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BRIEF REPORT

Chronic Pain and Mood Disorders Are Not Barriers to Symptom Improvement Under Collaborative Co-managed Care (C^3)

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Abstract

Objectives Patients with comorbid chronic pain and mood disorders have more severe gastrointestinal disease and higher healthcare expenses than their peers. We sought to determine whether management under our innovative Collaborative Co-Managed Care (C^3) general gastroenterology care model improved outcomes.

Methods Patient questionnaires completed by outpatients at our GI Motility Center were analyzed alongside demographic information to determine predictors of response to treatment based on adequate relief of gastrointestinal symptoms and improvement in quality of life.

Results These comorbidities did not significantly impair response and may be associated with improved response under our model.

Conclusions The C^3 general gastroenterology care model anchors on setting expectations and team-based communication and improves outcomes of, and access to, care.

Keywords Operations · Motility center · Quality of life · Equity

Introduction

Many patients referred to gastroenterologists have chronic overlapping pain conditions (COPCs) and mood disorders that portend greater disease severity and healthcare utilization [1]. As a result, GI practices often choose to silo care for affected patients into "motility centers", clinics anchored on frequent follow-up visits and complex care plans. Unfortunately, this arrangement is not broadly scalable, posing access and equity challenges. We developed an innovative healthcare delivery model in which motility center gastroenterologists serve as consultants for patients across diseases who maintain their referring provider as their care home, representing collaborative, co-managed care (C^3). Our center frames treatment goals and expectations, develops longitudinal step-wise care plans, and maximizes patient engagement in care with local teams. We care for patients with esophageal reflux and dysmotility, eosinophilic esophagitis, pelvic floor, and general GI disorders such as disorders of gut-brain interaction. We aimed to determine whether comorbid chronic pain and mood disorders mediate patient outcomes in our C^3 model independent of specific treatment paradigms.

Methods

We analyzed a cohort of outpatients seen at the GI Motility Center at Dartmouth-Hitchcock Medical Center and being managed using our innovative C^3 model [2]. Our study followed the TRIPOD checklist for multivariable prediction models [3]. The Institutional Review Board at Dartmouth-Hitchcock determined that this study was exempt from review, prior to initiation of our study. Individuals were identified based on completion of a baseline and at least one follow-up electronic clinic intake form in our electronic

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health record system (EMR). We included individuals at least 18 years and no more than 80 years old.

Patient age at treatment initiation was extracted from our EMR. The remainder of possible predictors of response as well as patient-reported outcomes were obtained from the electronic clinic intake questionnaires, including the presence of individual COPCs and mood disorders, prior management strategies utilized, and scores on several previously validated disease assessment tools.

Clinical response was measured by whether a patient achieved adequate relief of gastrointestinal symptoms as a valid and reliable end point for clinical practice. Health-related quality of life (HRQOL) was measured using the CDC HRQOL-4 instrument assessing patients' number of healthy days in the past 30 days.

Data analysis was performed using R package icenREG. We used the Turnbull estimator [4] to generate survival curves under interval censorship and unadjusted and derived adjusted hazard ratios (HRs) from the Finkelstein proportional hazard models, which summarizes adjusted and unadjusted differences by groups [5]. Outcomes were censored after the last date of follow-up. Of note, the HRs therefore represent probability of non-response, and a *lower* HR < 1.0 suggests a *higher* likelihood of response.

Results

We identified 94 patients seen at the GI Motility Center who met eligibility criteria and were included in the overall cohort. Baseline characteristics are reported in Table 1. The mean age was 47, 40% had at least one COPC, and 46% had at least one diagnosed mood disorder. 67% had tried at least one management strategy prior to referral to our center.

Sixty-two patients (65.9%) reported adequate relief at any follow-up point. Quality of life data were available for 91 patients (96.8%), with 44 of them reporting improvement (48.3%). Patients with chronic constipation on initial survey had statistically significantly more frequent achievement of relief of symptoms, with hazard ratio (HR) of non-response of 0.25 (p value: 0.0124, 95% Confidence Interval: 0.08–0.74), where low HR represents a higher likelihood of response. No other variables examined reached statistical significance as predictors of response. The presence of comorbid chronic pain conditions or mood disorders were also associated, though not significantly, with relief of symptoms and increased quality of life (Table 2, Fig. 1). When adjusted for the performance on all baseline symptom questionnaires, COPC had a HR of 0.50 (p value: 0.634) but a wide 95% confidence interval (0.03 to 8.5) for non-achievement of symptom relief. The unadjusted HR (0.55) had a narrower confidence interval (0.23 to 1.32). The unadjusted HR for non-achievement of symptom relief for mood disorders was 0.64 (0.2775; 0.28 to 1.44), while the adjusted increased to 0.99 with a p value of 0.999 and non-informative confidence interval. Results were similar for improvement in quality of life.

Table 1 Characteristics of the study cohort

Characteristic	Mean (*N*)	SD (%)
Age (mean at baseline questionnaire, years)	46.97	15.68
CDC HRQOL-4	10.13	9.87
FBDSI	91.09	76.28
IBS-SSS	153.44	97.69
VSI	57.40	21.08
GAD7	3.33	4.75
PHQ-9	2.85	4.10
ISI	6.78	5.62
Any COPC		
Migraine	19	20.43
Temporomandibular joint disorder	1	1.08
Chronic pelvic pain	8	8.60
Chronic fatigue	15	16.13
Interstitial cystitis	1	1.08
Endometriosis	2	2.15
Fibromyalgia	7	7.53
Mood disorder	43	46.24
IBS	44	47.31
Chronic constipation	38	40.86
Prior therapies tried		
Linaclotide	5	5.38
Plecanatide	1	1.08
Prucalopride	0	0.00
Tegaserod	0	0.00
Lubiprostone	3	3.23
Alosetron	0	0.00
Rifaximin	6	6.45
Eluxadoline	0	0.00
Proton pump inhibitor	53	56.99
Anti-depressant	21	22.58
Anti-anxiety	27	29.03
Pelvic floor physical therapy	4	4.30

CDC HRQOL-4 CDC Healthy Days Core Questions, *COPC* Chronic Overlapping Pain Condition, *FBDSI* Functional Bowel Disorder Severity Index, *GAD7* Generalized Anxiety Disorder Assessment, *IBS-SSS* Irritable Bowel Syndrome Severity Scoring System, *ISI* Insomnia Severity Index, *PHQ-9* Patient Healthy Questionnaire Quick Depression Assessment, *VSI* Visceral Sensitivity Index

Discussion

In our cohort of patients managed under the novel C^3 model, patients with comorbidities associated with increased disease severity and healthcare utilization (COPCs, mood disorders)

Table 2 Univariate analyses of potential factors associated with treatment response in individuals seen at our GI motility center

Variables	Adequate relief (HR, 95% CI)			*p* value	CDC HRQOL-4 (HR, 95% CI)			*p* value
	HR	Lower	Upper		HR	Lower	Upper	
Age	0.99	0.96	1.02	0.5027	1.00	0.98	1.02	0.9374
CDC	1.00	0.96	1.04	0.8701	0.99	0.97	1.02	0.6401
FBDSI	1.00	0.99	1.00	0.7650	1.00	0.99	1.00	0.9369
IBS-SSS	1.00	1.00	1.01	0.3745	1.00	1.00	1.00	0.5137
VSI	0.99	0.97	1.01	0.4376	0.99	0.97	1.00	0.1663
GAD7	0.98	0.91	1.05	0.5733	1.01	0.94	1.10	0.7196
PHQ-9	0.96	0.87	1.06	0.4028	0.99	0.89	1.09	0.7983
ISI	1.04	0.96	1.13	0.2908	1.04	0.98	1.11	0.1813
Any COPC	0.55	0.23	1.32	0.1808	0.66	0.29	1.51	0.3242
Migraine	0.79	0.29	2.19	0.6553	1.01	0.27	3.77	0.9904
TMJ								
Chronic pelvic pain	0.34	0.01	16.33	0.5852	0.20	0.00	240.21	0.6582
Chronic fatigue	1.19	0.40	3.49	0.7553	1.29	0.46	3.62	0.6268
Interstitial cystitis	1.15	0.71	1.84	0.5745	0.72	0.48	1.08	0.1099
Endometriosis	0.89	0.51	1.56	0.6881	0.72	0.00	636.45	0.9250
Fibromyalgia	1.42	0.02	102.55	0.8728				
Mood disorder	0.64	0.28	1.44	0.2775	0.70	0.34	1.45	0.3408
IBS	0.67	0.30	1.50	0.3336	0.78	0.39	1.54	0.4696
Chronic constipation	0.25	0.08	0.74	0.0124	0.50	0.24	1.06	0.0710

Blank data indicates insufficient data

CDC HRQOL-4 CDC Healthy Days Core Questions, *COPC* Chronic Overlapping Pain Condition, *FBDSI* Functional Bowel Disorder Severity Index, *GAD7* Generalized Anxiety Disorder Assessment, *IBS-SSS* Irritable Bowel Syndrome Severity Scoring System, *ISI* Insomnia Severity Index, *PHQ-9* Patient Healthy Questionnaire Quick Depression Assessment, *TMJ* Temporomandibular Joint Disorders, *VSI* Visceral Sensitivity Index

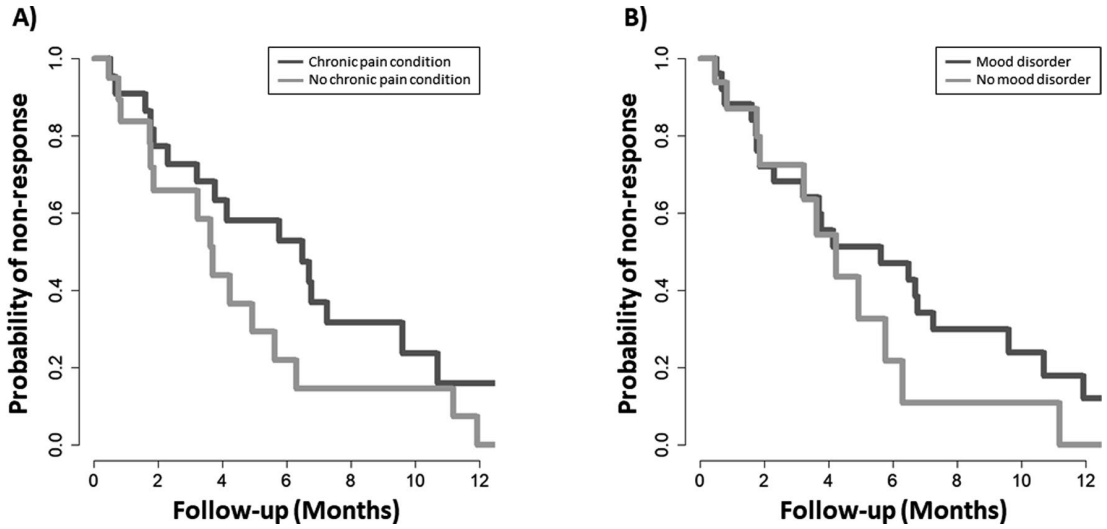

Fig. 1 Non-response probability by presence/absence of chronic pain conditions (**A**) or mood disorders (**B**). Survival curve estimation using the Turnbull estimator for Adequate Relief

were able to achieve relief of symptoms and improvement in quality of life at an at least similar, and possibly increased, rate to compared to that of patients without these comorbidities. That no significant difference was found between these

patients and their counterparts suggests that our care model effectively manages these patients. In fact, though limited by our small sample size, our hazard ratios of non-response of 0.50 to 0.70 strongly suggest that patients with these comorbidities had *better* outcomes than their peers.

The C^3 model anchors on setting up-front expectations with patients, referring providers, and across the team; including all members of the care team on a cohesive team; and, centering care around the patient with their local primary care provider at the helm with gastroenterology positioned as a consultant. As mood disorders and COPCs are so common, the C^3 model is a general gastroenterology care model that emphasizes the importance of patient-physician communication, specialist-referring provider communication, and team communication in contemporary healthcare [6]. In a recent publication, we detail concrete steps to replicate this care model in gastroenterology practices [2].

Interestingly, our findings were independent of focus on specific disease mechanisms. And, our model did not anchor on delivering or having access to complex multidisciplinary care. For example, while symptom severity was moderate or severe in many patients, fewer than 5% of patients in our cohort accessed allied health resources, and treatments prescribed to patients were myriad. In other words, no specific treatment modality can explain our findings, but rather our findings more likely relate to use of the Rome framework to deliver a positive diagnosis in general gastroenterology within the context of the C^3 healthcare delivery model as a whole.

We previously reported that the use of the C^3 model reduced the number of visits at our clinic from 3.1 visits to complete necessary care, compared to 5.8 visits at other Centers in the Gastroenterology Division, allowing us to shorten wait times for visits to 3 to 6 weeks rather than 6 to 12 months. (2) Additionally, we were able to triple the number of motility tests performed at our center, greatly increasing the amount of tertiary-care center level care administered while empowering patients' local GIs to continue primary management. This model therefore improves access to expert consultation and favors delivery of **health** versus healthcare. Thus, we demonstrate that healthcare delivery and operations management play a critical role in healthcare and that attention is needed in this area to attain further critical breakthroughs that improve health across the spectrum of GI diseases.

Author's contribution EVW, MAC and EDS were involved in study concept and design. PMC performed statistical analysis. EVW authored the initial draft of the manuscript. EDS supervised the conduct of this study. All authors critically revised the manuscript and approved the final copy.

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Declarations

Competing interests Dr. Shah has consulted for GI Supply, Ardelyx, Bausch Health, Mylan, Salix, Sanofi, Takeda, and Mahana. The other authors have no disclosures.

Ethical approval The Institutional Review Board at Dartmouth-Hitchcock determined that this study was exempt from review, prior to initiation of our study.

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