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Los Angeles

Physician ordering patterns for routine mammogram screening in response to an
electronic health record alert

A thesis submitted in partial satisfaction of the
requirements for the degree Master of Science in Clinical Research

by

Indira Gowda

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2020

ABSTRACT OF THE THESIS

Physician ordering patterns for routine mammogram screening in response to an
electronic alert

by

Indira Gowda

Masters of Science in Clinical Research

University of California, Los Angeles, 2020

Professor Douglas Bell, Chair

Abstract

Objective: Evaluate provider compliance with guidelines for routine screening of breast cancer before and after the implementation of a targeted “Best Practice Advisory” (BPA) alert, titled CareGaps, embedded in the routine health maintenance module in the UCLA electronic health record (EHR).

Design: The CareGaps BPA was deployed June 2019 in UCLA primary care clinics. We performed a difference-in-differences evaluation using a mixed effects logistic regression model. We compared mammogram order rates between our pre-intervention period and intervention period. These timeframes were broken into four study periods: Jan-May 2018, Jun – Oct 2018, Jan – May 2019 which were all included in our pre-intervention timeframe and Jun – Oct 2019 which was our intervention timeframe. Mammogram orders placed within two weeks of the encounter visit were considered related to the recent encounter and were considered for analysis. Provider characteristics such as specialty and years of practice and patient characteristics such as insurance and race were controlled for in the model.

Primary outcome: Encounter-based mammogram ordering rates were compared between the pre-intervention and intervention groups.

Secondary outcomes: We examined completion rates for breast cancer screening using the health maintenance status of “not due” as a proxy measure. We also examined the CareGaps orderset use between providers and looked at the ordering practices for mammography amongst providers exposed to the BPA.

Results: The total number of encounters steadily increased over time and ranged from 26,232 to 32,257. Overall the likelihood of placing a mammogram order significantly increased by about 6% between our pre-intervention and intervention groups. (adjusted odds ratio = 1.07, $p = 0.036$). We did not find a significant impact of the BPA in mammogram completion rates. We did

find however that use of the CareGaps orderset increased with deployment of the CareGaps BPA (OR 1.71, CI 1.43 – 2.07, $p < .0001$). We also found that those providers who were exposed to the BPA and chose to “address” the BPA by interacting with it such as acknowledging it or opening the CareGaps orderset were 25% more likely to place a mammogram order ($X^2 p < .0001$).

Conclusions: Implementation of a targeted BPA for addressing health maintenance topics such as breast cancer screening can be effective for alerting those providers who have not previously addressed these topics with patients.

The thesis of Indira Gowda is approved.

David Elashoff

Eran Halperin

Douglas Bell, Committee Chair

University of California, Los Angeles

2020

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Introduction

U.S. Preventative Service Task Force Guidelines considers breast cancer screening to be routine health maintenance.ⁱ As of 2015, the national breast cancer screening rate was about 72%, about 9% below the Healthy People 2020 goal for women aged 50-74.ⁱⁱ The HITECH Act of 2001 promoted adoption of health information technology and along with it meaningful use, which includes compliance with healthcare quality measures such as breast cancer screening.ⁱⁱⁱ Compliance with these measures can ultimately affect practice quality ratings and reimbursement for a health system. In order to help providers address these health maintenance topics that are gaps in care, UCLA Health developed an electronic alert known as the CareGaps best practice alert (BPA). The CareGaps BPA is a CDS tool that is integrated into the electronic health record (EHR) and deploys an algorithm to determine areas of deficiency for a patient's health maintenance topics such as diabetic care, routine vaccines, and cancer screening. We chose to focus this initial study on one health maintenance topic, breast cancer screening. The deployment of this BPA also corresponded with the implementation of a financially incentivized program for providers to close patient care gaps. There are numerous studies that evaluate the efficacy of BPAs in nudging provider behavior, however there are no studies we could find looking at CDS use for the health maintenance topic of breast cancer screening.

The CareGaps BPA was deployed June 2019 at UCLA Health, which has approximately 300 outpatient providers who see approximately 2.5 million outpatient visits annually at over 50 primary care clinics throughout the Southern California region.^{iv} The CareGaps BPA was implemented in primary care settings at UCLA Health and is a non-interruptive alert that displays passively in the patient's chart. The BPA alerts during outpatient encounters for patients with a care gap that is due. Providers can choose to interact with the BPA or ignore it. The objective of our study was to compare mammography-ordering rates before and after implementation of the CareGaps BPA over a 5-month period. We chose to end the study after 5 months because after November 3, 2019 the health maintenance module underwent an update that made it easier to address health maintenance care gaps without interacting with the BPA.

Methods

Study Design

In 2013 UCLA adopted the Epic EHR system, called CareConnect at UCLA, and the CareGaps BPA was deployed in primary care settings in June 2019. The BPA alerted the provider if a patient had a health maintenance status equal to “due soon”, “due on”, or “overdue” for breast cancer screening. If the provider chose to interact with the BPA they had three options: open the CareGaps orderset that allowed them to place necessary orders such as mammogram, acknowledge the BPA and leave comments about the BPA, or simply dismiss it.

Figure 1. CareGaps BPA

Plan

BestPractice Meds & Orders SmartSets Problem List Visit Diagnoses

BestPractice Advisories

Care Guidance (1)

ⓘ Patient has at least 1 DUE Care gap. Please address them using the Smartset below ✓ Accept (1) ✕ ⬆

[Provide Feedback about this BPA](#)

Open SmartSet Do Not Open **Care Gaps (Providers)** [Preview](#)

Acknowledge Reason

Defer for next encounter

✓ Accept (1)

The screenshot shows the CareGaps BPA. The BPA “fires” when there is at least one Health Maintenance topic that is “Due” for a patient. Selecting “Accept”, allows the provider to either open the CareGaps orderset, not to open it, or defer to next visit. Providers can also leave comments about the BPA.

Figure 2. CareGaps Orderset

Care Gaps (Providers) [Manage User Versions](#)

✓ From BestPractice

Patient has at least 1 DUE Care gap. Please address them using the Smartset below [Provide Feedback about this BPA](#)

[Click here to go to Health Maintenance Module.](#)

▼ **UCLA Care Gaps are DUE. To document outside studies, go to HM and click override**

▼ **Breast cancer screening is due.**

[Click here to view protocol #16285, USPSTF guidelines](#)

☐ Bilateral Screening Mammogram

☐ Mammogram, screening, bilat breast w implants

☐ Patient Instructions Breast Cancer- UCLA

☐ Patient Instructions Breast Cancer- USPSTF

▼ **Cervical cancer screening is due.**

[Click here to view USPSTF guidelines](#)

☐ Pap Smear (no defaults)

☐ Pap smear 30+ yo (with HPV), Surepath

This screenshot shows the opened CareGaps orderset, which indicates which orders are “Due” for patients and allows providers to place the necessary orders to meet these Care Gaps.

We conducted a retrospective study before and after implementation of the BPA. We analyzed four time periods across the years of 2018 and 2019; two groups for the months January – May

and two groups for June – October. For the last group, June – October 2019, the CareGaps BPA was implemented; the other three groups served as controls to determine the temporal trend.

We used a difference in differences analysis in order to compare encounter-based mammogram ordering rates and patient-based completion rates between those patients in the first half of 2018 and 2019, January-May, compared to those in the second half of the year, June-October. In order to limit the the effects of variation in the study from numerous provider ordering practices, we only included those providers who appeared in both study periods for the first and second half of one consecutive year, and excluded those who were not found in both study periods for the year. Our primary outcome was encounter-based mammogram ordering rates amongst providers within two weeks of an encounter. We compared these rates before and after implementation of the BPA.

Our secondary outcomes included: patient-based completion rates of mammogram orders, orderset usage, and mammogram ordering practices amongst the intervention group. For patient-based mammogram completion rates, we selected for those patients who completed their mammogram order within the same timeframe as their study period. In order to allow for enough time to adequately capture completion, we discarded the last month of orders in each study period. We used a health maintenance status equal to “not due” as a proxy measure that indicated the mammogram order had been completed. For orderset usage we looked at those providers who used the orderset to place a mammogram order before and after the deployment of the BPA. We also looked at mammogram ordering rates amongst providers after implementation of the BPA.

These analyses were considered IRB exempt as the data for this study was collected for purposes of improving UCLA operations. The analyses met criteria for exemption from IRB review under 45 CFR 46 104(d)(4)(iii). Research results were de-identified.

Study Population

Inclusion criteria for our study were: women between the ages of 50-74 with a primary care visit who had a health maintenance status of “due soon”, “due on”, or “overdue” for breast cancer screening. Patients not eligible for breast cancer screening or who had a health maintenance status other than: “due soon”, “due on”, or “overdue” were excluded.

Statistical Analysis

Descriptive statistics were collected for patients such as race, insurance type and for providers such as clinic group and specialty.

Using mixed effect logistic regression, provider ordering patterns were accounted for with random effect, which allowed for clustering amongst patients and fixed effects for year, period, and year by period interaction. For our primary outcome of provider mammogram ordering rates, we controlled for covariates such as patient race/ethnicity, insurance, and prior mammogram orders. We evaluated for an effect of moderators such as patient insurance, provider financial incentive program, and patient race/ethnicity on our intervention. For our secondary outcome of

patient-based mammogram completion rates we included the following covariates: patient ethnicity/race, insurance, MyChart activation, and patient age.

We used a third order interaction term to test for the presence of moderating effects such as patient insurance, patient race, prior mammogram orders.

For our secondary outcomes exploring practice patterns amongst our intervention group we used chi-square tests for our analyses.

Results

Demographic data

We identified 16,640 – 20,419 patients who accounted for 26,232 to 32,257 encounters across all four study periods. The majority of patients, 62.6%, were found in one study period with 3.3% found in all four study periods. The mean age of patients 55-57 (median age of patients was 55-56) and the majority of patients were white (56-61%) and non-Hispanic (77-80%.) In both study periods we found 60% were married, and 46-48% live in areas where over half of the population has a bachelor's degree. The majority of patients, 84-85%, were enrolled in the MyChart patient portal.

Table 1 Patient Study Population

Number of Periods Patients are Included In	
1	30460 (62.6%)
2	12200 (25.1%)
3	4355 (9.0%)
4	1623 (3.3%)

Table 2 Patient Demographic Data

	Study Period 1 Jan -May 2018		Study Period 2 Jun-Oct 2018		Study Period 2 Jan -May 2019		Study Period 2 Jun-Oct 2019	
	N		N		N		N	
All Patients	16640		17156		20419		20202	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Age	57.2	10.2	56.8	10.2	56	10.3	55.9	10.4
ADI	62	34.3	61.9	34.6	61.9	34.6	62.1	34.5
	N	%	N	%	N	%	N	%
Ethnicity								
Hispanic or Latino	1938	11.7	2001	11.7	2348	11.5	2258	11.2
Not Hispanic or Latino	13435	80.7	13700	79.9	15844	77.6	15679	77.6
Patient Refused	938	5.6	1013	6.0	1392	6.8	1414	7
Unknown	329	2.0	4442	2.6	835	4.1	851	4.3
Patient Race								
White or Caucasian	10250	61.6	10201	59.5	11654	57.1	11429	56.6
Native	55	0.3	57	0.3	68	0.3	76	0.4
Asian or Pacific Islander	1526	9.2	1761	10.3	1984	9.7	2027	10.1
Black	1053	6.3	1119	6.5	1265	6.2	1274	6.3
Multiple Races	636	3.8	620	3.6	747	3.7	688	3.4
Not Available	2388	14.4	2618	15.3	3606	17.7	3606	17.9
Declined to Specify	732	4.4	780	4.6	1095	5.4	1102	5.5
Marital Status								
Married or Domestic Partnership	10310	62.0	10309	60.1	12313	60.3	12296	60.9
Divorced or Legally Separated	1524	9.2	1650	9.6	1785	8.7	1734	8.6
Single	3920	23.6	4247	24.8	5145	25.2	4994	24.7
Widowed	678	4.1	690	4.0	811	4.0	742	3.7
Other	43	0.3	55	0.3	57	0.3	65	0.3
Not Available	165	1.0	205	1.2	308	1.5	371	1.8
Percent w/ Bachelors in Census Tract								
<10	1017	6.1	1085	6.3	1277	6.3	1228	6.1
10-20	1425	8.6	1447	8.4	1780	8.7	1715	8.5
20-30	1942	11.7	1963	11.4	2256	11.1	2216	11
30-40	2573	15.5	2575	15	3098	15.2	3131	15.5
40-50	3231	19.4	3369	19.6	3863	18.9	3877	19.2
50-60	2912	17.5	3105	18.1	3622	17.7	3635	18
60-70	1827	11	1911	11.1	2234	10.9	2094	10.4
70-80	310	1.9	322	1.9	385	1.9	383	2
80-90	30	0.2	38	0.2	34	0.2	32	0.2
90-100	395	2.4	392	2.3	490	2.4	488	2.4
Missing	978	5.9	949	5.5	1380	6.8	1403	6.9
MyChart User								
No	2655	16.0	2711	15.8	3104	15.2	3097	15.33
Yes	13985	84.0	14445	84.2	17315	84.8	17105	84.67
Insurance Payer								
Private/HMO	12704	76.3	13133	76.6	15789	77.3	15503	76.7
Public - Medicaid/HMO/Other	100	0.6	117	0.7	150	0.7	151	0.8
Public - Medicare/HMO	3705	22.3	3782	22.1	4324	21.2	4412	21.8
Insurance status not available	131	0.8	124	0.72	15	0.7	136	0.7

The total number of providers in the 2018 cohort was 561, and 572 in the 2019 cohort group.

When provider specialty information was available, a majority indicated that their specialty was internal medicine or family medicine, however for 19% this information was not complete for approximately half of our providers. About half of the providers, 50%, are found across all study periods. The average panel for providers was approximately 1,312-1,367. The average years in practice were 16 and the average years at UCLA was 6.

Table 3 Provider Study Population

Number of Periods Provider is Included		
1	167	(22.4%)
2	88	(11.8%)
3	119	(16.0%)
4	372	(49.9%)

Table 4 Provider Demographic Data

	Year*			
	2018		2019	
	Mean	SD	Mean	SD
Panel Size	1367.3	876.7	1312.9	869.5
Years in Practice	16.4	11.8	16.3	11.6
Years at UCLA	6.6	8.0	6.5	7.7
Specialty Code				
Missing	231	49.5	210	44.5
IM	144	30.8	159	33.7
MP_FM	92	19.7	103	21.8

*Included only paired providers (providers who appeared in both study periods in 2018 and those providers who appeared in both study periods in 2019)

Primary Outcome - Mammogram ordering rates

The rate of mammogram orders steadily increased from 19.9% to 26.7% over time. The majority of patients 60.5-63.3% did not have a prior mammogram order. Our analysis showed an overall upward trend between the years 2018-2019 for mammogram orders. When controlling for covariates such as patient insurance and patient race and temporal trends, we found that the BPA intervention significantly increased the likelihood of placing a mammogram order for our

intervention population. (adjusted OR 1.07, CI 1 – 1.13, p = 0.036). This relationship between temporal patterns and the BPA intervention is reflected in Figure 3.

Of the various moderator effects we analyzed, we found that patient insurance had a significant interaction with our intervention. We found that those patients with public insurance such as Medicaid or Medicare were significant more likely to have a mammogram order placed (OR 1.7, CI 1.36-2.14, p <.0001).

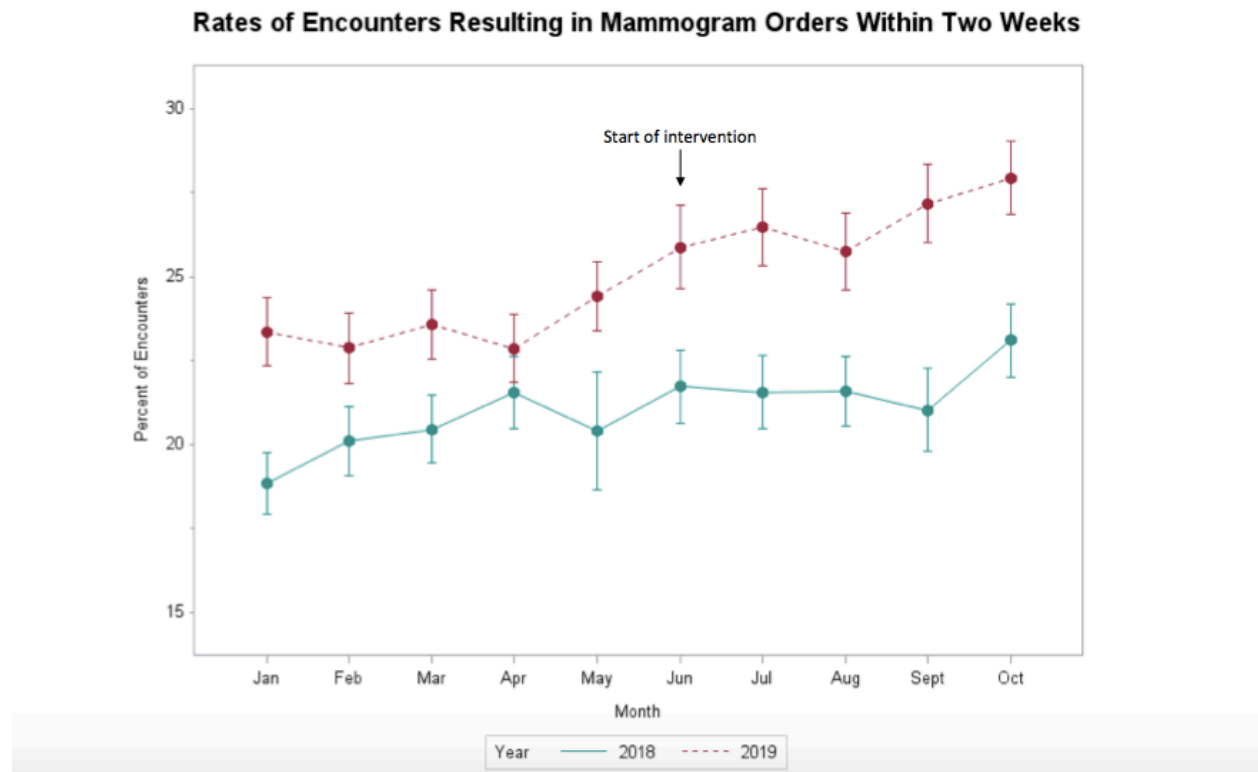
Table 5 Mammogram Order Summary

	2018 Period 1		2018 Period 2		2019 Period 1		2019 Period 2	
	N	%	N	%	N	%	N	%
Mammogram orders / Encounters	5282/26598	19.9	5773/26232	22.0	7629/32257	23.7	7405/27695	26.7
Prior mammogram order								
Yes	16457	63.1	15871	60.5	20425	63.3	17351	62.7
No	9613	36.9	10361	39.5	11832	36.7	10344	37.4
Completed orders/ Mammogram orders	1368/5282	25.9	1667/5773	28.9	2797/7629	36.7	2907/7405	39.3
Orderset use	414/5282	7.8	507/5773	8.8	854/7629	11.2	1254/7405	16.9

Table 6 Adjusted Logistic Regression Analysis for Mammogram Order Rates

Predictor	OR (95% CI)	P-value
Adjusted Model		
2018 Jun- Oct vs. Jan- May Period	1.09 (1.04, 1.14)	<.001
2019 Jun - Oct vs. Jan- May Period	1.16 (1.11, 1.21)	<.0001
Difference	1.07 (1.00, 1.13)	0.036

Figure 3. Mammograms Orders Placed within 2 weeks of Encounter Visit for all Patients



This figure shows the difference in mammogram order rates between 2018 and 2019 by month.

Table 7 Moderator Effects

Moderator	P-value
Insurance category	<0.001
Provider race	0.14
Provider ethnicity	0.22
Provider years at UCLA	0.29
Provider gender	0.31
Orderset opened at encounter	0.34
Provider panel size	0.59
Provider specialty	0.59
Patient race	0.71
Prior order	0.76
Provider years in practice	0.79

Table 8 Stratified Analyses by Insurance Category*Private*

Predictor	OR (95% CI)	P-value
2018 Jun - Oct vs. Jan – May Period	1.13 (1.08, 1.19)	<.0001
2019 Jun - Oct vs. Jan – May Period	1.13 (1.08, 1.18)	<.0001
Difference	1 (0.93, 1.07)	0.94

Public

Predictor	OR (95% CI)	P-value
2018 Jun - Oct vs. Jan – May Period	1.11 (0.92, 1.33)	0.29
2019 Jun - Oct vs. Jan – May Period	1.89 (1.66, 2.15)	<.0001
Difference	1.7 (1.36, 2.14)	<.0001

*Secondary Outcomes**Mammogram completion rates*

The rate of completed orders steadily increased over time from 25.9 to 39.3%. However, when we controlled for covariates such as: patient age, race, ethnicity, marital status, insurance, ADI, education, and MyChart use, we did not find that the BPA had a significant effect on the completion rates for mammogram orders, (adjusted OR 0.98, CI 0.89 – 1.08, p = 0.68).

Table 9 Mammogram Completion Rates 2018 vs. 2019 Adjusted Model

Main Comparison	OR (95% CI)	P-value
2018 Jun - Oct vs. Jan – May Period	1.20 (1.11, 1.30)	<.0001
2019 Jun - Oct vs. Jan – May Period	1.18 (1.11, 1.25)	<.0001
Difference	0.98 (0.89, 1.08)	0.68

Orderset Usage

We looked at provider orderset usage between our pre-intervention and intervention groups we found a steady increase in use from 7.8 to 16.9% throughout the study periods. We found that use

of the CareGaps orderset significantly increased after deployment of the BPA (OR 1.71, CI 1.43 – 2.07, $p < .0001$).

Table 10 Orderset Usage Adjusted Model

Predictor	OR (95% CI)	P-value
2018 Post vs. Pre Period	1.14 (0.98, 1.33)	0.08
2019 Post vs. Pre Period	1.97 (1.77, 2.19)	<.0001
Difference	1.72 (1.43, 2.07)	<.0001

BPA Acknowledgement

Overall we found that the majority of providers ignored the BPA, 96%, while about 4% addressed the BPA by either opening the orderset, Acknowledging the BPA, or overriding it. We found however amongst those providers who did address the BPA they were about 25% more likely to place a mammogram order as compared to those providers who ignored the BPA ($X^2 p < .0001$)

Table 11 Mammogram Order Rates amongst Intervention Group

	Ignored (N = 26,651)	Did Not Ignore (N = 1044)
No MM Order (N = 20,290)	19,762 (74.2%)	528 (50.6%)
MM Order (N = 7405)	6889 (25.9%)	516 (49.4%)

- Percentages refer to column percents
- Chi-square test: $p < .0001$

Conclusions

Overall we found that deployment of an electronic alert, BPA, affected provider practice behavior. Although the majority of providers did not “actively” interact with the BPA as it was passively displaying in the background and did not interfere with provider workflow, we found that after implementation of the BPA the rate of mammogram orders significantly increased and more providers used the Care Gaps orderset to place orders. Our findings match what has been found in previous studies that the majority of alerts, 90-95% are overridden.^{v.vi} The rationale for this high rate of dismissal of alerts by providers is thought to be secondary to numerous factors including alert fatigue or disruptive placement of alerts that interfere with provider workflow. Our study indicates however that simple passive display of an alert that is non-interruptive to provider workflow may serve as non-interruptive reminders to address certain aspects of patient care.

We found that patient insurance was a significant factor in affecting the outcomes of our intervention. Patients who had public insurance like Medicare or Medicaid were more likely to have a mammogram ordered. Understanding which patients are more likely to receive an intervention from an electronic alert may help us understand how to better tailor alerts to specific populations. We did not find a significant affect of patient race/ethnicity in affecting our outcomes. This may be because we did have a large amount of missing data for this variable. We found that the majority of patients have MyChart access, which means that they can receive messages from their healthcare team via an electronic patient portal. This may provide an opportunity to develop electronic alerts that are delivered to the patient’s portal and remind them to discuss routine health maintenance topics with their provider.

Our study had a few confounders such as provider incentives. Some of the providers were full time and financially incentivized to fulfill patient care gaps in health maintenance topics, while others were not. We did not separate these groups in our analyses. Also we did not capture demographic data for providers such as gender and race. We know from the literature that women are usually more likely to adhere to practice guidelines and this may play a role in addressing electronic alerts.^{vii} In the future we will want to capture this data in order to help us better understand if we should be customizing electronic alerts by provider demographics.

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