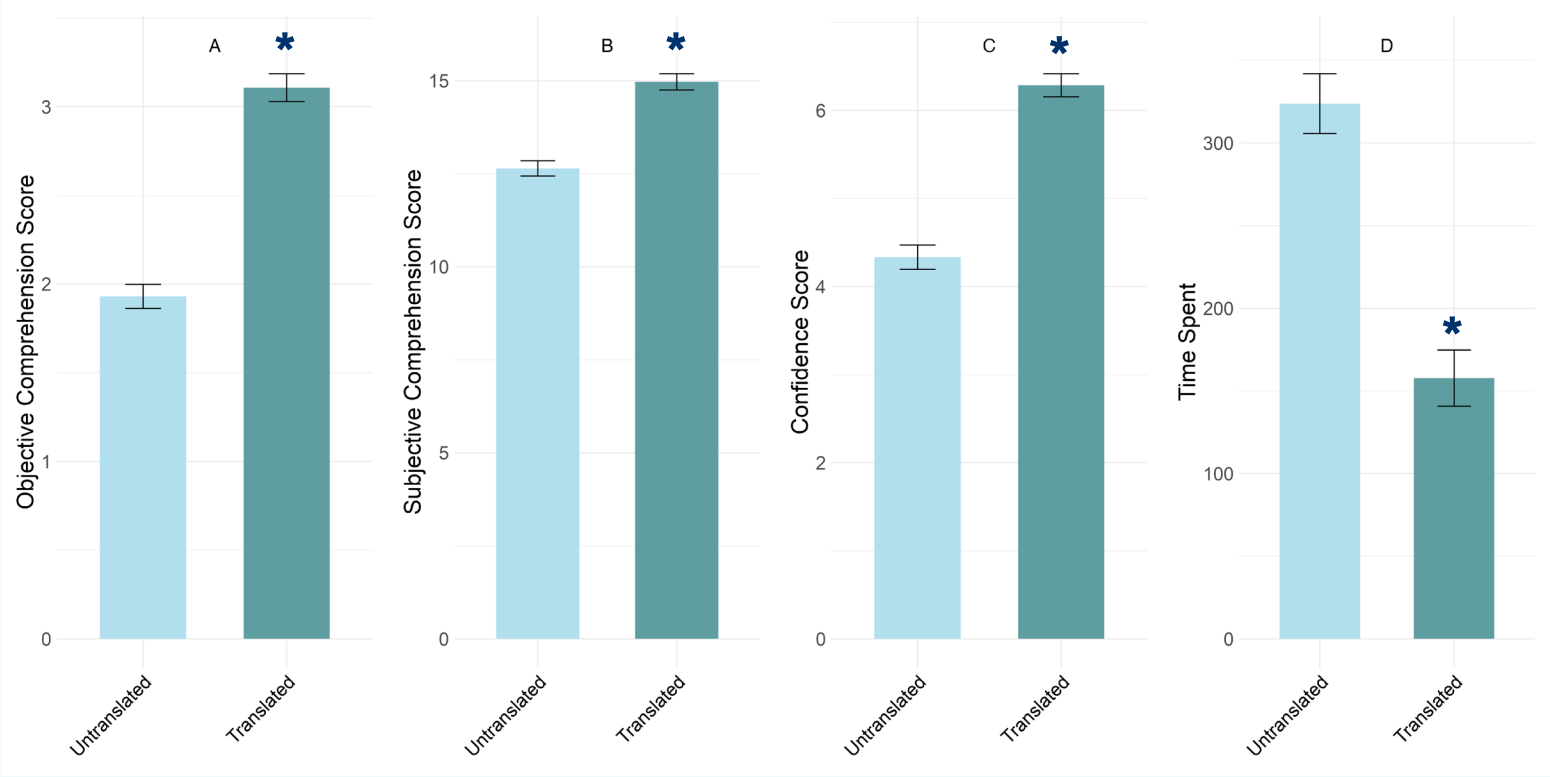
- Female (74%)
- Age 65+ (43%)
- Black (32%)
- Hispanic (2%)

- Below Bachelor's (29%)
- Non-native English proficiency (35%)
- Another language proficiency (16%)

- Low confidence with health info (30%)
- Low confidence with medical forms (10%)
- Low confidence with health knowledge (73%)

Results

Effect of GPT translation on objective and subjective comprehension, confidence, and reading time across all DSNs



Objective
61% increase
1.9 to 3.1 of 4

Subjective
18% increase
12.6 to 14.9 of 16

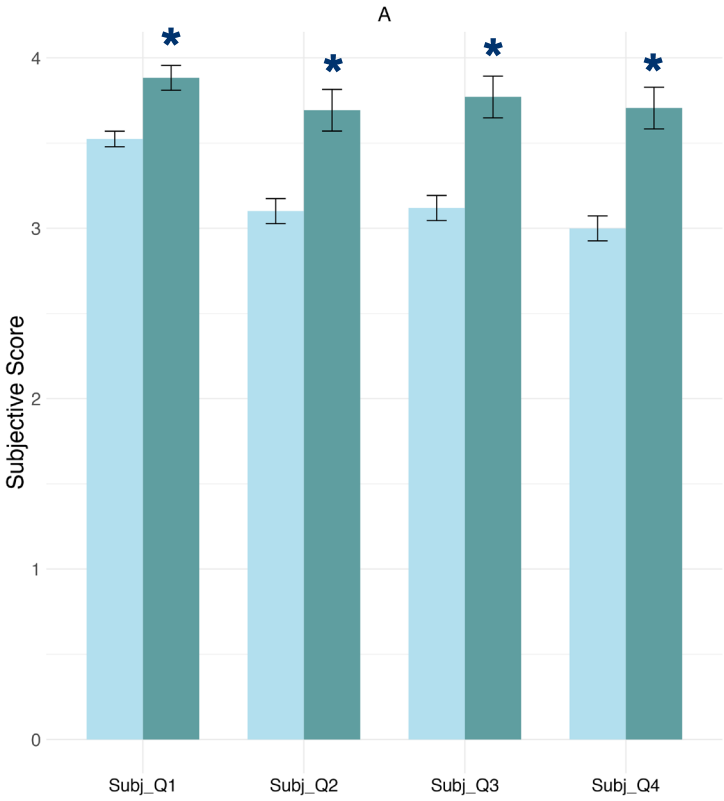
Confidence
45% increase
4.3 to 6.3 of 12

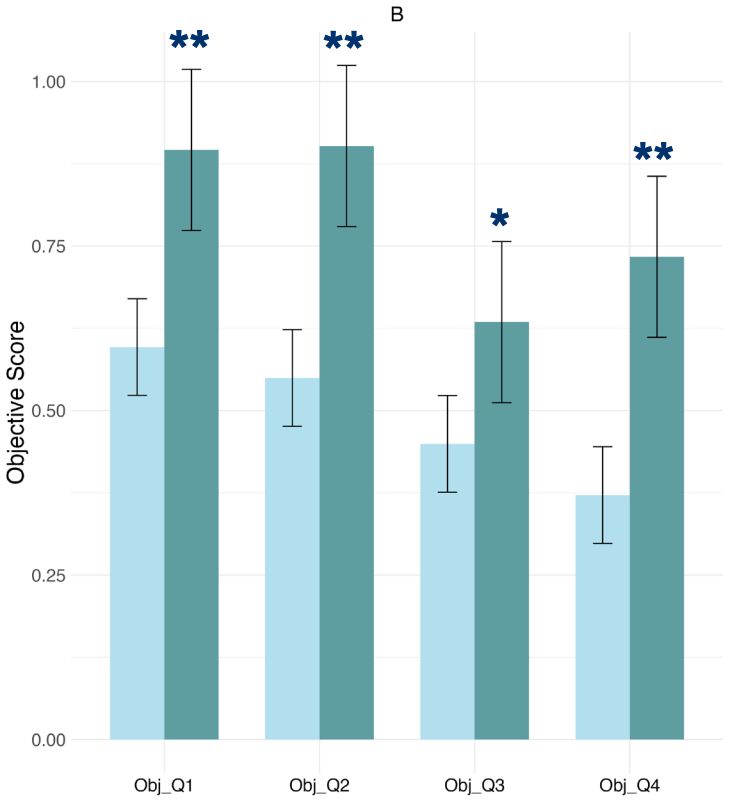
Time spent
51% decrease
323.8s to 157.8s

$p < 0.001$ *

Results

Effect of GPT translation on objective and subjective comprehension by individual questionnaire question theme





Q1:
Why was this patient admitted to the hospital?

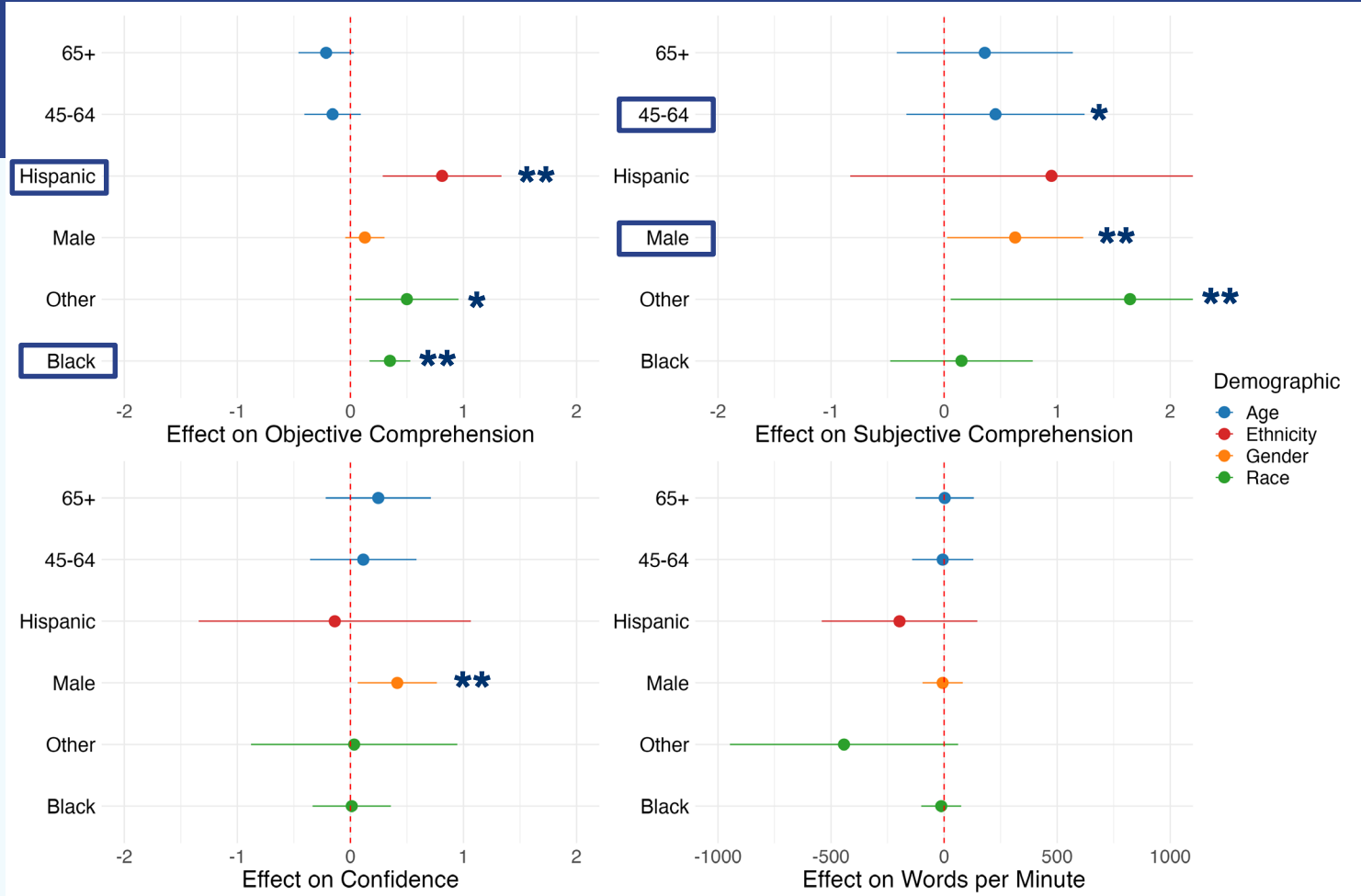
Q2:
Which of the following occurred during this patient's hospital stay?

Q3:
Which of the following is part of this patient's medication regimen after discharge?

Q4:
Why does this patient need to follow up with [specialist]?

$p < 0.01$ *
$p < 0.001$ **

Differential effect of GPT translation on outcomes by demographic



Results

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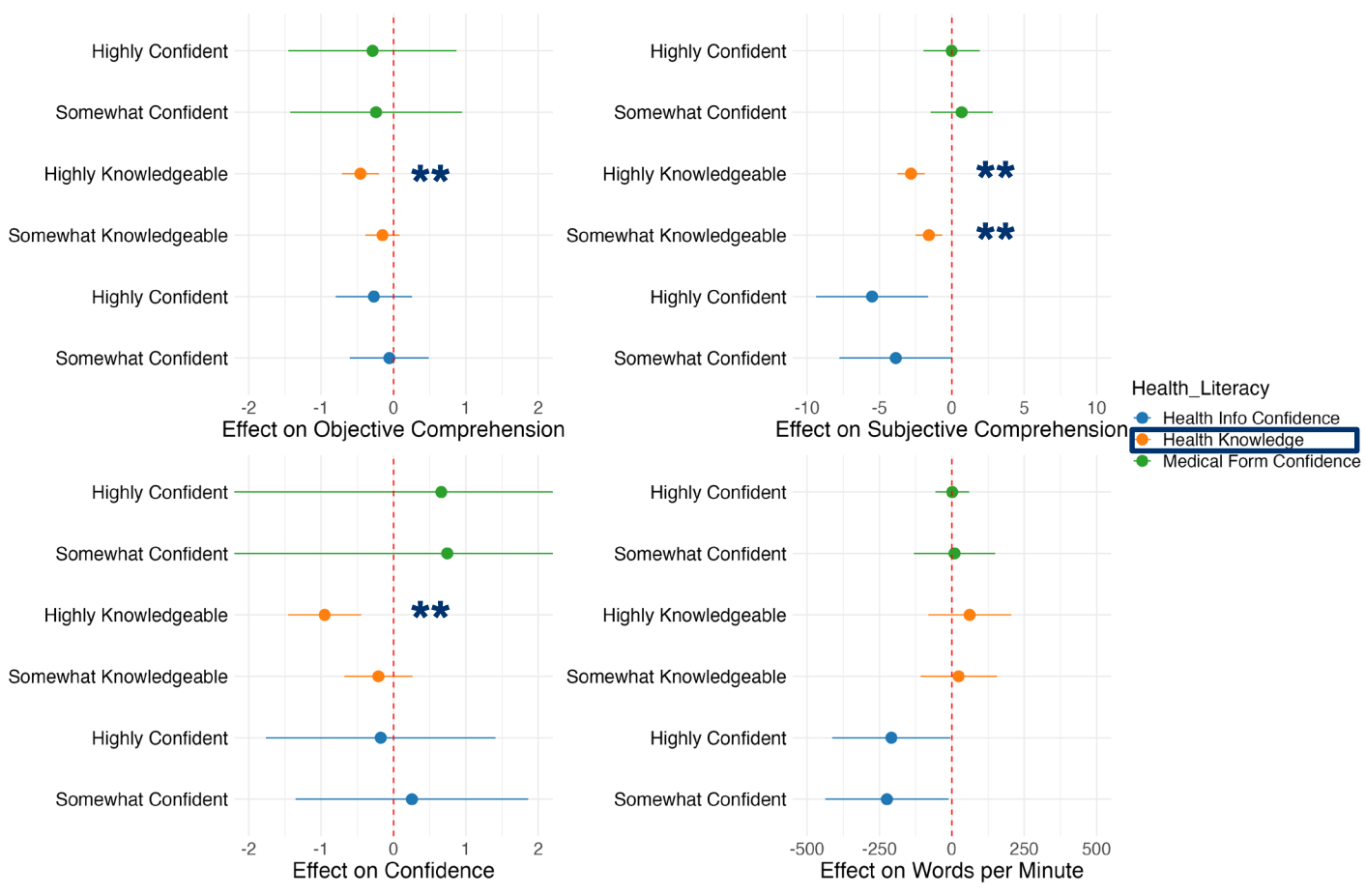
Q4:
Why does this patient need to follow up with [specialist]?

$p < 0.01$ *
$p < 0.001$ **

Differential effect of GPT translation on outcomes by level of HL



Results

Q1:
How confident are you understanding health information provided to you?

Q2:
What level of knowledge do you have in health sciences and/or medicine?

Q3:
How confident are you filling out medical forms by yourself?

$p < 0.001$ **

Conclusions

GPT4 translation of DSNs significantly improved patient comprehension of disease course and management while optimizing time spent reading them

This effect was significantly greater in marginalized populations with historically low HL, reducing the gap in comprehension scores between patient populations

Limitations

- Patients read a standardized set of DSNs instead of their own DSNs
- Enrolling patients through MyChart likely selected for those with higher levels of health literacy at baseline
- Despite enhancing enrollment for equal representation of race/ethnicity, modest sample of Hispanic patients enrolled in the study

Table 1: Regression Coefficients between Untranslated and Translated Discharge Summaries Across Different Models with Target Objective Readability Score

Feature	Model 1: Demographic		Model 2: Health literacy		Model 3: Both	
	Estimates	SE	Estimates	SE	Estimates	SE
Untranslated Summaries						
(Intercept)	2.22***	0.05	1.25***	0.34	1.51***	0.34
race: Black	-0.63***	0.08			-0.53***	0.08
race: Other	-0.13	0.29			-0.03	0.29
ethnicity	-0.74*	0.32			-0.69*	0.32
gender: Male	-0.29***	0.08			-0.25**	0.08
gender: Non-binary	-0.09	0.62			-0.05	0.61
medical form confidence			-0.11	0.13	-0.07	0.12
health inform confidence			0.16	0.09	0.11	0.09
health knowledge			0.32***	0.06	0.30***	0.06
english: Full Proficiency			-0.16*	0.08	-0.08	0.08
english: Low Proficiency			-0.78*	0.30	-0.35	0.31
educlevel: Below Bachelors			-0.18	0.09	-0.16	0.09
educlevel: Above Bachelors			0.01	0.08	0.01	0.08
R-squared	0.07		0.07		0.11	
Translated Summaries						
(Intercept)	3.19***	0.04	2.98***	0.26	2.99***	0.26
race: Black	-0.22***	0.06			-0.09	0.06
race: Other	-0.09	0.21			0.00	0.21
ethnicity	0.08	0.21			0.24	0.21
gender: Male	-0.07	0.06			-0.06	0.06
gender: Non-binary	0.27	0.38			0.16	0.37
medical form confidence			-0.06	0.09	-0.04	0.09
health inform confidence			0.09	0.07	0.08	0.07
health knowledge			0.09*	0.04	0.09	0.05
english: Full Proficiency			-0.24***	0.06	-0.23***	0.06
english: Low Proficiency			-1.01***	0.22	-1.03***	0.22
educlevel: Below Bachelors			-0.14*	0.07	-0.13	0.07
educlevel: Above Bachelors			-0.02	0.06	-0.02	0.06
R-squared	0.01		0.06		0.06	

Note: $^{*}p < 0.05$; $^{**}p < 0.01$; $^{***}p < 0.001$.

Future Work: Preliminary Data

GPT4-based plain language translation eliminates race disparities in objective comprehension scoresthat are not mediated by other factors of health literacy

Future Work: Preliminary Data (cont'd)

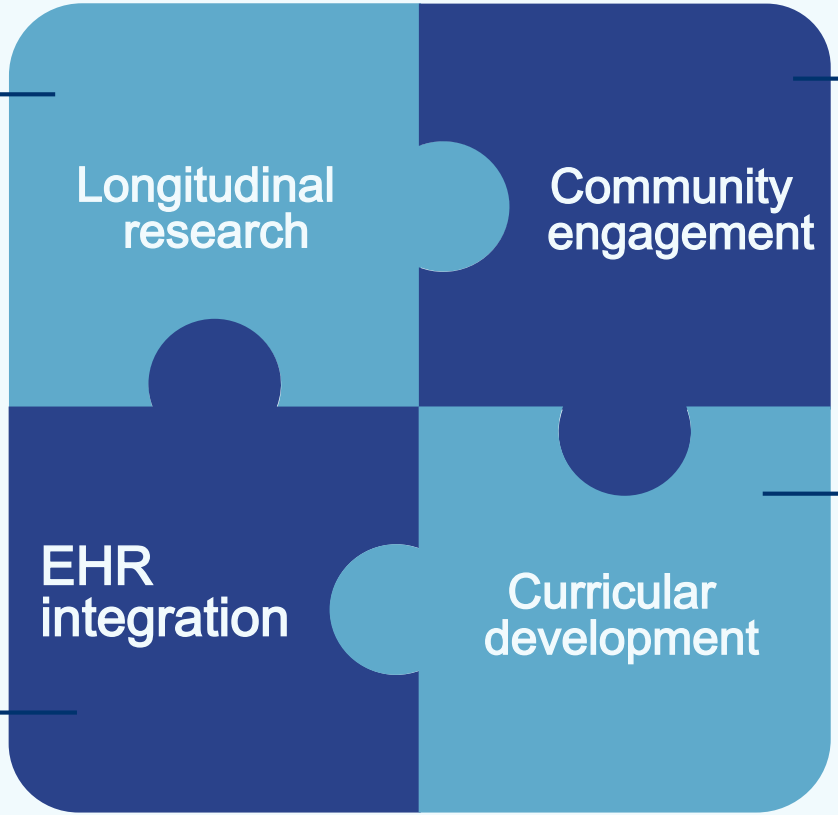
- Race is a significant and independent factor for health literacy
  - Objective comprehension scores were 0.63 points lower in Black patients than White patients ($p<0.001$) when controlling for all other health literacy factors.

- GPT translation closes this gap
  - The negative effect of race on objective comprehension scores is cut into a third when clinical notes are translated. Black patients scored 0.63 points lower before translation → 0.22 points lower after translation.

Next Steps

Effect of improved comprehension on health outcomes

Partner with Duke CERI and community leaders for tailored initiatives



Early introduction of models for accessible patient communication

Embed a "translate" feature within Epic interface

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THANK YOU!

Happy to take any questions

I understand why this patient came in to the hospital.

Strongly agree | Agree | Neither agree nor disagree | Disagree | Strongly disagree

I understand what occurred during this patient's hospital stay.

Strongly agree | Agree | Neither agree nor disagree | Disagree | Strongly disagree

I understand what this patient's medication regimen is after discharge.

Strongly agree | Agree | Neither agree nor disagree | Disagree | Strongly disagree

I understand what this patient needs to follow up on at their next appointment.

Strongly agree | Agree | Neither agree nor disagree | Disagree | Strongly disagree

1. Why was this patient admitted to the hospital?
    a. He had a community-acquired cough, runny nose, and pulmonary embolism
    b. He had small amount of blood in his sputum and infection in his lungs
    c. He had a history and symptoms of pulmonary embolism
    d. He had a contagious lung disease and needed to isolate from close contacts

    How confident do you feel about your response?
        a. Confident
        b. Somewhat confident
        c. Not confident

2. Which of the following occurred during this patient's hospital stay?
    a. He tested positive for C. difficile with toxin to EIA
    b. His hypertension medication was discontinued due to normal blood pressure
    c. His imaging tests found infection in his left lower lung
    d. He developed cough, runny nose, and pain at rest and movement of his left arm

    How confident do you feel about your response?
        a. Confident
        b. Somewhat confident
        c. Not confident

3. Which of the following is part of the medication regimen this patient needs to follow after discharge?
    a. Take antibiotics for 5 days after discharge from the hospital
    b. Pause blood thinning medication until one day after completing antibiotics
    c. Hold rivaroxaban until antibiotics have cleared community-acquired pneumonia
    d. Continue taking antibiotics until 8/10/23

    How confident do you feel about your response?
        a. Confident
        b. Somewhat confident
        c. Not confident

4. Why does this patient need to follow-up with a pulmonologist?
    a. To determine whether he should continue taking rivaroxaban
    b. To further evaluate his hypertension in an outpatient setting
    c. To discuss how to prevent community-acquired pneumonia from progressing to CTPEH
    d. To get a CT scan and look for changes from past blood clots in his lungs

    How confident do you feel about your response?
        a. Confident
        b. Somewhat confident
        c. Not confident

Your Stay at the Hospital (9/18/2023 to 9/24/2023)

- **Reason for Hospital Stay:** You were admitted because of DKA (Diabetic Ketoacidosis). This is a serious condition that happens when your body doesn't have enough insulin. Your blood sugar was too high because your insulin pump may not have been working right.
- **Main Treatment:** We gave you fluids and insulin through an IV (a tube in your vein) to help you get better.

Treatment in the Hospital

- **IV Fluids and Insulin:** We gave you special fluids and insulin through a tube in your arm to help bring your blood sugar down.

Other Medical Care

- **Flank Pain:** You had pain on the left side of your lower back when you came in, but it went away on its own.
- **Low Potassium and Magnesium:** We gave you medicine for this because it can happen with DKA and throwing up.
- **Asthma:** You kept using your regular asthma inhaler as needed.

Changes in Your Diabetes Treatment

- **Insulin Pump:** We stopped using your insulin pump because it might not be working properly.
- **New Insulin Plan:** Now, you'll use two kinds of insulin shots:
  - **Basaglar:** 20 units once a day.
  - **Humalog:** 5 units with each meal, plus extra if your blood sugar is high (this is called a sliding scale).

Medications to Take at Home

Start Taking These:

- **Humalog Insulin:** Inject 5 units, three times a day with meals.
- **Prochlorperazine (Compazine) 5 mg Tablet:** Take one tablet every 6 hours for nausea, if needed.

Continue Taking (With Changes):

- **Basaglar Insulin:** Inject 20 units once a day.

Continue Taking (No Changes):

- **Omeprazole (Prilosec) 20 mg Capsule:** Take one capsule once a day.
- **Albuterol Inhaler:** Use two puffs every 4 hours as needed for wheezing.

Stop Taking: Your old insulin pump medications.

Appointments After Leaving the Hospital

- **Primary Care Doctor:** Visit them on 9/25.
- **Diabetes Specialist (Endocrinologist):** Appointment on 10/23 with Dr. Robert Martin.

Why It's Important to See Your Doctors Again

- **Check Your Diabetes Control:** It's important to make sure the new insulin plan is working well for you.
- **Talk About Your Insulin Pump:** The diabetes specialist (endocrinologist) will help decide if you need a new insulin pump or if you should continue with injections.

Other Information

- **Allergies:** You have no known allergies.
- **Diet:** You can eat all kinds of foods.
- **Activity:** Keep moving and doing your normal activities as you feel able.

Remember, it's really important to take your medications as we've discussed, and to see your doctors on the dates mentioned. If you have any questions or feel sick, you should call your doctor right away.