Automated Screening to Enhance Proactive Consultation-Liaison Psychiatry Services in Acute Medicine Units:

Evaluation of Service Outcomes

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Abstract

Objective: Proactive consultation-liaison (C-L) psychiatry aims to meet the mental health needs of medical-surgical populations—many of which go unmet by the conventional C-L model—through systematic screening and integrated care. We implemented an automated screening list to enhance case identification of an existing proactive C-L service and evaluated service metrics along with clinician- and patient-reported outcomes.

Methods: Service outcomes were evaluated using historical and contemporary comparison data. Adjusted difference-in-difference analyses were used to determine change in consult characteristics, mean length of stay (LOS), and scores on Hospital Consumer Assessment of Healthcare Providers and Systems (HCAHPS). Practitioners and nurses were surveyed regarding service satisfaction, perceived safety, and burnout.

Results: During the intervention, the consult rate was 3-fold higher than at baseline. Change in time to consultation was equivocal. Overall mean LOS was not reduced, but observed LOS was 1.2 days shorter than expected among non-COVID patients receiving psychiatric consultation (*P* = not significant). Mean patient-rated hospital satisfaction on HCAHPS was 1 point higher on intervention units during the intervention. Surveys revealed broad satisfaction with this model among practitioners and improved perception of safety among nurses.

Conclusions: Proactive C-L psychiatry enhanced by automated screening was associated with improved service utilization and evidence suggestive of LOS reduction among those most likely to receive direct benefit from this model of care. Further, both patient and clinician ratings were improved during the intervention. Proactive C-L psychiatry provides benefits to patients, clinicians, and health systems and may be poised to achieve the Triple Aim in health care.

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Psychiatric comorbidity is present in roughly a half of medical inpatients[1,2] and associated with longer length of stay (LOS), higher health care costs, and lower staff satisfaction.[3,4] Mental health care in acute medical-surgical settings is traditionally delivered "reactively" by consultation-liaison (C-L) psychiatry services after clinical needs are identified by primary medical-surgical clinicians.[5] However, traditional C-L services usually address only a minority of actionable mental health needs.[1,6,7] By contrast, interdisciplinary proactive C-L services screen medical inpatient populations systematically for mental health concerns and deliver integrated care with primary teams, aiming to prevent crises and to manage a broad range of mental health issues.[5] Proactive C-L has been associated with reduced LOS, enhanced psychiatric service utilization, reduced time to psychiatric consultation, and improved practitioner and nurse satisfaction.[5,8]

Whereas screening for actionable mental health needs is the defining aspect of proactive C-L, how best to screen for them remains unclear. Screening in published work has ranged from the use of mental health questionnaires[9] to co-rounding with medical teams[1] and in-person visits by psychiatrists.[10] Currently, most proactive C-L services use a combination of manual chart review supplemented by direct collaboration with primary teams,[5,11] as has been done at our institution.[12] The electronic medical record (EMR) has also been used

Clinical Points

- Automated screening can facilitate enhanced psychiatric service utilization in hospital medicine.
- Data on length of stay reduction associated with this project were inconclusive.
- Patient- and clinician-reported outcomes were improved with this model of care.

to enhance case identification,[13] though the outcomes of using an automated EMR list have yet to be reported. Moreover, with growing disposition challenges and prolonged emergency department (ED) boarding times across the United States,[12] the use of an automated EMR report stands to enhance service capabilities by improving efficiency and reliability in identifying mental health needs.

Patient satisfaction, which now impacts Medicare reimbursements,[14] is another outcome that remains unexplored in association with proactive C-L. A recent study suggests that psychology consultations among medical inpatients were associated with improved patient satisfaction,[15] whereas the overall number of inpatient consultations (not restricted to mental health) has been associated with lower patient satisfaction.[16] Optimizing who receives consultations is important; however, to our knowledge, patient satisfaction with hospital care has not been assessed in relation to any type of psychiatric consultation. One suspects that patient satisfaction could be improved by addressing unmet mental health needs among medical-surgical inpatients.

We created an automated EMR screening list to enhance our screening process (previously reported[17]) and then evaluated service outcomes after a year-long implementation project. Our primary aim was to evaluate change in mean unit LOS using a regression-adjusted difference-in-difference ($\Delta\Delta_a$) model with historical and contemporary comparator units and sensitivity analyses, restricting our analysis to non-COVID patients receiving psychiatric consultation (ie, patients likeliest to receive direct benefit). Secondary aims evaluated additional service metrics, including patient- and clinician-reported outcomes.

METHODS

Model Innovation

In 2018, the Proactive Integration of Mental health care in Medicine (PRIME) service was developed at Strong Memorial Hospital (SMH) to serve 3 hospital medicine units staffed by advanced practice provider (APP) hospitalist teams. For this project, we created an automated EMR list to identify patients on APP-staffed hospital medicine services with acute mental health needs. This automated list, published in the EMR September 1, 2021, populated patients based on discrete form data that could index mental health acuity, severity, or complexity (Supplementary Table 1).[17]

During this project, PRIME consisted of a 0.8 full-time–equivalent (FTE) psychiatric nurse practitioner and 0.6 FTE psychiatrist, and it covered 3 hospital medicine units ("PRIME units"), as published previously.[12] This project expanded the scope of chart screening 2-fold, as it included patients in the ED awaiting transfer to a medicine unit. Both PRIME and general C-L psychiatry clinicians participated in daily screening; however, PRIME clinicians consulted only on patients on PRIME units, and general C-L service clinicians consulted on patients elsewhere. The screening clinician reviewed any potentially actionable mental health needs identified on chart review with the assigned primary team clinician.

Project Definitions

Comparison units consisted of the same 2 teaching hospital medicine units at SMH (SMH comparison) as previously described[12] plus 2 comparison medical-surgical units at Highland Hospital (HH comparison), an affiliate hospital in the same city, to account for regional care trends. Academic years are specified as follows: July 2017–June 2018 (pre-PRIME, the year prior to initial PRIME pilot), 2018–2019 (PRIME pilot, previously reported[12]), 2019–2020 (intervening year, not included in current analyses), 2020–2021 (pre–quality improvement [QI] [early COVID]), 2021–2022 (QI intervention [later COVID waves]). Unless otherwise specified, $\Delta\Delta_a$ analyses compare QI intervention to the pre-PRIME period, the last year prior to initial PRIME implementation. Consistent with prior analyses,[12] we exclude July/August due to staffing changes and onboarding.

All $\Delta\Delta_a$ analyses are adjusted for age, sex, race/ethnicity, Charlson comorbidity index (CCI), payer type, boarding time (arrival on unit minus time of admission order), discharged home (binary), failure to thrive (binary), and mental health diagnosis categories. We exclude the following outliers: LOS > 30, in-hospital mortality, discharge against medical advice, non-ED admission source, and patients with an eating disorder diagnosis (rationale previously described[12]).

Service Evaluation

We first characterized our sample; then we described change in consult rate and boarding times for each set of units and 3 periods. We evaluated time to consultation for PRIME and SMH comparison units (HH comparator units excluded for low volume) for the same 3 periods. Given the effect of boarding time on time to consult, we conducted a post hoc $\Delta\Delta_a$ analysis, setting time to consult ≥ 1 day as the dependent variable.

Next, we characterized the quarterly LOS trends on the 3 sets of units. All main $\Delta\Delta_a$ LOS analyses compare

Table 1.
Sample Characteristics

Patient Characteristics	Period 1: Pre-PRIME Period			Period 2: Pre-QI Period			Period 3: QI Period		
	SMH Comparison (n = 1,959)	HH Comparison (n = 2,351)	PRIME Units (n = 2,548)	SMH Comparison (n = 1,753)	HH Comparison (n = 2,500)	PRIME Units (n = 2,159)	SMH Comparison (n = 1,204)	HH Comparison (n = 2,349)	PRIME Units* (n = 1,370)
Age, mean (SD), y	61.7 (18.3)	61.0 (19.2)	63.7 (18.1)	62.9 (17.3)	62.6 (19.4)	63.3 (17.6)	62.7 (17.8)	64.5 (18.9)	64.2 (17.4)
Female, %	48.1	52.4	49.5	44.8	55.5	49.8	47.4	52.5	46.0
Race/ethnicity, %									
Non-Hispanic White	67.3	73.0	67.7	64.8	68.2	66.0	68.5	71.9	66.4
Non-Hispanic Black	23.9	19.9	22.6	24.8	23.4	23.8	21.2	20.7	23.4
Hispanic	5.9	4.4	6.7	6.3	5.0	6.1	6.5	4.5	6.0
Other	2.9	2.7	3.1	4.1	3.4	4.2	3.8	2.9	4.3
CCI, mean (SD), range, 0–18	0.73 (1.50)	1.31 (1.7)	0.7 (1.4)	1.79 (1.84)	1.49 (1.7)	1.87 (1.86)	1.84 (1.97)	1.55 (1.77)	2.02 (1.88)
Payer, %[a]									
Medicare	26.5	60.0	26.9	58.7	60.9	61.1	58.8	61.4	63.9
Medicaid	8.7	17.7	7.9	20.5	17.7	19.7	20.9	16.2	18.6
Other	64.8	22.3	65.2	20.8	21.4	19.1	20.3	22.4	17.4
Boarding time, mean (SD), days	1.7 (2.0)	1.5 (2.8)	2.0 (2.5)	2.2 (2.9)	1.6 (3.0)	2.2 (2.8)	3.2 (3.5)	1.6 (2.6)	3.5 (3.4)
Discharged home, %	84.2	76.9	78.5	82.8	82.1	79.9	80.6	84.3	79.7
Diagnoses, %									
Failure to thrive	1.8	3.8	2.4	4.8	4.7	6.3	4.9	4.6	8.5
Cognitive	2.9	10.2	3.5	8.6	10.5	11.8	9.1	12.9	11.8
Childhood	0.6	2.3	0.5	2.8	3.1	3.0	3.1	2.9	2.8
Mood	13.8	35.5	15.7	36.1	39.9	39.0	29.4	27.2	27.2
Psychotic	0.6	2.3	1.0	2.1	2.8	3.2	2.2	1.6	3.1
Substance	5.9	10.5	4.7	15.3	10.0	12.7	14.7	9.7	10.7
Other mental health	0.6	0.7	0.5	1.5	1.7	2.0	1.4	1.5	1.5
COVID	0.0	0.0	0.0	17.5	18.0	24.6	20.2	29.4	22.2
LOS, mean (SD), days	6.4 (4.9)	6.4 (4.9)	6.9 (5.3)	7.1 (5.2)	6.5 (5.0)	7.3 (5.5)	8.6 (6.0)	6.4 (4.8)	9.2 (6.1)

[a]Data on distribution of payer type information during the pre-PRIME period was incomplete due to a transition of the electronic medical record during that period; therefore, all unknown or missing payer data were classified under the "other" category.
*Intervention period and units.
Abbreviations: CCI = Charlson comorbidity index, HH = Highland Hospital, LOS = length of stay, PRIME = Proactive Integration of Mental health care in Medicine, QI = quality improvement, SMH = Strong Memorial Hospital.

the change in LOS from pre-PRIME to QI intervention on PRIME units versus LOS change on comparison units. For sensitivity analysis, we repeat $\Delta\Delta_a$ restricted to non-COVID patients who received psychiatric consultation—the patients likeliest to receive direct benefit.

We evaluated $\Delta\Delta_a$ in the Hospital Consumer Assessment of Healthcare Providers and Systems (HCAHPS) items analogous to the primary analysis (see Supplement A for description). Responses were converted to numerical values, with higher values being more favorable. Included items were scored ordinally 1–4 except for "overall rating of hospital," whose responses range from 0 to 10. To calculate aggregate section scores and account for skip patterns, all valid scores in each section were added, and each total was divided by the number of valid scores. The "overall rating of hospital" item was declared a priori as the HCAHPS item of primary interest.

Clinician-Related Evaluation

Before and after this project (August 2021 and 2022), we invited nurses and practitioners on PRIME and SMH comparison units to complete the same surveys as before.[4] Nursing respondents on PRIME and SMH comparison units are analogous; practitioners on PRIME units include physicians and APPs, whereas practitioner respondents on SMH comparison units included only attending physicians (resident physicians excluded for frequent turnover). Surveys were distributed by nursing and hospital medicine leadership, with 2 reminder e-mails per survey.

Responses were combined for each unit group (PRIME/SMH comparison), clinician type (practitioner/nurse), and time (before/after QI). Lower values represent more favorable responses. An average sum of the 10 main survey items was calculated for each clinician subgroup (range, 10–50). Subscale items were aggregated, and internal consistency was evaluated with Cronbach α or bivariate correlation.

We conducted pairwise comparisons between average sums using nonparametric, exact Mann Whitney U tests to determine change over time on PRIME and SMH comparison units. Next, we evaluated pre-post practitioner responses. Average sum and aggregated

Table 2.
HCAHPS Change in Section Scores[a]

Section	Observed	Expected	*P* Value
Your care from nurses[b]	3.44	3.30	.22
Your care from doctors[b]	3.65	3.37	.02*
The hospital environment[b]	3.05	2.86	.18
Your experiences in this hospital[b]	3.10	2.89	.19
Overall rating of hospital[c]	8.03	7.05	.04*
Recommend hospital to others[d]	3.49	3.20	.06
Understanding care on discharge[e]	3.35	3.17	.14

[a]Across the 3 sets of units and 3 study periods, 1,682 HCAHPS surveys were included in $\Delta\Delta_a$ analyses to adjust for patient-level covariates. Of these, 75 surveys were from PRIME units during the QI intervention period.
[b]Aggregated items: never (1), sometimes (2), usually (3), always (4).
[c]Single item: ranges from 0 to 10.
[d]Single item: definitely no (1), probably no (2), probably yes (3), definitely yes (4).
[e]Aggregated items: strongly disagree (1), disagree (2), agree (3), strongly agree (4).
*$P < .05$.
Abbreviation: HCAHPS = Hospital Consumer Assessment of Healthcare Providers and Systems, PRIME = Proactive Integration of Mental health care in Medicine, QI = quality improvement.

subscale items were reported. A low number of responses of SMH comparison unit practitioners precluded pairwise comparisons between PRIME and SMH comparison units. We also reported Cohen *d* values for effect sizes (≥ 0.2 small, ≥ 0.5 medium, ≥ 0.8 large). Nursing survey analyses were analogous to that of practitioners except that PRIME and SMH comparison nurse responses were compared given an adequate number of SMH comparison respondents.

RESULTS

Service Outcomes

Sample characteristics are reported in Table 1. The proportion of patients on PRIME units who received a consultation during the pre-PRIME year was 3.2% versus 9.6% during QI intervention (without exclusions, the QI intervention consult rate was 13.5%). The SMH comparison unit consult rate was effectively unchanged, from 3.2% to 3.5%. On $\Delta\Delta_a$ analysis, the consult rate on PRIME units was 2.7 times higher during the QI intervention period than expected after adjusting for covariates ($P < .001$).

In absolute terms, mean boarding time was substantially higher during the QI intervention period than the pre-PRIME period, increasing from 2.0 to 3.5 days for patients admitted to PRIME units and from 1.7 to 3.2 days for patients admitted to SMH comparison units. Boarding time for HH comparison units was unchanged, from 1.5 days to 1.6 days.

During the QI intervention, unadjusted mean time to consult on PRIME units was slightly less than it was during the pre-PRIME year (1.5 days vs 1.7 days, respectively). This was despite substantially longer boarding time, suggesting that a larger proportion of psychiatric consultation orders were placed on patients prior to arrival on PRIME units. Curiously, time to psychiatric consult order on SMH comparison units was lower during QI intervention period than the pre-QI period (0.7 days vs 1.2 days, respectively), in the absence of proactive screening on these units and, as above, with an unchanged consult rate.

On $\Delta\Delta_a$ analysis, consult latency was not reduced compared to the pre-PRIME year; rather, it was 0.36 days longer than expected (1.15 days expected vs 1.51 days observed, $P = .65$), which was due in large part to the shorter time to consultation on SMH comparison units during the QI intervention. In a post hoc $\Delta\Delta_a$ analysis that defined prolonged time to consult categorically as ≥ 1 day, we found that that the likelihood of consultation within a day of admission order was nearly identical to the expected value (0.44% observed, 0.46% expected, $P = .81$). This provides further evidence that proactive screening among boarding patients was effective given that boarding times were even longer during the QI intervention period.

Length of Stay

The mean LOS increased on both PRIME and SMH comparison units over the prior few years (Supplementary Figure 1). For the primary $\Delta\Delta_a$ analysis, we found that the *expected* LOS during the QI intervention year was 9.3 days compared to 6.9 days during the pre-PRIME year, indicating a marked increase in overall care complexity of PRIME unit patients during the QI intervention. However, the *observed* LOS was 9.6, or 0.3 days (3.3%) higher than expected (P = not significant). Our QI project was not associated with a reduction in unit-wide mean LOS.

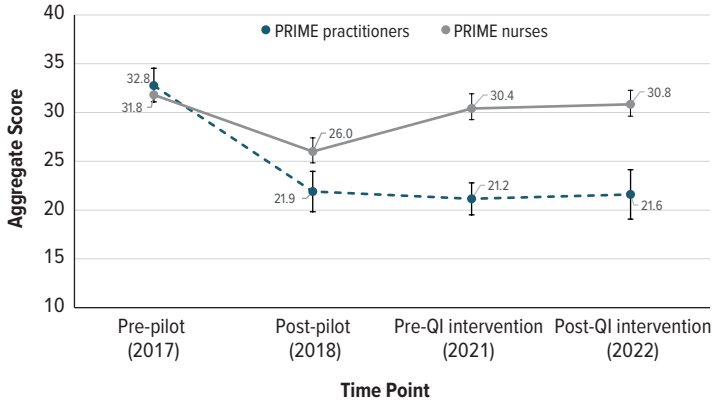
Secondary $\Delta\Delta_a$ analyses found that patients receiving psychiatric consultation (n = 131) had a 0.5 day (3.8%) shorter LOS than expected (12.6 vs 12.2 days, P = not significant). Excluding patients with COVID did not affect the primary LOS analysis (expected 9.2 vs observed 9.5 days, or 3.4% higher); however, it did reveal an even more favorable point estimate of LOS reduction among patients receiving psychiatric consultation of 1.2 days (n = 108; expected 12.4 vs observed 11.2 days, 9.1% reduction, P = not significant).

HCAHPS Item

Across units, the response rate was 9.3%; this includes 6.9% for PRIME units, 7.7% for SMH comparison units, and 12.3% for HH comparison units. On $\Delta\Delta_a$ analysis, each of the mean HCAHPS section scores was higher than expected during the intervention (Table 2). Of these, patient ratings of "care from doctors" was statistically improved, and the single item "overall rating of hospital," an a priori outcome of interest, was statistically improved as well ($P = .036$). Improvement in likelihood of recommending the hospital to others trended toward statistical significance.

Figure 1.

Surveys of PRIME Practitioners and Nurses Over Time[a,b,c]



[a]Mean and 95% confidence interval error bar shown. Mann Whitney U tests performed between time points.
[b]Practitioners: $P < .001$ for comparisons time point 1 vs 2, 1 vs 3, and 1 vs 4.
[c]Nurses: $P < .001$ for comparison time point 1 vs 2, $P < .001$ for comparison time point 2 vs 3, and $P < .05$ for comparison time point 2 vs 4.
Abbreviations: PRIME = Proactive Integration of Mental health care in Medicine, QI = quality improvement.

Table 3.

Practitioner Surveys, PRIME Units Before and After QI, Including Comparison Unit Practitioners

	Before QI		After QI		PRIME Units Before vs After QI	
Subscale, mean (SD)[a]	PRIME Units (n = 20)	SMH Comparison (n = 4)	PRIME Units (n = 10)	SMH Comparison (n = 2)	Cohen *d*	*P* Value
Resource adequacy (4 items)[b]	1.29 (0.27)	2.44 (0.72)	1.43 (0.59)	2.25 (1.06)	−0.34	.926
Organizational culture						
Personal/psychological safety (2 items)[c]	1.28 (0.34)	2.38 (0.95)	1.20 (0.35)	2.25 (1.06)	0.22	.495
Time for improvement efforts (2 items)[d]	3.53 (0.83)	4.38 (0.48)	3.50 (1.18)	4.50 (0.71)	0.03	.964
Burnout (2 items)[e]	3.20 (0.95)	3.00 (0.71)	3.25 (0.86)	4.00 (1.41)	−0.05	.964
Aggregate score (10 items)[f]	21.15 (3.51)	29.25 (5.56)	21.60 (3.53)	30.50 (10.61)	−0.13	.740

[a]Subscale scores are on a scale from 1 = strongly agree to 5 = strongly disagree. All subscales scored so that lower values indicate more favorable results. *P* values shown for Mann Whitney U test.
[b]Behavioral health care competency survey: resource adequacy domain (4 items), Cronbach α = 0.71.
[c]One item from the organizational culture survey (psychological safety) and 1 item on personal safety, $r = 0.52$ ($P = .001$).
[d]Organizational culture survey (2 items), $r = 0.77$ ($P < .001$).
[e]Two items adapted from the Maslach Burnout Inventory. Missing $n_{before\ QI} = 1$. Emotional exhaustion item and depersonalization item, $r = 0.62$ ($P < .001$).
[f]Aggregate score of 10 items (scale 10–50). Missing $n_{after\ QI} = 1$. Resource adequacy (4 items), organizational culture (4 items), and burnout items (2 items), Cronbach α = 0.77.
Abbreviations: PRIME = Proactive Integration of Mental health care in Medicine, QI = quality improvement, SMH = Strong Memorial Hospital.

Clinician-Rated Outcomes

The number of surveys completed by each subgroup is shown in Supplementary Table 2. Figure 1 depicts responses by PRIME clinicians over time. Practitioner responses before QI were improved relative to responses before PRIME originally launched ($P < .001$). Practitioner responses after QI remained improved relative to pre-PRIME baseline ($P < .001$). Nurse responses before this QI project had largely returned to pre-PRIME levels and remained similar at the end of the QI project.

Although mean PRIME practitioner responses were considerably more favorable than practitioner responses on SMH comparison units (statistical comparison omitted due to small SMH comparison sample size), there was no change in overall aggregate or subscale scores over the course of this QI project (Table 3).

Table 4.
Nursing Surveys, PRIME vs SMH Comparison Units Before and After QI

Subscale, mean (SD)[a]	Before QI				After QI			
	PRIME (n = 29)	SMH Comparison (n = 37)	Cohen *d*	*P* Value	PRIME (n = 19)	SMH Comparison (n = 10)	Cohen *d*	*P* Value
Resource adequacy (4 items)[b]	2.16 (0.80)	2.48 (0.89)	−0.38	.136	2.22 (0.84)	2.83 (1.11)	−0.64	.140
Organizational culture								
Personal/psychological safety (2 items)[c]	2.48 (0.77)	3.14 (1.11)	−0.67	.013*	2.61 (0.97)	3.35 (0.78)	−0.82	.025*
Time for improvement efforts (2 items)[d]	4.24 (0.64)	4.23 (0.76)	0.02	.873	4.16 (0.69)	4.50 (0.58)	−0.52	.180
Burnout (2 items)[e]	4.17 (0.76)	4.22 (0.82)	−0.06	.709	4.21 (0.89)	4.55 (0.44)	−0.44	.484
Competency survey[f]								
Assessment competency (8 items)	2.08 (0.67)	1.95 (0.52)	0.21	.440	2.13 (0.91)	1.76 (0.53)	0.45	.297
Intervention competency (8 items)	2.41 (0.65)	2.54 (0.74)	−0.18	.328	2.50 (0.88)	2.41 (0.41)	0.11	.764
Aggregate score (10 items)[g]	30.41 (4.74)	33.08 (6.41)	−0.47	.086	30.84 (7.10)	36.10 (5.74)	−0.79	.054

[a]Subscale scores are on a scale from 1 = strongly agree to 5 = strongly disagree. All subscales scored so that lower values indicate more favorable result. *P* values shown for Mann Whitney U test.
[b]BHCC survey resource adequacy domain (4 items), Cronbach α: $\alpha_{\text{before QI}} = 0.72$, $\alpha_{\text{after QI}} = 0.77$.
[c]One item from the organizational culture survey (psychological safety) and 1 item on personal safety, $r_{\text{before QI}} = 0.55$ ($P < .001$) and $r_{\text{after QI}} = 0.41$ ($P = .026$).
[d]Organizational culture survey (2 items), $r_{\text{before QI}} = 0.48$ ($P < .001$) and $r_{\text{after QI}} = 0.68$ ($P < .001$).
[e]Two items adapted from the Maslach Burnout Inventory. Emotional exhaustion item and depersonalization item, $r_{\text{before QI}} = 0.56$ ($P < .001$) and $r_{\text{after QI}} = 0.68$ ($P < .001$).
[f]BHCC survey assessment domain (8 items), Cronbach $\alpha_{\text{before QI}} = 0.83$ and $\alpha_{\text{after QI}} = 0.94$; BHCC survey practice/intervention competency domain (8 items), Cronbach $\alpha_{\text{before QI}} = 0.85$ and $\alpha_{\text{after QI}} = 0.83$.
[g]Aggregate score of 10 items (scale 10–50). Resource adequacy (4 items), organizational culture (4 items), and burnout (2 items), Cronbach $\alpha_{\text{before QI}} = 0.75$ and $\alpha_{\text{after QI}} = 0.85$.
*$P < .05$.
Abbreviations: BHCC = behavioral health care competency, QI = quality improvement, SMH = Strong Memorial Hospital.

Before the QI project, nurses on PRIME units reported moderately higher safety than nurses on comparison units (Cohen $d = -0.67$) (Table 4). There was a trend of greater overall favorability among nurses on PRIME units versus nurses on comparison units (30.4 vs 33.1, Cohen $d = -0.47$, $P = .086$). After the QI intervention period, nurses on PRIME units continued to report moderately higher safety ratings than nurses on comparison units (Cohen $d = -0.82$). Consistent with responses before QI, there was a continued trend of greater overall favorability among nurses on PRIME units versus nurses on comparison units (Cohen $d = -0.79$, $P = .054$). Before/after subscale scores of PRIME nurses and comparison unit nurses did not change (Supplementary Tables 3 and 4).

DISCUSSION

This current report of mixed results expands upon our prior work describing the clinical value of a proactive C-L service by characterizing service outcomes after implementing an automated screening list. We did not find proactive C-L to be associated with unit-wide LOS reduction, yet sensitivity analyses restricted to non-COVID patients receiving psychiatric consultation favored PRIME, with average LOS 1.2 days shorter than expected. If this point estimate is correct, then PRIME might have reduced up to 155 hospital days, annualized, consistent with prior evidence of financial benefit with this model.[18]

During this project, the consult rate was 3-fold higher than during the pre-PRIME year, indicating that this model continued to address previously unmet mental health needs. Additionally, these analyses excluded patients with LOS > 30 days, a subpopulation with a considerably higher psychiatric consult rate, hence the pre-exclusion QI consult rate of 13.5% across PRIME units. Despite the further lengthening of boarding times and no change on main time-to-consult $\Delta\Delta_a$ analysis, the absolute time to psychiatric consultation was unchanged, implying that screening was effective. The results of a post hoc analysis defining prolonged time to consult as ≥ 1 day was consistent with greater degree of proactivity.

Supplementary Figure 1 reveals that the unadjusted hospital LOS increased considerably, especially about a year into the COVID pandemic, with the expected LOS during the QI intervention year more than 2 days longer than pre-QI when adjusting for the rising prevalence of covariates associated with LOS. The rising LOS is attributable to a reduced number of available skilled nursing facility beds in the community related to workforce impacts of COVID. Delayed disposition and increased inpatient census were also likely responsible for upstream delays in transfer from the ED to inpatient units.[19]

Results of patient-reported outcomes on HCAHPS

were broadly favorable, with statistical improvements in ratings of doctors and the hospital overall. In fact, the mean hospital rating was higher than expected by nearly a full point on a 10-point scale. Although we cannot attribute these changes in full to our project, it is at least plausible that PRIME's presence accounted for a portion of this effect. To our knowledge, the finding of improved patient-reported outcomes during a C-L psychiatry intervention is novel, and it deserves replication.

Practitioner-reported improvements evident after the original pilot were maintained through COVID. Going from 32.8 (note: 30 is neutral) to 21 implied that the rating of each item was, on average, a full point improved on the Likert scale. Although statistical comparison was omitted between PRIME and SMH comparison practitioners, the before and after point estimates of the SMH comparison unit practitioners were nearly identical to the pre-PRIME baseline.

Nurse perceptions of safety on PRIME units appeared to be more favorable than SMH comparison unit respondents before and after this project (Cohen d = −0.67 [medium effect size] and 0.82 [large], respectively). This is especially encouraging in view of the greater medical complexity of unit populations during the QI intervention period. The lack of improvement on overall composite scores could be explained by higher nurse distress and burnout since COVID,[20] leading to increased turnover and a higher proportion of travel nurses to fill vacancies. Additionally, PRIME provided greater collaborative support to practitioners than to nurses. There is an opportunity for further interprofessional mental health collaboration with nurses.[21]

Similar to how collaborative care aims to provide population-level benefits in outpatient settings, proactive C-L aims to provide benefits for inpatient medical populations.[5,22] Our results suggest that proactive C-L, as enhanced with automated screening, could help to achieve the Institute for Healthcare Improvement's Triple Aim and even the informal Quadruple Aim, which adds clinician wellness.[23,24] Although the proactive C-L literature is expanding, it remains primarily limited to academic hospital medicine services, with rare publications elsewhere such as critical care[25] or rural settings.[6] Expanding into settings with higher per-patient care costs may make for an even stronger argument for proactive C-L. Another gap in the proactive C-L literature is the absence of randomized controlled trials,[26] though the results of the HOME Study[27] are forthcoming.

This study was subject to the following limitations. First, this was QI rather than research, and our population was not necessarily generalizable to other settings. Second, the intervention was delivered in a nonrandomized fashion without blinding. Nevertheless, other than clinician surveys, these data were collected without clinician awareness, and survey respondents knew survey responses were anonymous. Third, we could not rule out the potential effects of variably overlapping QI projects that may have affected our reported outcomes. Fourth, HCAHPS scores represented responses from a subpopulation of inpatients who chose to respond and thus could be partly confounded by response rate bias[28]; however, this potential was mitigated via regression-adjusted analyses of HCAHPS data that controlled for patient-level covariates.

Our proactive C-L service enhanced by automated EMR screening resulted in an increased consult rate, evidence consistent with earlier consultation, and a trend of reduced hospital LOS among patients expected to receive direct benefit. Patients' mean hospital rating improved on PRIME units. Our service was rated more favorably by practitioners overall and by nurses in terms of safety. Our year-long QI project therefore provides evidence of how proactive C-L could be poised to meet the Triple Aim of health care.

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FOR CNS DISORDERS

Supplementary Material

Article Title: Automated Screening to Enhance Proactive Consultation-Liaison Psychiatry Services in Acute Medicine Units: Evaluation of Service Outcomes

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LIST OF SUPPLEMENTARY MATERIAL FOR THE ARTICLE

DISCLAIMER

This Supplementary Material has been provided by the author(s) as an enhancement to the published article. It has been approved by peer review; however, it has undergone neither editing nor formatting by in-house editorial staff. The material is presented in the manner supplied by the author.

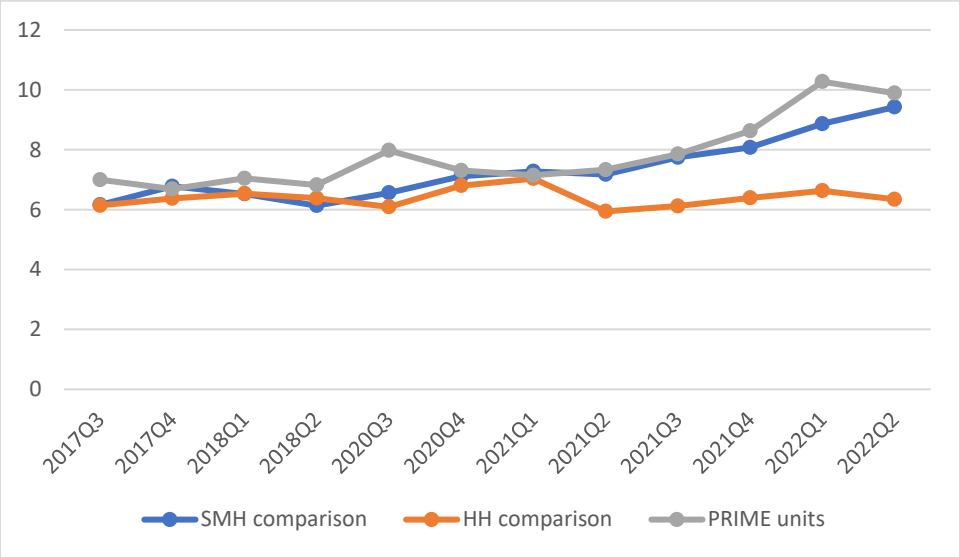
Supplement A: Description of Hospital Consumer Assessment of Healthcare Providers and Systems (HCAHPS)

The HCAHPS survey is a nationally administered, publicly reported survey used across the United States sent to a random sample of adult patients from 48 hours to 6 weeks after discharge.[1] It asks discharged patients 29 questions about their experiences during their recent inpatient episode of care. The sections on the survey include the following topics: care from nurses (4 items), care from doctors (3 items), hospital environment (2 items), experiences in the hospital (5 items), disposition information (3 items), overall rating of hospital (1 item), would they recommend the hospital (1 item), and understanding care on discharge (3 items). Remaining items pertain to demographics and overall health.

Hospitals subject to the Inpatient Prospective Payment System update provisions are required to collect and submit HCAHPS data. HCAHPS data also affect value-based incentive payments in the Hospital Value-Based Purchasing Program.

1. U.S. Centers for Medicare & Medicaid Services. HCAHPS: Patients' Perspectives of Care Survey. (https://www.cms.gov/Medicare/Quality-Initiatives-Patient-Assessment-Instruments/HospitalQualityInits/HospitalHCAHPS).

Supplementary Figure 1: Mean length of stay by quarter



Supplementary Table 1: Items in Electronic Medical Record Screening List[a]

Clinical information	Discrete data being populated
Suicidal ideation	Q1, nursing admission screen[b]
Prior suicide attempt	Q2, nursing admission screen[b]
Behavioral activation	Q3, nursing admission screen[b] ("behavioral or emotional disturbance") Restraints order (non-violent or violent) Sitter (*i.e.*, 1:1) order (suicide or safety)
Psychiatric morbidity	≥ 3 mental health diagnoses on diagnostic value set
Psychotic disorder	Psychotic disorder diagnostic value set (includes bipolar disorders)
Antipsychotic[c]	Ordered for an antipsychotic or mood stabilizer within the antipsychotic pharmaceutical class
Psychotropics	Ordered for ≥ 3 psychotropics on value set for all medications within the pharmaceutical classes of antipsychotics, antidepressants, stimulants, hypnotics, antianxiety agents, and miscellaneous psychotherapeutics.

[a]See previous publication for details regarding development and performance: Oldham MA, Heaney B, Gleber C, Lee HB, Maeng DD. Using Discrete Form Data in the Electronic Medical Record to Predict the Likelihood of Psychiatric Consultation. J Acad Consult Liaison Psychiatry 2023 Oct 17.

[b]The initial nursing evaluation completed after admission asks three questions pertaining to acute risk, and responses are scored as yes or no.

[c]The antipsychotic grouper also included antiemetics with D2 antagonism as well as ondansetron.

Supplementary Table 2: Completed surveys by subgroup

Clinician	**Group**	**Before pilot** 2018[a]	**After pilot** 2019[a]		**Before QI** 2021	**After QI** 2022
Practitioners	PRIME	*n* = 20	*n* = 21	COVID	*n* = 20	*n* = 10
	Comparison	--	--		*n* = 4	*n* = 2
Nurses	PRIME	*n* = 32	*n* = 31		*n* = 29	*n* = 19
	Comparison	--	--		*n* = 37	*n* = 10

[a]See previous publication for details: Oldham MA, Walsh P, Maeng DD, et al. Integration of a proactive, multidisciplinary mental health team on hospital medicine improves provider and nursing satisfaction. J Psychosom Res 2020 Jul;134:110112.

Supplementary Table 3: Nurse survey, PRIME units before and after QI

	Before QI (n = 29)	After QI (n = 19)		
Subscale	Mean (*SD*)	Mean (*SD*)	Cohen's *d*	*p*-value
Resource adequacy (4 items)[a]	2.16 (0.80)	2.22 (0.84)	-0.08	0.671
Organizational culture				
Personal and psychological safety (2 items)[b]	2.48 (0.77)	2.61 (0.97)	-0.14	0.863
Time for improvement efforts (2 items)[c]	4.24 (0.64)	4.16 (0.69)	0.13	0.614
Burnout (2 items)[d]	4.17 (0.76)	4.21 (0.89)	-0.05	0.660
Competency survey[e]				
Assessment competency (8 items)	2.08 (0.67)	2.13 (0.91)	-0.06	0.866
Intervention competency (8 items)	2.41 (0.65)	2.50 (0.88)	-0.11	0.751
Aggregate Score (10 items)[f]	30.41 (4.74)	30.84 (7.10)	-0.07	0.891

Subscale scores are on a scale from 1 = strongly agree to 5 = strongly disagree. All subscales scored so that lower values indicate more favorable result. *p*-values shown for Mann Whitney U test.

Abbreviations: QI, quality improvement; SD, standard deviation

[a]Behavioral Health Care Competency (BHCC) survey. Resource adequacy domain: 4 items, Cronbach's alpha (α) = 0.70.

[b]One item from Organizational Culture survey (psychological safety) and 1 item on personal safety, r = 0.33 (p = 0.021).

[c]Organizational Culture Survey: 2 items, r = 0.49 ($p < 0.001$).

[d]Two items adapted from Maslach Burnout Inventory. Missing $n_{\text{after QI}}$ = 1. Emotional exhaustion item and depersonalization item, r = 0.63 ($p < 0.001$).

[e]BHCC survey: Missing $n_{\text{after QI}}$ = 1. Assessment domain, 8 items, α = 0.89. Practice/intervention competency domain: 8 items, α = 0.89.

[f]Aggregate score of 10 items (scale 10 – 50): Missing $n_{\text{after QI}}$ = 1. Resource adequacy (4 items), organizational culture (4 items), and burnout items (2 items). Cronbach's alpha (α) = 0.77.

Supplementary Table 4: Nurse survey, Comparison units before and after QI

	Before QI (n = 37)	After QI (n = 10)		
Subscale	Mean (SD)	Mean (SD)	Cohen's d	p-value
Resource adequacy (4 items)[a]	2.48 (0.89)	2.83 (1.11)	-0.37	0.395
Organizational culture				
Personal and psychological safety (2 items)[b]	3.14 (1.11)	3.35 (0.78)	-0.20	0.655
Time for improvement efforts (2 items)[c]	4.23 (0.76)	4.50 (0.58)	-0.37	0.300
Burnout (2 items)[d]	4.22 (0.82)	4.55 (0.44)	-0.44	0.265
Competency survey[e]				
Assessment competency (8 items)	1.95 (0.52)	1.76 (0.53)	0.37	0.374
Intervention competency (8 items)	2.54 (0.74)	2.41 (0.41)	0.19	0.794
Aggregate Score (10 items)[f]	33.08 (6.41)	36.10 (5.74)	-0.48	0.316

Subscale scores are on a scale from 1 = strongly agree to 5 = strongly disagree. All subscales scored so that lower values indicate more favorable result. p-values shown for Mann Whitney U test.

Abbreviations: QI, quality improvement; SD, standard deviation

[a]Behavioral Health Care Competency (BHCC) survey. Resource adequacy domain: 4 items, Cronbach's alpha (α) = 0.76.

[b]One item from Organizational Culture survey (psychological safety) and 1 item on personal safety, r = 0.54 ($p < 0.001$).

[c]Organizational Culture Survey: 2 items, r = 0.57 ($p < 0.001$).

[d]Two items adapted from Maslach Burnout Inventory. Emotional exhaustion item and depersonalization item, r = 0.56 ($p < 0.001$).

[e]BHCC survey: Assessment domain, 8 items, α = 0.84. Practice/intervention competency domain: 8 items, α = 0.78.

[f]Aggregate score of 10 items (scale 10 – 50): Resource adequacy (4 items), organizational culture (4 items), and burnout items (2 items). Cronbach's alpha (α) = 0.79.