

SUPPLEMENTARY DATA

Supplementary Table 1. Summary Statistics for Each Year: 2011-2014

Variables	Mean (Std. Dev.); Frequency %			
	2011 (N=10,904)	2012 (N=12,767)	2013 (N=13,629)	2014 (N=15,316)
Visit and messaging frequency [min-max]				
Any message	45%	73%	82%	82%
Message frequency among users [1-59]	3.9 (4.1)	4.5 (4.4)	5.2 (4.8)	5.3 (5.5)
Any patient-initiated message	44%	59%	62%	65%
Patient-initiated message frequency, if any [1-44]	3.6 (3.6)	4.0 (3.9)	4.1 (3.9)	3.3 (4.0)
Any provider-initiated message	12%	50%	66%	63%
Provider-initiated message frequency, if any [1-31]	1.5 (1.0)	1.9 (1.3)	2.5 (2.0)	2.0 (2.1)
Visits to a primary care physician or diabetes-related specialist [1-67]	3.9 (3.2)	3.8 (3.1)	3.7 (2.9)	3.8 (3.0)
Patient characteristics [min-max]				
Age [18-75]	55.9 (11.5)	55.9 (11.6)	56.3 (11.6)	56.4 (11.7)
Female	40%	43%	43%	43%
Insulin prescription	19%	19%	20%	21%
Comorbidities (Charlson comorbidity index without age)[1-14]	2.1 (1.5)	2.0 (1.4)	1.9 (1.3)	1.9 (1.3)
Race/ethnicity				
Non-Hispanic white	45%	44%	42%	40%
Black	3%	3%	3%	3%
Asian	30%	31%	32%	32%
Latino	5%	5%	5%	5%
Other race or race not reported	18%	18%	19%	21%
Non-English preferred	8%	8%	8%	8%
Insurance type				
Preferred provider organization plan	66%	73%	75%	78%
Health maintenance organization plan	32%	24%	23%	19%
Other insurance	2%	2%	2%	2%
Years with the primary care physician [0-15]	3.8 (3.0)	4.3 (3.2)	4.6 (3.5)	4.9 (3.7)
Provider characteristics				
Female	50%	53%	56%	58%
Number of years of practice [4-48]	18.6 (8.5)	19.2 (8.5)	19.8 (8.6)	20.6 (8.9)
Number of patients with diabetes [1-211]	80.0 (38.1)	89.1 (40.2)	91.3 (41.9)	91.4 (44.3)

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Supplementary Table 2. Results from a logistic regression with adjustment of clustering
Outcome: Met HbA1c <8% (64 mmol/mol) target (0/1)

Variables	Odds Ratio	95% Confidence Interval
Visit frequency (ref= 1)		
2	1.16**	1.08 - 1.25
3	1.29**	1.18 - 1.40
4 or more	1.46**	1.35 - 1.58
Message frequency (ref= 1)		
2	1.17**	1.06 - 1.28
3	1.38**	1.25 - 1.53
4 or more	1.55**	1.43 - 1.69
No message (ref= any message)	0.83**	0.77 - 0.90
Female	0.96	1.03 - 1.03
Age	1.03**	0.89 - 1.03
Insulin prescription	0.25**	0.23 - 0.27
Charlson comorbidity index (not counting age; 0,1, 2, 3 or more)	0.87**	0.83 - 0.91
Race/ethnicity (ref= non-Hispanic white)		
Black	0.71**	0.58 - 0.86
Asian	1.13**	1.03 - 1.23
Latino	0.77**	0.66 - 0.89
Other or unknown	0.73**	0.67 - 0.80
Prefer non-English (ref= prefer English)	1.06	0.93 - 1.21
Insurance type (ref= PPO)		
HMO	1.13**	1.05 - 1.22
Other insurance	0.63**	0.53 - 0.74
Number of years with the primary provider	1.02**	1.01 - 1.03
Primary provider is female	1.04	0.96 - 1.13
Number of patients with diabetes in the primary provider's panel /10	1.01*	1.00 - 1.02
Number of months of a year as an active patient	1.01	1.01 - 1.01
Year (ref= 2011)		
2012	0.72**	0.68 - 0.77
2013	0.59**	0.55 - 0.64
2014	0.57**	0.53 - 0.61
Number of observations	52,548	

**p<0.01, *p<0.05

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Supplementary Table 3. Results from a logistic regression with adjustment of clustering
Outcome: whether met each quality target (0/1)^(a)

	Odds ratios from each subgroup regression are presented		
	Eye exam (eye screening for diabetic retinal disease) ^(b)	HbA1c screening (A nephropathy screening test or evidence of nephropathy)	Nephropathy monitoring (Screening of HbA1c each 6 months)
Visit frequency (ref= 1)			
2	1.30**	2.07**	1.43**
3	1.55**	3.43**	1.78**
4 or more	2.27**	4.80**	2.15**
Message frequency (ref= 1)			
2	1.16**	1.20	1.07
3	1.25**	1.89**	1.42**
4 or more	1.34**	1.96**	1.28**
No message (ref= any message)	0.85**	0.65**	0.74**
Female	1.03	1.02**	1.03**
Age	0.99**	0.72**	0.60**
Insulin prescription	1.27**	1.08	1.24**
Charlson comorbidity index (not counting age; 0,1, 2, 3+)	1.07**	0.97	1.53**
Race/ethnicity (ref=non-Hispanic white)			
Black	1.04	1.35	1.07
Asian	1.32**	1.78**	1.38**
Latino	1.10	1.15	1.02
Other or unknown	1.11*	1.45**	1.28**
Prefer non-English (ref= prefer English)	1.06	1.45*	1.29*
Insurance type (ref= PPO)			
HMO	1.98**	2.05**	1.62**
Other insurance	0.67**	0.42**	0.64**
Number of years with the primary provider	1.07**	1.02*	1.02*
Primary provider is female	1.02	1.12	1.10
Number of patients with diabetes in the primary provider's panel /10	0.99**	1.02*	1.01*
Number of months of a year as an active patient	1.02**	1.03**	1.03**
Year (ref= 2011)			
2012		0.92	0.81**
2013	2.99**	0.86	0.53**
2014	3.01**	1.18	0.42**
Number of observations	41,334	52,541	52,567

**p<0.01, *p<0.05

(a) The unit of analysis was patient-year. As one patient could be included up to four times in the 4-year period of analysis, we accounted for patient-level clustering using Huber-White standard errors.(b) This metric has been used since 2012, and thus, data from 2012 to 2014, using 2012 as the referent category.

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Supplementary Table 4. Message and visit frequency and the likelihood of meeting HbA1c<8% (64 mmol/mol) target – Alternative specifications of visit and message frequencies ^(a)

Variables	Odds Ratio
Model 1: Visit and message frequencies as a continuous variable	
Number of visits	1.04**
Number of messages	1.04**
No message (ref= any message)	0.75**
Model 2: Visit and patient-initiated and provider-initiated message frequencies as a continuous variable	
Number of visits	1.04**
Number of patient-initiated messages	1.04**
Number of provider-initiated messages	1.03**
No message (ref= any message)	0.75**

**p<0.01

(a) In the multilevel regression analysis, patient-level (age, sex, Insulin prescription, number of comorbidities, race/ethnicity, language preference, insurance type, number of years with primary care provider) and provider-level (sex, number of patients with diabetes) factors (as shown in Supplementary Table 3) and patient-level clustering are adjusted.

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Supplementary Table 5. Results from individual fixed effects regression
Outcome: Met HbA1c <8% (64 mmol/mol) target ^{(a)(b)}

Variables	Coefficient	t-stat
Visit frequency (ref=1)		
2	0.0019	(0.0042)
3	-0.15	(-0.29)
4 or more	1.59**	(3.26)
Message frequency (ref=1)		
2	1.29*	(2.34)
3	1.58**	(2.65)
4 or more	2.16**	(4.25)
No message (ref= any message)	0.48	(1.00)
Age	-1.78**	(-10.2)
Insulin prescription	-6.45**	(-8.50)
Insurance type (ref=PPO)		
HMO	1.59**	(2.58)
Other insurance	-0.60	(-0.41)
Number of years with the primary provider	-0.15	(-1.23)
Primary provider is female	-0.62	(-0.54)
Number of patients with diabetes in the primary provider's panel /10	0.044	(0.44)
Number of months of a year as an active patient	0.18**	(28.1)
Year (ref=2011)		
2012	-0.54	(-1.71)
2013	-0.82**	(-2.79)
Constant	167**	(18.20)
Number of observations	52,548	
Number of patients	20,648	

**p<0.01

(a) Time invariant covariates (patient sex, number of comorbidities defined at baseline, race/ethnicity, language preference), and indicator of year 2014 were dropped from the fixed effects estimation due to collinearity.

(b) Linear probability model was used as an alternative to logistic regression model. In fixed effects logistic model, most observations (with the same independent and dependent variables over time) are dropped from the estimation sample.

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**Supplementary Table 6. Results from difference-in-differences regression
Outcome: Met HbA1c <8% (64 mmol/mol) target**

Variables	Odds Ratio	95% Confidence Interval
Any message	1.34**	1.19 - 1.51
Post expansion of messaging services (year 2012, 2013, 2014)	0.60**	0.55 - 0.65
Post X any message	1.18**	1.04 - 1.34
Visit frequency (ref= 1)		
2	1.18**	1.09 - 1.27
3	1.33**	1.22 - 1.44
4 or more	1.55**	1.44 - 1.67
Age	1.03**	1.03 - 1.03
Female	0.98	0.91 - 1.05
Insulin prescription	0.26**	0.24 - 0.27
Charlson comorbidity index (not counting age; 0,1, 2, 3 or more)	0.88**	0.84 - 0.91
Race/ethnicity (ref= non-Hispanic white)		
Black	0.68**	0.56 - 0.83
Asian	1.11*	1.02 - 1.21
Latino	0.75**	0.65 - 0.88
Other or unknown	0.72**	0.66 - 0.79
Prefer non-English (ref= prefer English)	1.05	0.92 - 1.19
Insurance type (ref= PPO)		
HMO	1.14**	1.06 - 1.23
Other insurance	0.62**	0.53 - 0.74
Number of years with the primary provider	1.02**	1.00 - 1.03
Primary provider is female	1.04	0.96 - 1.12
Number of patients with diabetes in the primary provider's panel /10	1.01*	1.00 - 1.02
Number of months of a year as an active patient	1.01**	1.01 - 1.01
Number of observations	52,548	

**p<0.01, *p<0.05

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Supplementary Table 7. Message and visit frequency and the likelihood of meeting HbA1c<8% (64 mmol/mol) target – Subgroup analysis by patient’s preferred language ^(a)

Odds ratios from each subgroup regression are presented

Variables	age 65 or older N=14,579	age 18-64 N=37,969	Insulin use N=10,375	No insulin use N=42,173	CCI 3 or more N=12,011	CCI 1 or 2 N=40,537	Preferring non-English N=4,201	Preferring English N=48,347
Visit frequency (ref= 1)								
2	1.18*	1.15**	0.97	1.19**	1.13	1.17**	1.61**	1.13**
3	1.52**	1.23**	1.11	1.29**	1.31*	1.28**	1.61**	1.26**
4 or more	1.73**	1.39**	1.11	1.65**	1.54**	1.44**	1.71**	1.44**
Message frequency (ref= 1)								
2	1.23	1.16**	1.31**	1.11	1.19	1.16**	1.33	1.16**
3	1.25	1.41**	1.37**	1.39**	1.43**	1.36**	1.46	1.37**
4 or more	1.67**	1.53**	1.66**	1.53**	1.51**	1.56**	1.40*	1.56**
No message (ref= any message)	0.80*	0.83**	1.01	0.77**	0.80*	0.84**	0.89	0.83**

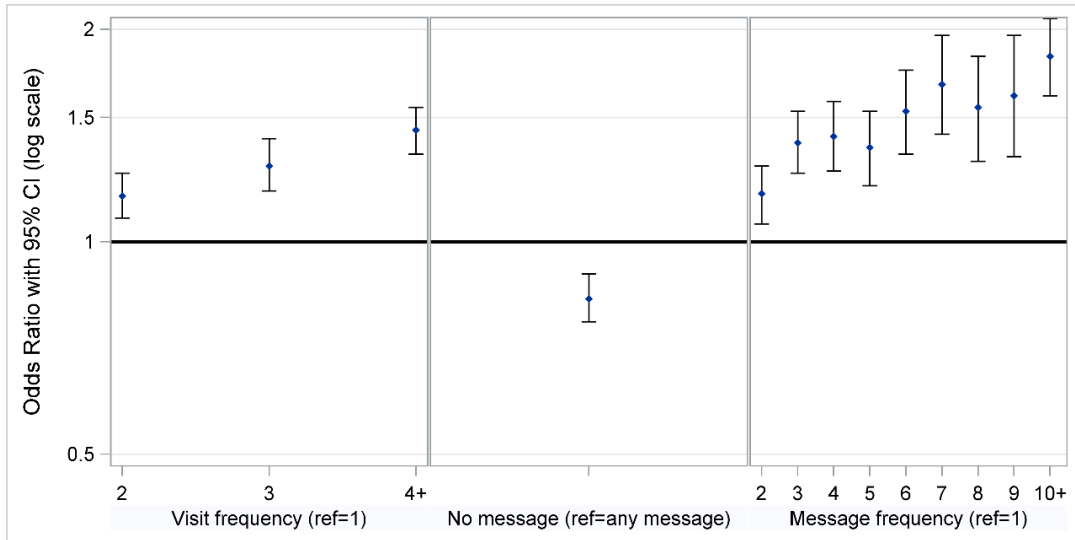
**p<0.01, *p<0.05

In the multilevel regression analysis, patient-level (age, sex, Insulin prescription, number of comorbidities, race/ethnicity, language preference, insurance type, number of years with primary care provider) and provider-level (sex, number of patients with diabetes) factors and patient-level clustering are adjusted.

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Supplementary Figure 1. Effect of messaging frequencies on the likelihood of meeting HbA1c<8% (64 mmol/mol) target

Odds Ratio with 95% CI from Multivariate Analysis ^(a)



In the multilevel regression analysis, patient-level (age, sex, Insulin prescription, number of comorbidities, race/ethnicity, language preference, insurance type, number of years with primary care provider) and provider-level (sex, number of patients with diabetes) factors and patient-level clustering are adjusted.