

Supplementary Online Content

Manz CR, Parikh RB, Small DS, et al. Effect of integrating machine learning mortality estimates with behavioral nudges to clinicians on serious illness conversations among patients with cancer: a stepped-wedge cluster randomized clinical trial. *JAMA Oncol*. Published online October 15, 2020. doi:10.1001/jamaoncol.2020.4759

eFigure 1. Stepped-Wedge Design Overview

eFigure 2. Example Clinician Emails by Performance

eFigure 3. Serious Illness Conversations for High-Risk Patients by Clinic

eTable 1. High-Risk Patient Encounter Characteristics

eTable 2. Patient Encounters and SIC Rates by Clinic and Control vs Intervention

eTable 3. Regression Table for Serious Illness Conversation Model Including All Patients

eTable 4. Regression Table for Serious Illness Conversation Model Including High Risk Patients Only

eTable 5. Fully Adjusted Models for Serious Illness Conversations (Sics) for All Patients and for High Risk Patients Only

eTable 6. Serious Illness Conversations (Sics) for All Patients, Documented Within 7 Days

eTable 7. Serious Illness Conversations (Sics), Adjusted for Clinician Time From SIC Guide Training to Trial Start Date

eTable 8. Regression Table for Advance Care Planning Model Including All Patients

eTable 9. Regression Table for Advance Care Planning Model Including High Risk Patients Only

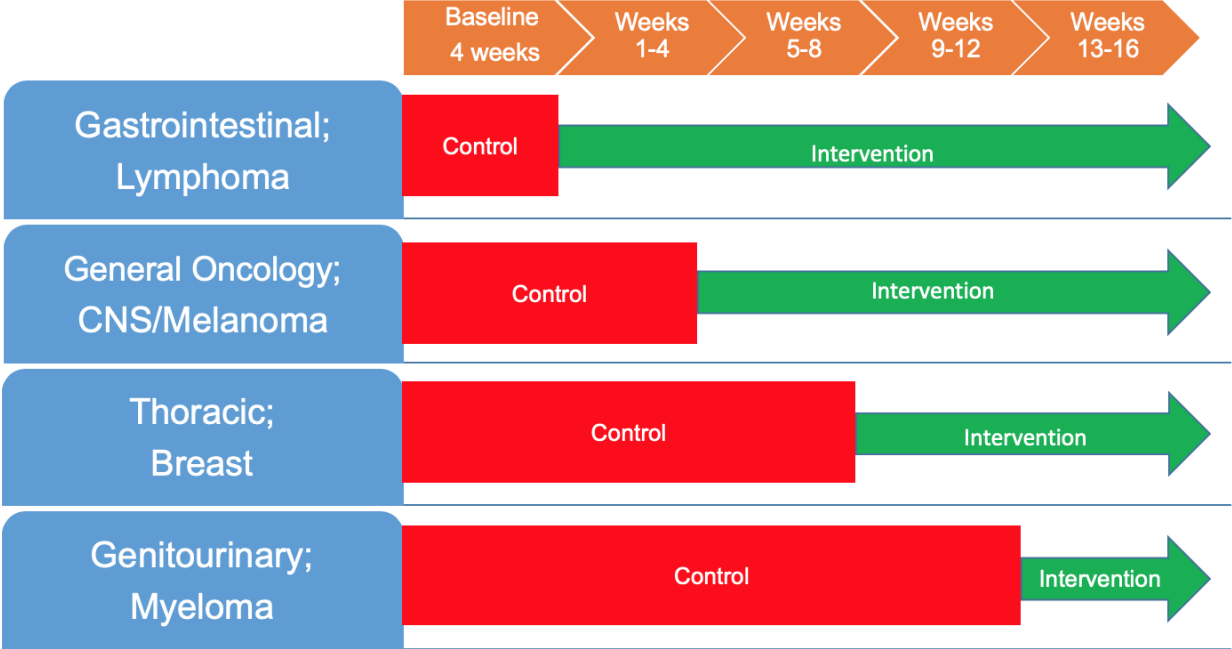
eTable 10. Fully Adjusted Models for Advance Care Planning (Acps) for All Patients and for High Risk Patients Only

eTable 11. Adjusted Change in Advance Care Planning Conversations (Sics), Documented Within 7 days

eTable 12. Adjusted Change in Serious Illness Conversations (Sics) and Advanced Care Planning for Non-High-Risk Patients

This supplementary material has been provided by the authors to give readers additional information about their work.

eFigure 1. Stepped-Wedge Design Overview



eFigure 2. Example Clinician Emails by Performance

a. Email to clinicians who are not in the top 10 clinicians with the most serious illness conversations in the prior four weeks

Next week's high-risk patients for Serious Illness Conversations

Thursday, July 18, 2019 at 8:05 AM

[Show Details](#)

Dear _____ :

The ACC is working to help oncologists have earlier Serious Illness Conversations with patients. In the past four weeks, you have documented **2 conversations**.

18 oncology clinicians have documented more conversations than you during that time.

We have identified patients scheduled to see you next week who may benefit from a Serious Illness Conversation. [Click here](#) to view your list (you must be connected to the UPHS network).

Sincerely,

b. Email to the 10 clinicians with the most serious illness conversation in the prior four weeks

Next week's high-risk patients for Serious Illness Conversations

Thursday, July 25, 2019 at 8:05 AM

[Show Details](#)

Dear _____

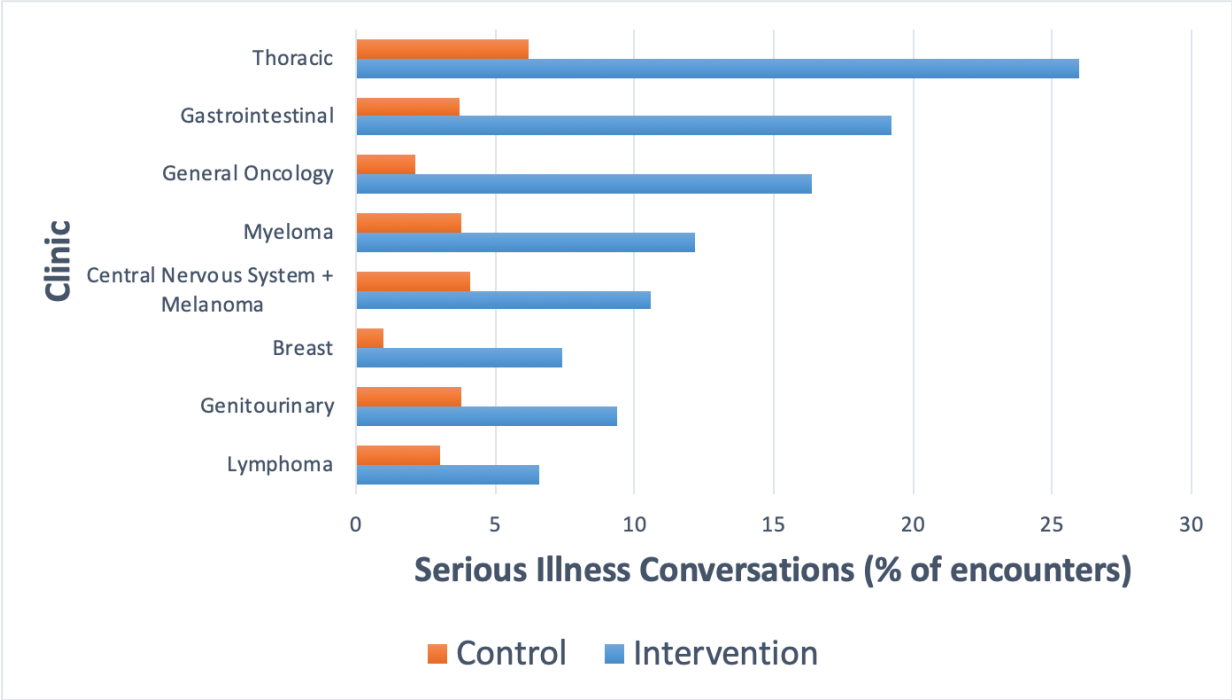
The ACC is working to help oncologists have earlier Serious Illness Conversations with patients. In the past four weeks, you have documented **11 conversations**.

You are among the top performers - keep up the great work!

We have identified patients scheduled to see you next week who may benefit from a Serious Illness Conversation. [Click here](#) to view your list (you must be connected to the UPHS network).

Sincerely,

eFigure 3. Serious Illness Conversations for High-Risk Patients by Clinic



eTable 1. High-Risk Patient Encounter Characteristics

Characteristic	Control (n = 2125)	Intervention (n = 1999)
Sociodemographics		
Age, Mean (SD)	64.5 (12.7)	64.4 (13)
Female Gender, No. (%)	1070 (50.4%)	1025 (51.3%)
Race/Ethnicity, No. (%)		
White non-Hispanic	1494 (70.3%)	1417 (70.9%)
Black non-Hispanic	467 (22%)	408 (20.4%)
Other	164 (7.7%)	174 (8.7%)
Insurance, No. (%)		
Commercial	809 (38.1%)	782 (39.1%)
Medicare	1149 (54.1%)	1060 (53%)
Medicaid	167 (7.9%)	157 (7.9%)
Clinic		
Breast	311 (14.6%)	204 (10.2%)
Central Nervous System Tumors + Melanoma	145 (6.8%)	161 (8.1%)
Gastrointestinal	136 (6.4%)	527 (26.4%)
General oncology	292 (13.7%)	415 (20.8%)
Genitourinary	318 (15%)	64 (3.2%)
Lymphoma	67 (3.2%)	272 (13.6%)
Myeloma	420 (19.8%)	98 (4.9%)
Thoracic	436 (20.5%)	258 (12.9%)
Clinical		
Charlson comorbidity index, median (IQR)	8 (3-9)	8 (3-9)
Predicted mortality risk, mean (SD)*	34% (20-53%)	36% (20-56%)

SD = Standard deviation

IQR = Interquartile range

* 180-day mortality risk as predicted by mortality prediction algorithm

eTable 2. Patient Encounters and SIC Rates by Clinic and Control vs Intervention

Intervention Assignment	Number of patient encounters		Percent of encounters with SIC (X/Y)	
	Control	Intervention	Control	Intervention
Breast	2003	1520	0.4% (8/2003)	1.6% (25/1520)
Central Nervous System/ Melanoma	762	1188	1.4% (11/762)	4.2% (50/1188)
Gastrointestinal	624	2770	2.7% (17/624)	8.6% (239/2770)
General oncology	2171	3757	1% (21/2171)	3.3% (125/3757)
Genitourinary	1792	451	0.7% (13/1792)	2.2% (10/451)
Lymphoma	541	2289	0.9% (5/541)	1.8% (42/2289)
Myeloma	2592	707	1.2% (32/2592)	2.5% (18/707)
Thoracic	1685	1207	2.8% (48/1685)	10.2% (123/1207)
Total	12170	13889	1.3% (155/12170)	4.6% (632/13889)

eTable 3. Regression Table for Serious Illness Conversation Model Including All Patients

Variable	Estimate	P Value	OR (CI)
Wedge			
10/7/19 – 11/3/19	0.8552	0.0002	2.35 (1.5-3.69)
7/15/19 – 8/11/19	0.2788	0.1368	1.32 (0.92-1.91)
8/12/19 – 9/8/19	0.5318	0.0074	1.7 (1.15-2.51)
9/9/19 – 10/6/19	0.5809	0.0203	1.79 (1.09-2.92)
Intervention			
Pre	Ref	-	Ref
Post	0.7028	<.0001	2.02 (1.44-2.83)
Clinic			
Lymphoma	Ref	-	Ref
Gastrointestinal	1.5814	0.0002	4.86 (2.14-11.03)
Thoracic	1.5448	0.0003	4.69 (2.02-10.88)
Central Nervous System / Melanoma	0.7444	0.0664	2.11 (0.95-4.66)
Myeloma	0.2841	0.577	1.33 (0.49-3.61)
Genitourinary	-0.0877	0.8423	0.92 (0.39-2.17)
General oncology	0.4759	0.2153	1.61 (0.76-3.42)
Breast	-0.3874	0.5014	0.68 (0.22-2.1)

eTable 4. Regression Table for Serious Illness Conversation Model Including High Risk Patients Only

Variable	Estimate	P Value	OR (CI)
Wedge			
10/7/19 – 11/3/19	1.1016	<.0001	3.01 (1.73-5.22)
7/15/19 – 8/11/19	0.4216	0.0794	1.52 (0.95-2.44)
8/12/19 – 9/8/19	0.637	0.0177	1.89 (1.12-3.2)
9/9/19 – 10/6/19	0.7633	0.009	2.15 (1.21-3.8)
Intervention			
Pre	Ref	-	Ref
Post	1.0011	<.0001	2.72 (1.73-4.28)
Clinic			
Lymphoma	Ref	-	Ref
Gastrointestinal	1.1453	0.0077	3.14 (1.35-7.29)
Thoracic	1.2996	0.0075	3.67 (1.41-9.52)
Central Nervous System / Melanoma	0.4679	0.3988	1.6 (0.54-4.73)
Myeloma	0.4484	0.3251	1.57 (0.64-3.82)
Genitourinary	0.3504	0.487	1.42 (0.53-3.81)
General oncology	0.7842	0.1208	2.19 (0.81-5.9)
Breast	-0.2734	0.5367	0.76 (0.32-1.81)

eTable 5. Fully Adjusted Models for Serious Illness Conversations (Sics) for All Patients and for High Risk Patients Only

Serious Illness Conversation	Control	Intervention	Adjusted Difference for Intervention Relative to Control, Percentage Points (95% CI)	P Value
All patient encounters	1.3% (155/12170)	4.6% (632/13889)	3.3% (2.3-4.5)	<.001
Fully Adjusted Model	-	-	3.3% (2.3-4.5)	<.001
Subgroup analyses				
Age				
18-35 years	0.4% (3/682)	1.2% (12/982)	-	-
36-50 years	1% (16/1546)	3.2% (64/1998)	-	-
51-64 years	1.5% (63/4130)	4.8% (221/4619)	-	-
≥ 65 years	1.3% (73/5812)	5.3% (335/6290)	-	-
Gender				
Female	1.3% (85/6426)	4.1% (312/7576)	-	-
Male	1.2% (70/5744)	5.1% (320/6313)	-	-
Race/Ethnicity				
White non-Hispanic	1.3% (108/8629)	4.5% (435/9709)	-	-
Black non-Hispanic	1.5% (37/2436)	4.6% (128/2772)	-	-
Other	0.9% (10/1105)	4.9% (69/1408)	-	-
Insurance				
Commercial	1.3% (69/5467)	3.5% (230/6522)	-	-
Medicare	1.3% (80/5953)	5.5% (345/6321)	-	-
Medicaid	0.8% (6/750)	5.4% (57/1046)	-	-
Predicted mortality risk				
0.0 - 0.1	0.3% (26/8247)	1.2% (110/9475)	-	-
>0.1 to 0.2	1.3% (20/1566)	6.8% (108/1596)	-	-
>0.2 to 0.3	2% (13/642)	10.2% (73/713)	-	-
>0.3 to 0.4	3.4% (15/443)	13.4% (65/486)	-	-
>0.4 to 0.5	4.6% (14/303)	18.4% (71/385)	-	-
>0.5	9.2% (62/677)	25.1% (183/730)	-	-
High-risk patient encounters	3.6% (77/2125)	15.2% (304/1999)	11.6% (8.2-15.5)	<.001
Fully Adjusted Model	-	-	11.6% (8.2-15.5)	<.001
Subgroup analyses				
Age				
18-35 years	2.9% (2/70)	12.9% (9/70)	-	-
36-50 years	3.2% (6/189)	13.3% (26/195)	-	-
51-64 years	5% (39/775)	14.9% (104/696)	-	-

≥ 65 years	2.7% (30/1091)	15.9% (165/1038)	-	-
Gender				
Female	3.8% (41/1070)	15% (154/1025)	-	-
Male	3.4% (36/1055)	15.4% (150/974)	-	-
Race/Ethnicity				
White non-Hispanic	3.9% (58/1494)	14.2% (201/1417)	-	-
Black non-Hispanic	3.6% (17/467)	16.9% (69/408)	-	-
Other	1.2% (2/164)	19.5% (34/174)	-	-
Insurance				
Commercial	4.6% (37/809)	11.5% (90/782)	-	-
Medicare	3.3% (38/1149)	16.3% (173/1060)	-	-
Medicaid	1.2% (2/167)	26.1% (41/157)	-	-

eTable 6. Serious Illness Conversations (Sics) for All Patients, Documented Within 7 Days

Serious Illness Conversation	Control	Intervention	Adjusted Difference for Intervention Relative to Control, Percentage Points (95% CI)	P Value
All patient encounters	0.9% (114/12170)	3.7% (515/13889)	2.8% (1.8-4)	<.001
High-risk patient encounters	2.9% (61/2125)	12.2% (243/1999)	9.3% (6-13.1)	<.001

eTable 7. Serious Illness Conversations (Sics), Adjusted for Clinician Time From SIC Guide Training to Trial Start Date

	Odds Ratio	95% Confidence Interval	P value
SICs, all patients: main model	2.02	1.44-2.83	<.001
Sensitivity model: main model + training interval variable*	2.03	1.44-2.85	<.001
SICs, high risk patients: main model	2.72	1.73-4.28	<.001
Sensitivity model: main model + training interval variable	2.74	1.74-4.31	<.001

* Training interval variable is the clinician-level time from Serious Illness Conversation Guide Training to the start date of the trial

eTable 8. Regression Table for Advance Care Planning Model Including All Patients

Variable	Estimate	P Value	OR (CI)
Wedge			
10/7/19 – 11/3/19	0.7919	<.0001	2.21 (1.6-3.04)
7/15/19 – 8/11/19	0.2555	0.0201	1.29 (1.04-1.6)
8/12/19 – 9/8/19	0.6287	<.0001	1.88 (1.41-2.5)
9/9/19 – 10/6/19	0.6313	0.0002	1.88 (1.34-2.63)
Intervention			
Pre	Ref	-	Ref
Post	0.3603	0.001	1.43 (1.16-1.78)
Clinic			
Lymphoma	Ref	-	Ref
Gastrointestinal	1.5608	<.0001	4.76 (2.23-10.15)
Thoracic	1.5699	0.0001	4.81 (2.17-10.63)
Central Nervous System / Melanoma	0.6904	0.0732	1.99 (0.94-4.24)
Myeloma	0.0772	0.8776	1.08 (0.4-2.89)
Genitourinary	-0.2742	0.5272	0.76 (0.32-1.78)
General oncology	0.431	0.2301	1.54 (0.76-3.11)
Breast	-0.4974	0.3698	0.61 (0.21-1.8)

eTable 9. Regression Table for Advance Care Planning Model Including High Risk Patients Only

Variable	Estimate	P Value	OR (CI)
Wedge			
10/7/19 – 11/3/19	0.9919	0.0001	2.7 (1.63-4.46)
7/15/19 – 8/11/19	0.3681	0.0626	1.44 (0.98-2.13)
8/12/19 – 9/8/19	0.7603	0.0033	2.14 (1.29-3.55)
9/9/19 – 10/6/19	0.7732	0.0023	2.17 (1.32-3.57)
Intervention			
Pre	Ref	-	Ref
Post	0.6889	<.0001	1.99 (1.43-2.78)
Clinic			
Lymphoma	Ref	-	Ref
Gastrointestinal	1.0697	0.0101	2.91 (1.29-6.59)
Thoracic	1.3665	0.0045	3.92 (1.53-10.07)
Central Nervous System / Melanoma	0.4808	0.3259	1.62 (0.62-4.22)
Myeloma	0.1775	0.7052	1.19 (0.48-3)
Genitourinary	0.1164	0.8312	1.12 (0.39-3.28)
General oncology	0.7487	0.1465	2.11 (0.77-5.81)
Breast	-0.3233	0.5029	0.72 (0.28-1.86)

eTable 10. Fully Adjusted Models for Advance Care Planning (Acps) for All Patients and for High Risk Patients Only

Advanced Care Planning	Control	Intervention	Adjusted Difference for Intervention Relative to Control, Percentage Points (95% CI)	P Value
All patient encounters	1.9% (231/12170)	4.9% (680/13889)	3% (2.1-4.1)	.001
Fully Adjusted Model	-	-	3% (2.1-4.1)	<.001
Subgroup analyses				
Age				
18-35 years	0.4% (3/682)	1.3% (13/982)	-	-
36-50 years	1.6% (25/1546)	3.3% (65/1998)	-	-
51-64 years	2.2% (91/4130)	5.1% (237/4619)	-	-
≥ 65 years	1.9% (112/5812)	5.8% (365/6290)	-	-
Gender				
Female	1.9% (120/6426)	4.5% (340/7576)	-	-
Male	1.9% (111/5744)	5.4% (340/6313)	-	-
Race/Ethnicity				
White non-Hispanic	1.9% (162/8629)	4.8% (464/9709)	-	-
Black non-Hispanic	2% (48/2436)	5% (139/2772)	-	-
Other	1.9% (21/1105)	5.5% (77/1408)	-	-
Insurance				
Commercial	1.8% (101/5467)	3.9% (253/6522)	-	-
Medicare	2% (121/5953)	5.8% (369/6321)	-	-
Medicaid	1.2% (9/750)	5.5% (58/1046)	-	-
Predicted mortality risk				
0.0 - 0.1	0.4% (33/8247)	1.2% (118/9475)	-	-
>0.1 to 0.2	2.2% (34/1566)	7.1% (113/1596)	-	-
>0.2 to 0.3	4% (26/642)	11.2% (80/713)	-	-
>0.3 to 0.4	5.4% (24/443)	14% (68/486)	-	-
>0.4 to 0.5	6.6% (20/303)	20.5% (79/385)	-	-
>0.5	13.1% (89/677)	27.4% (200/730)	-	-
High-risk patient encounters				
	5.8% (124/2125)	17.5% (350/1999)	11.7% (8.4-15.7)	<.001
Fully Adjusted Model	-	-	11.7% (8.4-15.7)	<.001
Subgroup analyses				
Age				
18-35 years	2.9% (2/70)	12.9% (9/70)	-	-
36-50 years	6.3% (12/189)	15.4% (30/195)	-	-
51-64 years	7% (54/775)	17% (118/696)	-	-

≥ 65 years	5.1% (56/1091)	18.6% (193/1038)	-	-
Gender				
Female	5.9% (63/1070)	17.5% (179/1025)	-	-
Male	5.8% (61/1055)	17.6% (171/974)	-	-
Race/Ethnicity				
White non-Hispanic	6.2% (93/1494)	16.3% (231/1417)	-	-
Black non-Hispanic	4.7% (22/467)	19.6% (80/408)	-	-
Other	5.5% (9/164)	22.4% (39/174)	-	-
Insurance				
Commercial	6.7% (54/809)	14.3% (112/782)	-	-
Medicare	5.7% (66/1149)	18.5% (196/1060)	-	-
Medicaid	2.4% (4/167)	26.8% (42/157)	-	-

eTable 11. Adjusted Change in Advance Care Planning Conversations (Sics), Documented Within 7 days

Advanced Care Planning	Control	Intervention	Adjusted Difference for Intervention Relative to Control, Percentage Points (95% CI)	P Value
All patient encounters	1% (120/12170)	3.7% (515/13889)	2.7% (1.7-3.9)	0.0001
High-risk patient encounters	3.1% (66/2125)	12.4% (247/1999)	9.3% (6-13.1)	<.0001

eTable 12. Adjusted Change in Serious Illness Conversations (Sics) and Advanced Care Planning for Non-High-Risk Patients

Outcome	Control	Intervention	Adjusted Difference for Intervention Relative to Control, Percentage Points (95% CI)^a	P Value
Non high-risk patient encounters: Serious Illness Conversations	0.7% (76/10298)	2.5% (300/12130)	1.8% (1.0-2.7)	0.0524
Non high-risk patient encounters: Advance Care Planning	1.1% (117/10298)	2.8% (339/12130)	1.7% (0.9-2.5)	0.35

^a This post-hoc analysis was performed using the same model used in the primary and secondary outcomes reported in the manuscript.