

1 **Validation of the What Matters Index: a brief, patient-**
2 **reported index that guides care for chronic conditions and can**
3 **substitute for computer-generated risk models**

Commented [K1]: Line and page numbers have been added in accordance with the target journal's instructions.

Commented [K2]: The changes made to the title were implemented to clarify the objective and significance of the study presented in this paper.

Commented [K3]: The target journal's instructions indicate that a short title (not more than 100 characters) should also be included when submitting the document. I would suggest: "The What Matters Index: a brief, patient-reported index that guides care for chronic conditions".

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5
6 John H. Wasson¹, Lynn Ho², Laura Soloway³, L. Gordon Moore³

Commented [K4]: The target journal's instructions state that titles are not to be included in the author byline.

Commented [K5]: The corresponding author information has been formatted following the target journal's instructions, including the deletion of this author's physical address.

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8 ¹ Centers for Health and Aging, Dartmouth Medical School, [Hanover, NH, USA](#)

9 ² North Kingstown Family Practice, North Kingstown, RI, [USA](#)

10 ³ 3M Health Information Systems

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14
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16 Support and Conflict of Interest Statement: The authors and private practice clinicians
17 contributed their time. There are no conflicts of interest.

21 **Abstract**

22 Current health care delivery relies on complex, computer-generated risk models
23 constructed from insurance claims and medical record data. However, these models produce
24 inaccurate predictions of risk levels for individual patients. Moreover, such models do not
25 explicitly guide care, and also undermine health management investments in many patients at
26 lesser risk. Therefore, this study prospectively tested an alternative risk assessment model that
27 is simple, broadly applicable, and based on patient reports.

28 Five measures with well-documented impacts on the use of health services are summed
29 to create a “What Matters Index.” These measures are: 1) insufficient confidence to self-
30 manage health problems, 2) pain, 3) bothersome emotions, 4) polypharmacy, and 5) adverse
31 medication effects. We compare the sensitivity and predictive values of this index with two
32 representative risk models in a population of 8619 Medicaid recipients.

33 For patients with index scores of 1, 2, and ≥ 3 , the odds ratios (with 95% confidence
34 intervals) for subsequent hospitalization within 1 year, relative to patients with WMI of 0, are
35 1.3 (1.1–1.6), 2.0 (1.6–2.4), and 3.4 (2.9–4.0), respectively; for emergency room use, the
36 corresponding odds ratios are 1.3 (1.1–1.4), 1.9 (1.6–2.1), and 2.9 (2.6–3.3). The proposed index
37 and the conventional risk models exhibit similar sensitivities, predictive values, and statistical
38 concordance measures for subsequent hospital or emergency room use. However, the
39 conventional models’ performances were inferior for the majority of patients whose needs
40 were not identified by those models.

41 We also demonstrate how the proposed index can guide care for all patients. In
42 summary, in contrast to computer-generated risk models, the patient-reported “What Matters

Commented [K7]: The first sentence was eliminated from the abstract because clarifying other sentences in the abstract added words in excess of the target journal’s 300-word limit. The sentence that was eliminated was unnecessary because this paper does not dispute the idea that services could be delivered to certain patients in an effort to control future health expenditures on their behalf. Rather, the paper proposes a new, more efficient, and less costly way in which such patients can be identified.

Commented [K8]: The verb tense has been adjusted to maintain consistency throughout the abstract.

Commented [K9]: This sentence has been relocated so that the structure of the abstract matches the structure of the main text.

43 index” immediately and unambiguously identifies fundamental, remediable needs for each
44 patient. By empowering patients to express their needs, the proposed index can be used to
45 design and deliver services that are effective for patients with chronic conditions. We also
46 demonstrate how the proposed index can guide care for all patients.

47

48 Introduction

49 The increasing prevalence of non-communicable, chronic disease is a major global
50 health problem. The dominant strategy applied to control the escalating cost of chronic disease
51 management is based on computer-generated risk models (CRMs) constructed from insurance
52 claims and medical record data that designate a few patients at greatest risk for requiring costly
53 care; these patients become targets for intensive interventions. Unfortunately, considerable
54 evidence has exposed the substantial limitations of the CRM strategy [1-6].

55 _____ Three deficiencies render CRM-based interventions inherently ill-advised. First, CRMs
56 can not make accurate predictions for individual patients [7]. The reported data illustrate the
57 implications of these individual inaccuracies for clinical practice: a minority of the highest-risk
58 decile use the hospital within two years, in contrast to almost three times as many patients not
59 designated high-risk who nonetheless require hospital resources in the same time period [8,9].

60 In practice, this large false positive rate wastes scarce resources on the many patients in the
61 highest-risk subgroup who will not use costly care, while care is relatively rationed for those not
62 designated as at-risk, including the many false negatives destined to use costly services. From a
63 public policy perspective, CRM-based targeting may perpetuate underinvestment in chronic
64 disease prevention and management across all risk strata of a population [10].

Commented [K10]: This sentence has been relocated to so that the dominant strategy is first defined and then critiqued.

Commented [K11]: The in-text citations in this document have been formatted for compliance with the intended publisher’s formatting guidelines.

Commented [K12]: This substitution (for “high-user”) represents a significant change in meaning. I have implemented the substitution here and at the other three instances in which the phrase “high-user” originally appeared, because the text indicates that the patients designated as highest-risk by the CRMs are not always the patients who are actually the most frequent users of health care resources. If the meaning change is inappropriate, the change can be rejected here and at the other instances highlighted in my comments below.

Commented [K13]: Please confirm my interpretation of the intended meaning: that these patients used hospital resources in the time period under consideration.

65 Second, CRMs based on demographics, diagnoses, and past use do not provide specific,
66 real-time guidance for needs that matter to patients. Rather, CRMs output a general,
67 asynchronous designation of risk, offered with the implicit assumption that clinicians can select
68 and apply corrective action that will mitigate that risk. This generality supports neither clinicians
69 nor patients, who must struggle during a time-constrained visit to identify a few current
70 concerns that might respond to a management plan and thus decrease risk. Third, CRMs are
71 based on “what is the matter” (such as diagnoses and test results), rather than “what matters”
72 to patients (such as bothersome symptoms and specific functional limits). Thus, CRMs are often
73 too abstract, untimely, or irrelevant to support patient engagement in care, and patient
74 engagement in care is increasingly recognized as a highly effective strategy for delivering health
75 care in the face of rising demand and shrinking budgets [11].

Commented [K14]: Please confirm my interpretation of the intended meaning: that clinicians are the people expected to select and apply the corrective action.

76 The authors of this paper recently tested the hypothesis that a clinical prediction rule
77 based on a few self-reported measures may address the inadequacies of current CRM-based
78 interventions for patients with chronic conditions [12]. We named this clinical prediction rule
79 the “What Matters Index” (WMI) because it proved to be an appropriate indicator of patients’
80 quality of life—that is, what matters to patients. The WMI is based on a concise set of
81 memorable measures that can be addressed by immediate actions and a management plan,
82 and for which there is significant evidence that action can positively impact patient outcomes
83 [13-20]. The proposed index is evaluated by summing the five binary scores, with an index of 0
84 representing a patient with the fewest reported problems and an index of 5 representing one
85 with the most reported problems. The five WMI measures are listed in Table 1.

Commented [K15]: Although this statement would never be questioned by anyone with any experience in American health care, adding a citation to this second CRM deficiency would further substantiate the need for an alternative approach to risk assessment.

Commented [K16]: Please note the meaning change, as described above.

Commented [K17]: Table names and captions were adjusted to comply with the target journal’s instructions.

87 **Table 1. Patient-Reported Measures in the “What Matters Index” (WMI).**

Patient-Reported Measure
<p>Insufficient Health Confidence</p> <p>How confident are you that you can manage and control most of your health problems?</p> <p><i>(Not very confident or somewhat confident, scored as 1; versus very confident, scored as zero)</i></p>
<p>Pain</p> <p>During the past four weeks, how much bodily pain have you generally had?</p> <p><i>(Extreme or moderate pain, scored as 1; versus none, very mild, or mild, scored as zero)</i></p>
<p>Emotions</p> <p>During the past four weeks, how much have you been bothered by emotional problems such as feeling anxious, irritable, depressed, or sad?</p> <p><i>(Extremely or quite a bit, scored as 1; versus not at all, a little, or somewhat, scored as zero)</i></p>
<p>Polypharmacy</p> <p>How many prescription medicines are you taking more than three days a week?</p> <p><i>(More than five, scored as 1; versus 5 or less, scored as zero)</i></p>
<p>Adverse Effects from Medicines</p> <p>Do you think any of your pills are making you sick?</p> <p><i>(Yes or maybe, scored as 1; versus no, scored as zero)</i></p>

Commented [K18]: I have relocated the information that formerly appeared in the footnote to the preceding paragraph because the scale used to evaluate the WMI in relation to predicted risk is an important component of the description of the index. For visually-oriented readers, who will focus on the table contents, the evaluation method is clear from the stated binary values; for textually-oriented readers, who may skim the table headings, the evaluation method is now present in the main text, which may encourage such readers to review the table in more depth.

88

89 ——— In addition to its foundation in clinical evidence for likely impact on patient outcomes,

90 [the WMI proved to be strongly associated with a history of emergency and hospital use](#) when

91 retrospectively tested in three populations: age 18–64 (n = 8,619), 50–64 (n = 7,408), and 65+

92 (n = 3,566). For example, regardless of a patient's financial status, a WMI ≥ 2 was associated
93 with approximately twice the odds of costly health care usage compared to a WMI = 0; for WMI
94 ≥ 3 , usage was approximately three times higher than for WMI = 0. The WMI's positive
95 predictive value was found to be comparable to a CRM based on multiple diagnoses and
96 medications. These preliminary results suggested that the WMI can adequately stratify risk
97 levels (relative to a CRM) and immediately guide care that matters to patients. However,
98 retrospective results guarantee neither future performance nor applicability in practice.
99 Therefore, this report prospectively compares the WMI to two representative CRMs and
100 illustrates how the WMI can be used to promote health care provider and patient engagement
101 in improving health care delivery and health outcomes.

Commented [K19]: Please confirm my interpretation of the baseline for this comparison.

103 **Materials and methods**

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104 **Participants, data sources, and outcomes**

105 Patient members of a Midwestern statewide Medicaid program were required to
106 complete a comprehensive, free, online health assessment called HowsYourHealth
107 (www.HowsYourHealth.org) [21]. The branching logic of the online assessment includes the five
108 WMI items, in addition to queries regarding demographics, symptoms, concerns, function,
109 conditions, experience of care, preventive interventions, and past use. Of the 26,130 adults who
110 completed the survey in 2014, 8771 fulfilled the eligibility criteria for this prospective
111 assessment, which were identical to those used to develop the WMI and were based on patient
112 self-identification of at least one of five chronic conditions—hypertension, cardiovascular

113 disease, diabetes, respiratory disease, [or](#) arthritis—or use of at least one chronic medication.
114 Outcome information based on insurance claims data was available for all patients; [however](#),
115 the claims data [indicated only the occurrence of](#) emergency or hospital use, not frequency of
116 use. Of the 8771 eligible Medicaid patients [for whom](#) information [regarding](#) subsequent
117 emergency or hospital service [use was available](#), 152 [had missing WMI variables](#) and were
118 eliminated from the analysis.

Commented [K21]: The meaning of this text is unclear in this context. Perhaps the following would convey the intended meaning: “had incompletely responded to the WMI assessment”.

119

120 Predictors

121 The predictors listed in Table [1](#) are identical to those used [to](#) develop the WMI.
122 We selected five binary (yes or no, 1 or 0) measures from a previous distillation of patient-
123 reported “vital signs” [22]. By design, these measures are immediately available from patients,
124 without retrieval of data from electronic health records or insurance claims; easily interpretable
125 [and](#) translatable; and limited in number so that they are [more easily](#) memorized [23]. The sum
126 of the five measures, a number from 0 to 5, constitutes the WMI—[a direct expression of what](#)
127 [matters to patients](#).
128 [First](#), insufficient health confidence is an easy-to-measure [representation of](#) a patient’s
129 lack of ability to manage health problems. A low level of self-management capacity predicts
130 poor engagement in self-care and is associated with increased use of costly health care services
131 [13-16]. [The second and third predictors—](#)emotional problems and pain—significantly impact
132 the attainment of health confidence over time [16]. These measures are fundamental to the
133 human condition and considerably influence health and use of services. [Furthermore](#),
134 [e](#)motional problems and pain often respond to simple behavioral interventions and are

135 frequently assessed as vital signs in clinical settings [18,19]. [The final two predictors,](#)
136 [polypharmacy and medication side effects,](#) account for a large percentage of preventable
137 hospital and emergency department uses [20]. Multiple medications can [cause](#) harmful
138 interactions, [and](#) even without such interactions, side effects can reduce adherence [14].
139

140 **[Representative CRMs](#)**

141 [To evaluate the advantages or disadvantages of the WMI, we compared the proposed](#)
142 [index with two representative CRMs commonly employed to assess risks for](#) patients with
143 chronic conditions. [First, the Centers for Medicare and Medicaid Services in the United States](#)
144 [suggest the use of a CRM to select patients for complex care reimbursement, and the state that](#)
145 [participated in our study has implemented a CRM based on patient self-reporting of the types](#)
146 [of information that can be obtained from a billing system or electronic medical record. In the](#)
147 [Medicaid CRM,](#) a patient is considered complex and at-risk if they report both that they are
148 taking three or more medications and [that](#) they have two or more chronic conditions. [Second, a](#)
149 proprietary CRM, the 3M™ Clinical Risk Groups, uses insurance claims to assign individuals to
150 one of a set of risk groups based on historical clinical and demographic characteristics; [these](#)
151 risk groups can be combined [to](#) predict costly care [24].
152

153 **Analysis**

154 **[Predictive](#) reliability of the WMI**

Commented [K22]: As a further accommodation of the reviewer's comment, please consider adding the following sentence at the end of this paragraph: "Although a hybrid model that combines the WMI with a CRM may further improve prediction accuracy, the complexity of integrating patient-based measures with claims-based measures requires substantial resources that are currently unavailable."

Commented [K23]: I have substituted "predictive" for "prospective" here and in the corresponding heading in the Results section to emphasize the objective and significance of the proposed WMI approach.

155 The number of patients in the study population who were expected to require
156 emergency or hospital care easily surpassed the minimum suggested to develop and validate
157 clinical prediction rules: at least five to ten observations for each WMI measure, or 25–50
158 predicted emergency or hospital uses [25,26]. To test the association between the WMI sums
159 and emergency or hospital use during the year after the patient self-assessments, odds ratios
160 were determined based on 95% confidence intervals, comparing the likelihood that patients
161 with higher WMI sums would use emergency or hospital care versus patients with a WMI of 0.
162 The WMI's capacity to predict emergency or hospital use was also examined by logistic
163 regression, after considering the self-reported characteristics of age, gender, number of chronic
164 conditions (listed above), and poverty (i.e., sometimes or always not able to pay for essentials
165 such as food, clothing, or housing).

Commented [K24]: Please confirm my interpretation of the intended meaning of "completion".

Commented [K25]: This phrase has been added so that the way in which the odds ratios were determined is specified here in the methods section.

167 **Comparison of WMI to representative CRMs**

168 We compared the WMI and representative CRMs in three respects: (i) sensitivity and
169 positive predictive values for costly care; (ii) concordance statistic (c-statistic), to assess the
170 relationship between the probability of a correct detection and the probability of a false alarm;
171 and (iii) distribution of the five WMI measures among patients designated by the CRMs to be at
172 higher or lower risk. Because predictive values are influenced by prevalence, we adjusted the
173 WMI test threshold so that the WMI designated a similar proportion of "at-risk" patients as
174 each of the different CRMs.

Commented [K26]: To improve clarity, please consider specifying the inputs among which the uncertainty was apportioned.

Commented [K27]: Rather than subdivide the "Illustration" section between the methods and results sections, I have relocated the text from the methods section to appear under what is now a level 1 heading after the results section. Thus, this practical illustration is seamlessly provided to the reader, and the results are provided immediately after the methods without the intervening description of a practical application method.

176 **Results**

177 **Patient characteristics**

178 Despite [this Medicaid population's](#) youth (40% aged 18–49 and none over 65), [it](#) has a
179 high prevalence of serious chronic conditions such as diabetes (31%), respiratory diseases
180 (39%), and atherosclerosis (17%), and more than a third (35%) report taking more than 5
181 prescription medications. Most (70%) are [sometimes](#) unable to pay for food, clothing, and
182 housing. More than 40% report that they [lack confidence that](#) they can manage and control
183 most of their health problems. Additional characteristics of this population are described in the
184 Supporting Information.

186 **Predictive reliability of the WMI**

187 During the year following [their](#) completion of the WMI [assessment](#), [half of the patients](#)
188 [used the emergency department](#) and 20% were admitted to [a](#) hospital. [There was a strong](#)
189 association between WMI magnitude and increased use of hospital or emergency services
190 during the subsequent year ([Fig 1](#)). The odds ratios (with 95% [confidence intervals](#)) for
191 subsequent hospitalization of [patients with](#) WMI [sums of](#) 1, 2, and ≥ 3 were 1.3 (1.1–1.6), 2.0
192 (1.6–2.4), and 3.4 (2.9–4.0); for emergency room use, [the corresponding ratios](#) were 1.3 (1.1–
193 1.4), 1.9 (1.6–2.1), and 2.9 (2.6–3.3). These findings validate the pattern observed during [the](#)
194 development of the WMI [12].

196 **Fig One.** [Odds ratios for subsequent use of costly care comparing patients with WMI > 0 to](#)
197 [those with WMI = 0. Sample population: 8619 Medicaid patients; 95% confidence intervals.](#)

Commented [K31]: Please confirm that I understand this correctly: half of the entire Medicaid population of 8,619 (approximately 4,300 patients) used the emergency department within one year of having completed the WMI assessment online. (That's a lot of people!)

Commented [K32]: Figure citations have been adjusted in accordance with the intended publisher's instructions.

Commented [K33]: The description of the reference group for the odds ratio calculation was removed here because it has been added in the methods section and does not need to be repeated.

Commented [K34]: The figure captions, including their titles and legends, have been formatted in accordance with the intended publisher's instructions.

198

199 Logistic regression models [considering](#) age, gender, number of chronic conditions, and
200 poverty indicated that, [among all of these variables, the](#) WMI was the [one](#) most highly
201 associated with subsequent emergency or hospital use ([p < 0.001](#)).

202

203 Comparison of WMI to [representative](#) CRMs

204 [In](#) Table 2, the proportions of patients designated [as](#) at-risk [by the WMI and by each](#)
205 [CRM](#) have been matched so that their sensitivities and predictive values can be compared. [The](#)
206 Medicare CRM identifies roughly half the population as being at-risk, [and to](#) approximate the
207 Medicare CRM target population, the WMI threshold was set to ≥ 2 . For comparably sized
208 populations, the WMI and Medicare CRM sensitivities and positive predictive values for future
209 hospital use were essentially the same. [The](#) [predictive](#) performances of the proprietary CRM
210 and the WMI were [also](#) equivalent [for comparably sized at-risk populations, implemented by](#)
211 [setting the WMI threshold to \$\geq 3\$.](#)

212

213 **Table 2.** Sensitivities and predictive values for subsequent hospital use [of the WMI and CRMs.](#)

Method	WMI ≥ 2	Medicare CRM	WMI ≥ 3	Proprietary CRM
Proportion of all patients designated "at-risk"	0.53	0.51	0.30	0.30

Commented [K35]: This term has been substituted for "prospective" to re-emphasize the WMI's objective and significance.

Sensitivity of method in the population	0.69	0.64	0.45	0.43
Positive predictive value ^a	0.26	0.25	0.30	0.28
C-statistic (area under the receiver operation curve) ^b				

Commented [K36]: The footnotes have been formatted according to the target journal's instructions.

214 ^a Positive Predictive Value: Proportion of patients predicted to be “at-risk for hospital use” who
 215 were actually hospitalized in the following year.

Commented [K37]: The text describing the two CRMs was eliminated because their methods of determining risk are described in the methods section, and the WMI thresholds are described in the preceding paragraph.

216 ^b A c-statistic expresses the relationship between the probability of detection and the
 217 probability of a false alarm. In general, a less than excellent “c statistic” (< 0.90) will often
 218 incorrectly classify individual patients in at-risk and not at-risk categories.

219
 220 However, each of the tested methods produced low predictive values and low c-
 221 statistics, a reminder that most “at-risk” designated ambulatory patients are not destined to
 222 use hospital services. Therefore, although either a CRM or the WMI can provide actuarial
 223 stratification to identify future risks for costly care, resource allocation based on only these
 224 forecasts is inefficient because of their low positive predictive values. Nonetheless, Fig 2 shows
 225 that needs identified by the WMI are distributed among all patients and are not confined to the
 226 higher risk patients designated by the CRMs. For example, 984 and 1586 patients reporting a
 227 WMI score ≥ 3 were designated by the proprietary CRM as being in the higher and lower risk
 228 groups, respectively. Thus, using CRMs to target resources ignores a large proportion of
 229 patients at risk for requiring future costly care. Moreover, CRMs are indifferent to potentially
 230 remediable risk factors that are easily identifiable from patient self-reports.

231

232 **Fig Two. Distribution of WMI measures for Medicaid patients in relation to CRM risk levels.**

233 The WMI sums five measures—insufficient confidence to manage health problems, level of
234 pain, emotional problems, polypharmacy, and adverse medication effects. The Medicare CRM
235 identifies complexity if the patient has two or more diagnoses and three or more prescriptions.
236 The proprietary CRM is a claims-based classification system for risk, where the higher risk group
237 is predicted to include the 30% of patients with the highest reported claim value.

Commented [K38]: The Fig 2 legends were deleted because they appeared to be axis labels contained in the graphs themselves.

Commented [K39]: Please consider adjusting the title in the figure to match the figure title here.

239 **A hybrid prediction model?**

240 Hybrid prediction models based on the addition of self-report to administrative and clinical data
241 do not seem to warrant the effort if the goal is high accuracy. (7,8,27) For example, within this
242 Medicaid cohort, a combination of the proprietary CRM and WMI marginally increased the c-
243 statistic from XXX and XXX to a hybrid level of XXXX. This improvement seems to be largely a
244 difference that has no practical distinction since incorrect classification remains and
245 considerable effort would be required to make the hybridized model timely and useful in a
246 clinical practice.

Commented [K40]: Please confirm my interpretation of the intended meaning.

Commented [K41]: Please confirm my interpretation of the intended meaning: that the higher risk group is determined based on claim value.

Commented [K42]: I recommend eliminating these footnotes (which have been reformatted as a figure legend) to allow the reader to focus on the graphical representations of the data, which make a very compelling argument. The three models have all been detailed in the preceding text, and the WMI was also described graphically in Table 1, so readers will be sufficiently acquainted with the different approaches whether they approach the paper textually or graphically.

Commented [K43]: I haven't worked on this section at all, but perhaps the information could be included in the methods subsection that describes the CRMs, either before or after the sentence I have suggested in my comment at the end of that subsection.

248 **An illustration: using the WMI to plan patient and provider**

249 **engagement**

250 Each WMI item is meant to elicit an action to meet the patient's needs. A very common
251 remediable risk factor included in the WMI is the patient's lack of confidence in their ability to
252 manage most health problems and concerns, which is associated with many adverse health

Commented [K44]: Rather than subdivide this section between the methods and results sections, I have formatted this text as a level 1 heading, and relocated the text from the methods section to this position. Thus, this practical illustration is seamlessly provided to the reader. Please note that although the text below appears to have been entirely altered because the Word program has tracked the relocation, in fact, most of the text is original, including all of the verbatim queries and responses.

253 experiences, [including more frequent](#) (and often avoidable) emergency or hospital care [use](#),
254 lost time from work, and medical harm [13]. [Applying the WMI model, patients who say they](#)
255 [are not confident that they can control and manage most of their health problems are then](#)
256 [asked by medical assistants or the online health assessment \(www.HowsYourHealth.org\) to](#)
257 [answer the query, “What would it take for you to be able to say that you are very confident](#)
258 [that you can control most of your health problems during the next two months” \[12,20\]? Their](#)
259 [verbatim responses are included in a summary report for the clinicians who provide their care.](#)
260 [Examples of queries for the other WMI items are listed elsewhere \[9\].](#)

261 [_____ To illustrate how the WMI identifies population needs in a clinical setting, we analyzed](#)
262 [the verbatim responses to the online assessment of 1915 adult patients from across the United](#)
263 [States. These patients met the identical selection criteria that was used to select the Medicaid](#)
264 [population sample for the prospective assessment. The verbatim responses, in which patients](#)
265 [identified the health care interventions that they perceived would be most effective, could be](#)
266 [generally classified into the following three categories.](#)

267 [1\) Changes in professional health care. Patients most often request better](#)
268 [information and education. In addition, they seek clarification of their diagnoses,](#)
269 [timely sharing of test results, and when possible, additional relief of symptoms.](#)
270 [Examples: \(a\) “Help of a doctor who will actually listen and take my problems](#)
271 [seriously without just pushing medication.” Michigan; WMI = 2. \(b\) “If I got an](#)
272 [accurately diagnose of my illness, and able to get a specific course of treatment I](#)
273 [could control and manage my health problems.” Texas; WMI = 2.](#)

Commented [K45]: The three categories are now introduced after the selection criteria for this group are described, which also affords the opportunity to re-emphasize the WMI's patient-reporting basis.

274 2) Personal changes. Patients acknowledge their need to improve time-
275 management, motivation, and lifestyle. Examples: (a) "Staying focused on what
276 is required to be healthier." New Hampshire; WMI = 2. (b) "More time and
277 attention to my diabetes." North Carolina. WMI = 2.
278 3) Non-professional support and guidance. Patients request coaching or support in
279 the workplace, home, and/or community; financial assistance may also be
280 needed. Examples: (a) "Finances are stopping me from getting medical help. Co-
281 pays for doctors and medications has taken most of my life savings." Rhode
282 Island; WMI = 2. (b) "Need some coaching." Minnesota; WMI = 2.

283 The patient's inability to specify a change, (listing of multiple changes), or uninterpretable
284 responses were considered to constitute a non-response category. (The contribution of the WMI
285 to the number of patient responses in each of the three categories was examined by logistic
286 regression after considering self-reported age, gender, number of chronic conditions, and
287 poverty (i.e., sometimes or always not able to pay for essentials such as food, clothing, or
288 housing). Fig 3 compiles 1915 patients' verbatim responses regarding changes they require to
289 improve their health confidence, and illustrates how their needs vary in relation to their WMI
290 sums.

291
292 **Fig 3. Influence of What Matters Index (WMI) on patient reports of changes needed to**
293 **improve their health confidence. "Non-professional support and guidance" includes coaching**
294 **or less formal support in the workplace, home, and/or community; needed financial assistance**
295 **is also included here. "Personal changes" includes time management, lifestyle, and motivation**

Commented [K46]: The meaning of this text is unclear in this context because this type of patient response would appear to warrant inclusion in multiple categories, such as when a patient identifies both changes in professional health care and personal changes as potentially effective remedies.

Commented [K47]: To improve clarity, please consider either "The correlation between the patients' WMI sums and ..." or "The correlation between each of the 5 WMI indicators and ...".

296 [changes](#). “Changes in [professional health care](#)” includes patients’ most [frequent](#) request for
297 better information and education; in addition, they may request clarification of diagnoses,
298 [timely sharing of test results](#), and relief of persistent [symptoms](#).

Commented [K48]: The text describing the way in which this data was collected has been eliminated here because that information is clearly described in the methods section.

299
300 For this sample population of adult patients with chronic conditions, higher WMI [sums](#)
301 [are strongly associated with an increased](#) likelihood that the respondents [identify a need for](#)
302 professional assistance, and [with a reduced](#) likelihood that they consider their personal
303 behavior as the primary remediable cause for their low confidence. Logistic regression confirms
304 the persistence of this pattern ($p < 0.001$) regardless of patient age, gender, financial status, or
305 number of chronic conditions. For patients who [used](#) hospital or emergency care in the past
306 year and had a WMI ≥ 3 , half (70/142) believed that the [event may](#) have been avoidable; for
307 those having a WMI = 1, [approximately](#) one in five (15/76) shared that belief.

Commented [K49]: This text has been reformatted following the intended publisher’s instructions for figure legends. To improve clarity and consistency, please consider deleting the asterisks from the figure itself.

309 Discussion

310 Despite extensive evidence of [to the contrary](#), the [idea](#) that [population health and](#)
311 [associated costs can be effectively managed with CRM-based](#) interventions is entrenched in
312 current practice. This report prospectively demonstrates that compared to two [representative](#)
313 CRMs, the WMI is both reliable and comparable in its capacity to forecast risk for costly care.
314 [Moreover](#), the WMI [demonstrates](#) superior [performance in relation](#) to CRMs in [terms of](#)
315 providing care guidance [that is specific](#) for each patient and enhancing a [medical](#) practice’s
316 capacity to plan care for many patients. As an example [of the WMI’s superior performance in a](#)
317 [practical setting](#), to improve their health confidence, patients with chronic conditions are likely

Commented [K50]: Please note the meaning change, as described in my comment on the introduction.

318 to request behavioral change support if their WMI is low, [whereas they are likely to request](#)
319 more attention to medical diagnostics, therapeutics, and education if their WMI is high. [Thus,](#)
320 [the WMI data enables health care providers to allocate resources in relation to patient-](#)
321 [identified needs that are associated with avoidable emergency or hospital use.](#)

322 [The WMI offers the following additional advantages.](#)

- 323 • [It has no direct cost.](#)
- 324 • [It equitably assesses the](#) remediable needs of all patients, not [only](#) a designated
325 few.
- 326 • [It is unambiguous and is therefore](#) much less likely to [produce](#) high variances in
327 interpretation [compared to the](#) list of patients generated by a CRM.
- 328 • [It correlates strongly with overall quality of life and can therefore](#) be used to
329 monitor the impact of interventions designed to improve patients' quality of life.
- 330 • [It applies in any setting because it is patient-reported and does not require](#)
331 insurance claims, electronic medical records, or complicated scoring methods.

332 [The WMI's advantages are particularly suited to improving public health.](#) [Many](#)
333 validated, self-reported prediction instruments [have been developed and applied to](#)
334 [populations of](#) community-dwelling older adults at risk for hospitalization, functional decline,
335 institutionalization, and death [28]. The WMI differs from these in being broadly applicable to
336 all adults with chronic conditions, [as well as](#) specific in its focus on remediable needs.
337 [Furthermore,](#) people do not need a high level of education, access to professional health care,
338 or English proficiency to use the WMI. [Patients](#) simply answer each question and bring their
339 responses to the attention of someone [who can](#) help them address each problem, [such as](#) a

Commented [K51]: I relocated this bullet point to the first position because of the emphasis many people place on cost.

Commented [K52]: I have eliminated the "Implications" and "Limitations" subheadings because discussion sections commonly present both topics, and the section is not so long that it requires subdivisions. In addition, this sentence has been relocated to serve as the transition from the list of advantages above to the ways in which these advantages can be capitalized upon to support public health.

340 health professional, a support group, or even a website [like](#) the one used to develop the WMI
341 ([HowsYourHealth.org](#)). [The results presented in this paper demonstrate that when the WMI](#)
342 [sum](#) is two or more, the risk for costly emergency and/or hospital [use](#) is high; therefore,
343 [patients, providers, and payers would all benefit if the WMI data were](#) brought to the attention
344 of health professionals. Services appropriate for the level of risk based on “what matters” [to](#)
345 [patients](#) is the goal.

346 _____ Several limitations of the WMI deserve comment. [First, the WMI’s capacity to improve](#)
347 [health outcomes and reduce costs is limited by the extent to which CRMs are entrenched in](#)
348 [health management practice. In other words, a critical sociological limitation of the WMI is,](#)
349 [ironically, the challenge it represents to the flawed but widely adopted status quo.](#) It is true that
350 a small proportion of patients account for a large proportion of the costs of care; that CRMs can
351 identify some patients who will cost more than others; and that payers can use computer
352 algorithms to generate lists of these patients [almost effortlessly](#) and send them to [medical](#)
353 [practitioners](#) who will, with incentives, [act on](#) the lists. [However,](#) evidence [suggests](#) that this
354 approach is [ineffective at](#) controlling [care](#) costs, does nothing to specifically guide care for
355 individual patients, and probably has negative consequence for those not targeted [1-6,12].
356 Similar inadequacies have been previously documented for intensive care management based
357 on targeting distinct diseases, an antecedent to the current [CRM-based](#) interventions [29].

358 _____ [Second,](#) these prospective results were derived from a large sample of Medicaid
359 patients, [and whether](#) the WMI would perform similarly [for](#) non-Medicaid patients is a valid
360 concern. To address this point, the Supporting Information shows similar results for a smaller
361 sample of 1061 older patients from nine private practices, [selected](#) using the same patient

Commented [K53]: I have added text here to state the limitation explicitly. However, because of the extent to which CRM interests may be represented in your readership, I recommend leading with what is currently the second limitation (sample population), because that limitation is a common methodological concern that would be less likely to offend the reader. This paragraph describing the first limitation could be presented after the paragraph describing the second limitation; that location also supports the subsequent paragraph describing the limited availability of cost assessment data, which is related to the sociological limitation.

Commented [K54]: This sentence has been relocated so that the limitation is introduced before it is critiqued. However, I recommend eliminating this sentence because this is actually a limit *on* the WMI (society limiting the WMI’s impact) rather than a limit *of* the WMI (the WMI model limiting the WMI’s impact). The sentence structure draws attention to the societal failure, which may attract the ire of readers invested in the CRM approach.

Commented [K55]: Please note the meaning change, as described in my comment on the introduction.

362 criteria and assessed [by the same](#) methods. [For](#) the private practice patients with chronic
363 conditions, the odds ratios (with 95% [confidence intervals](#) compared to a WMI of 0) for
364 subsequent emergency room use were 1.8 (1.1–2.8), 2.1 (1.2–3.6), and 3.0 (1.4–6.3) [for](#)
365 [patients with](#) WMIs [of](#) 1, 2, or ≥ 3 , respectively. For WMIs of 1 or ≥ 2 , the odds ratios of
366 subsequent hospitalization were 1.4 (0.8–2.6) and 2.4 (1.2–4.5), respectively. [The](#) sensitivity
367 and positive predictive values [of the](#) WMI were identical to those of the Medicare CRM.
368 _____ Finally, although a controlled cost-effectiveness trial has not yet been conducted [to](#)
369 [compare the value of the WMI-and CRM-based strategies](#), and a description of the optimum
370 [intervention](#) types and timing for [the](#) different WMI levels is not yet available, the WMI's
371 advantages strongly suggest that it is ethically more justifiable and economically more sensible
372 to implement simple, self-reported measures [to determine](#) what matters to all patients and to
373 use [those](#) results to guide care. Patient reporting [is increasingly recognized](#) as the [most](#)
374 [appropriate](#) basis for chronic care management [because of](#) its ease of implementation and
375 benefits for patients and the providers who serve them [21, 30]. [The](#) WMI [results](#) validate the
376 utility of parsimonious patient-reported measures in [guiding](#) the delivery [of](#) services that
377 matter to patients with chronic conditions [31]. [As a possible substitute for claims-based](#)
378 [predictive models, patient reports on these few WMI measures may be complemented by](#)
379 [additional measures for different](#) [circumstances](#).

380

381 Conclusion

382 By [considering](#) what patients say about their [own](#) health, the WMI identifies both
383 important needs that matter and risks [for](#) costly health care use. [Whereas](#) the complex and

Commented [K56]: To further address the reviewer's suggestion, please consider adding the following clause to the end of this sentence: "..., and perhaps a hybrid model that integrates the WMI and CRMs may further improve predictive capability."

384 opaque algorithms of computer-generated risk models, which leave [by far](#) the [greatest](#) share of
385 [patients who use costly care](#) in the low-risk [category](#) and do not provide standardized follow-up
386 [procedures](#) for high-risk patients, the brief, unambiguous WMI [can guide](#) care plans [that](#)
387 mitigate risks [for](#) all patients with chronic conditions.
388

389 Acknowledgements

390 To further [confirm](#) the reliability of the What Matters Index in an older, private-practice
391 population, the following physicians provided baseline and subsequent utilization data for 1061
392 patients: J. Antonucci, MD; A. Arena, MD; S. Behtash, DO; J. Bloomer, MD; L. Denny, MD; G.
393 Hanson, MD; J. Hearst, MD; L. Ho, MD; K. Oaks, MD; M. Nunlist, MD; and A. Wood, MD. [The](#)
394 Supporting Information contains additional information comparing the Medicaid and [private](#)
395 [practice](#) populations.
396

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485

486 **Supporting Information**

Commented [K57]: This section has been added in accordance with the target journal’s instructions.

487 [S1 Table. Additional Information for the Three Populations Cited in this Report.](#)

488 [S2 Table. Actual Uses for the Populations Based on the What Matters Index \(WMI\).](#)

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