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The Multidimensional Prognostic Index in general practice: One-year follow-up study

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Abstract

Background: Older patients' health problems in general practice (GP) can often not be assigned to a specific disease, requiring a paradigm shift to goal-oriented, personalised care for clinical decision making.

Purpose: To investigate the predictive value of the comprehensive geriatric assessment (CGA)-based Multidimensional Prognostic Index (MPI) in a GP setting with respect to the main healthcare indicators during the 12 months following initial evaluation.

Methods: One hundred twenty-five consecutive patients aged 70 years and older were enrolled in a GP and followed up to one year. All patients underwent a CGA based on which the MPI was calculated and subdivided into three risk groups (MPI-1, 0-0.33 = low risk, MPI-2, 0.34-0.66 = moderate risk and MPI-3, 0.67-1, severe risk). Grade of Care (GC), hospitalization rate, mortality, nursing home admission, use of home care services, falls, number of general practitioner contacts (GPC), of geriatric resources (GR) and geriatric syndromes (GS) during the 12 months following initial evaluation were collected.

Results: The MPI was significantly associated with number of GS ($P < .001$), GR ($P < .001$), GC ($P < .001$) as well as with the average number of GPC per year (mean 10.4, $P = .046$). Interestingly, the clinical judgement of the general practitioner, in this case knowing his patients for 16 years on average, was associated with adverse outcomes to a similar extent than the prediction offered by the MPI (GP/adverse outcomes and MPI/adverse outcomes $P < .001$).

Conclusion: The MPI is strongly associated with adverse outcomes in older GP patients and strongly predicts the number of GPC up to one year after initial evaluation. Considering the feasibility and the strong clinimetric properties of the MPI, its collection should be encouraged as early as possible to disclose risk conditions, implement tailored preventive strategies and improve cost-effectiveness of healthcare resources use.

Alberto Pilotto and Maria Cristina Polidori equal supervisors

1 | INTRODUCTION

Population's ageing is one of the biggest challenges of the present time and of the next decades. Due to it, physicians, health practitioners and policy makers face huge efforts to manage multimorbidity, frailty and functional impairment.[1,2] The high disease burden and the associated functional limitations profoundly affect the high utilisation of healthcare resources[3-5] and, in Germany as in other countries, the growing number of general practitioner contacts (GPC).[6] Older adults are frequent users of general practice (GP), with at least 10% of the people over 60 years visiting their GP over 10 times per year and even more often persons older than 70 years.[6,7]

This development represents a major challenge for GP physicians because of the large and steadily increasing number of often complex conditions requiring time-consuming multidimensional examinations.[2,8-11] Together with the objective logistic difficulties, one reason for the challenged prompt identification of seniors at risk in the community is the frequent underreporting of complaints by older patients considering some frailty-related symptoms part of "normal" ageing.[12] Other reasons include subtle progression of functional loss[11] as well as heterogeneity of ageing and its phenotypes.[13,14]

The cornerstone of geriatric medicine, the comprehensive geriatric assessment (CGA), has been shown in the recent years to provide an adequate diagnostic and therapeutic management of older patients.[12,15] The strength of the CGA resides in its ability to accurately address domains such as physical health, functional status, mental health, medication use and socioeconomic parameters. It can improve diagnosis, disclose risk of and therefore prevent geriatric syndromes (GS) such as instability, immobility and cognitive impairment.[15-17]

While the CGA is available to healthcare practitioners since over three decades,[18,19] 10 years ago its "development tool" was described for the first time, the Multidimensional Prognostic Index (MPI).[20] The MPI is calculated based on a mathematical algorithm applied on an 8-domain CGA[20] and has been identified as the most valid, accurate and feasible among available forecast indicators for older adults.[21] The MPI has been shown to improve clinical assessment and treatment of hospitalised older patients suffering from a wide range of age-related conditions.[21-25] Within the frame of an ongoing action in various clinical and healthcare settings in the large metropolitan area of Cologne, Germany, to identify seniors at risk of poor outcomes to establish cost-effective tailored interventions, the aim of this study was to address the potential role of the CGA-based MPI in a typical German GP setting. The predictive power of the MPI was investigated by means of the analysis of its association to main healthcare indicators including nursing needs (grade of care, GC), rates of falls, hospitalisation, mortality, nursing home admission as well as use of home care services collected for 12 months following initial evaluation.

What is known?

Older patients' complex health problems requiring a paradigm shift to goal-oriented, personalised care can be addressed by means of the comprehensive geriatric assessment (CGA). Multidimensional prognosis calculation with the CGA-based Multidimensional Prognostic Index (MPI) has been shown to be highly predictive of adverse outcomes in hospitalised older multimorbid adults.

What does this article add?

The present investigation shows that the MPI is strongly associated with adverse events in older patients from a general practice setting and that it not only predicts future poor outcomes able to negatively affect patients' functioning and trajectories; it is also strongly associated with serious events in the year preceding the evaluation, suggesting that the MPI accurately depicts the multidimensional health status of older adults, supporting targeted high-quality decision making.

2 | METHODS

2.1 | Patients

Between November 2017 and March 2018, 256 patients were consecutively screened for inclusion criteria at a rural GP established over 30 years ago by the same family physician collaborating to the present investigation. Patients were included if older than 70 years of age, multimorbid (more than two chronic conditions required prolonged treatment) and giving consent to participate in the study. Reasons for exclusion from the study were 1. unable to evaluate due to limited time budget during regular consultation hours (n = 130), 2. refusal to participate (n = 1). The final sample size included 125 patients.

2.2 | Clinical evaluation

After giving informed consent, all participants underwent a CGA-based MPI calculation. Briefly, The MPI[20,22,25,26] includes Cumulative Illness Rating Scale (CIRS),[27,28] Exton Smith Scale (ESS),[27] Mini Nutritional Assessment Short Form (MNA-SF),[26] Katz's Activities of Daily Living (ADL),[29] Lawton's Instrumental Activities of Daily Living (IADL),[30] Short Portable Mental Status Questionnaire (SPMSQ)[31] plus number of drugs administered including over-the counter (OCT) drugs and living conditions. The MPI is a continuous variable from 0 to 1 allowing the allocation of patients into one of three mortality risk grades (MPI-1, 0-0.33 = low risk, MPI-2, 0.34-0.66 = moderate risk and MPI-3, 0.67-1, severe risk) at 1 month and 1 year.[20]

During the MPI collection, the presence of common GS (including incontinence, instability, cognitive impairment, depression or

irritability, inanition, sensorial impairment, as well as chronic pain, insomnia, irritable colon, impoverishment and isolation, immobility, polypharmacy, iatrogenic disease, incoherence/delirium, fluid/electrolyte imbalance and swallowing disorders) as well as of resources (GR) (favourable intellectual, physical, social, and economic resources and good living conditions, motivational, emotional, mnestic, competence-related resources) were collected in all patients as previously described.[25]

Nursing needs were evaluated by means of the GC, established by the German institutional nursing care insurance and identified using GC grades 1 to 5, with score 1 indicating minimal dependence.[32] Additional information on the GP physician's judgement (judging prognosis into low risk—moderate risk—high risk for adverse outcomes without a CGA), main diagnoses, professional status prior to retirement, years of education and level of educational requirements (the last profession prior to retirement was categorised within the framework of the social-scientific professional grouping of the 2010 German classification system of professions - Klassifikation der Berufe 2010, KldB-, which subdivides the requirements of the executed task according to four complexity grades[33]), as well as hospitalization, falls and number of GPC during the 12 months preceding the MPI collection were also evaluated. Social aspects were reported by interview about living status, social isolation and social support.

A 12-month follow-up was performed using the data of the patient's file as provided by the GP concerning one-year survival, reason and number of GPC, use of home care services, GC (change), nursing home admission, hospitalisations, falls and number of medication (change).

2.3 | Registration, participant consent & ethics

The study is registered at the German Clinical Trials Register (DRKS00012820) and complies with the ethics rules for human experimentation that are stated in the Declaration of Helsinki (1983). The study was approved by the Ethics Committee of the University Hospital of Cologne (EK 17-298), and each patient (or proxy in three cases, when medical record indicated incapacity to give informed consent) signed informed consent.

2.4 | Statistical analysis

Descriptive statistics were expressed using absolute numbers and relative frequencies for description of categorical variables as well as mean (SD) or median (interquartile range, IQR) for continuous variables. Univariate tests such as one-way (ANOVA) for mean and Chi-squared or Fisher's exact test for frequencies were used in order to explore the data.

The reciprocal relationship between presence of GS and GR was evaluated by subtracting from the GS index (individual's number of GS divided by 17 total GS) the GR one (individual's number of GR divided by 10 total GR) as described previously.[25]

A negative binominal regression analysis was used for the assessment of the effect of MPI on the level of GC and the number of GS and GR after adjusting for age, gender and level of educational requirement. Except for mortality, deceased patients were excluded from the analysis of negative outcomes. The same statistical method was used to address the number of GPC during the time of the study after adjusting for age, gender and level of educational requirements. No other adjustments were performed unless otherwise specified.

A multiple logistic regression after adjustment for age, gender and level of educational requirements was used to identify presence and severity of adverse outcomes according to prognosis. Adverse outcomes were considered as the occurrence of at least one event among mortality, hospitalisation, falls, use of home care services, GC and nursing home admission.

Finally, an ROC curve was calculated to evaluate the power of prognosis assessment.

Two-tailed probabilities were reported and a significant level alpha of 5% was used for each analysis. All analyses were performed using STATA (version 14.2, StataCorp.) software and SPSS (Statistical Package for Social Sciences, SPSS Inc, version 24.0) software.

3 | RESULTS

3.1 | Demographics

Patients were treated by the same GP physician in average for 16.2 years (SD 8.2).

The demographic and clinical characteristics of the 125 patients according to MPI group are described in Table 1. Higher MPI score was significantly associated with higher age ($P < .001$).

There was a strong correlation between GC and MPI score ($P < .001$), 92% of MPI-1 patients showing no nursing needs (GC = 0) and all MPI-3 patients having GC 1-5. For each increase of one decimal point on MPI at baseline, the probability of GC increases to 83.1% ($P < .001$) after adjusting for gender, age, level of educational requirement, insurance and main diagnosis.

A higher MPI score was significantly associated with more long-term diagnoses ($P < .001$) as well as to the leading main diagnosis ($P < .001$; Table 1).

3.2 | Geriatric syndromes & geriatric resources

Patients with higher MPI displayed significantly higher mean number of GS ($P < .001$) - for each increase on MPI of 0.1 point, the number of GS raised by 23.4% ($P < .001$, Table 1).

The average number of geriatric resources (GR) were 5.5 (Table 1), a higher mean number of GR being significantly associated with a lower MPI ($P < .001$). The number of GR decreased by 10.8% with an increase on MPI of 0.1 point ($P = .001$).

A significantly inverse association was shown with the average number of GS and GR ($P < .001$) adjusted for age, gender, GC and MPI group. Also, a highly significantly association between having more GR than GS and a lower MPI ($P < .001$) was observed.

TABLE 1 Demographic and clinical characteristics of the patient sample according to MPI group

		Total N = 125	MPI 1 N = 84 (67.2%)	MPI 2 N = 34 (27.2%)	MPI 3 N = 7 (5.6%)	*P*-value†
Demographic						
Female, n (%)		61 (48.8)	39 (46,4)	19 (55,9)	3 (42,9)	.674
Age (y), mean (SD)		79.2 (6.6)	77.6 (5.7)	81.9 (6.6)	85.1 (8.8)	<.001*
Education (y), mean (SD)		11.5 (4.1)	11.8 (4.4)	11.35 (3.7)	9.6 (1.5)	.226
Body mass index (BMI), mean (SD)		27.5 (5.7)	26.9 (5.0)	28.9 (6.4)	27.9 (8.6)	.229
Grade of care, median (IQR)		0 (0-1)	0 (0-0)	2 (0-3)	3 (3-5)	<.001*
Grade of Care, n (%)	None	92 (73.6)	78 (92.9)	14 (41.2)	0	<.001*
	GC 1	4 (3.2)	2 (2.4)	2 (5.9)	0	
	GC 2	7 (5.6)	2 (2.4)	4 (11.8)	1 (14.3)	
	GC 3	14 (11.2)	2 (2.4)	9 (26.5)	3 (42.9)	
	GC ≥4	8 (6.4)	0	5 (14.7)	3 (42.9)	
Number of long-term diagnoses, mean (SD)		6.6 (2.9)	5.8 (2.4)	8.1 (3.3)	8.6 (2.5)	<.001*
Main Diagnosis, n (%)	Cardiovascular disease	49 (39.2)	36 (42.9)	13 (38.2)	0	<.001*
	Musculoskeletal disease	26 (20.8)	21 (25.0)	5 (14.7)	0	
	Dementia	10 (8.0)	0	5 (14.7)	5 (71.4)	
	Stroke	10 (8.0)	2 (2.4)	6 (17.7)	2 (28.6)	
	Cancer	6 (4.8)	4 (4.8)	2 (5.9)	0	
	Neurological disease	6 (4.8)	4 (4.8)	2 (5.9)	0	
	Respiratory disease	5 (4.0)	4 (4.8)	1 (2.9)	0	
	Other	13 (10.4)	13 (15.5)	0	0	
Number of Geriatric syndromes, mean (SD)		4.16 (2.2)	3.3 (1.7)	5.5 (1.7)	8.0 (2.2)	<.001*
Geriatric syndromes	Incontinence	53 (42.4)	26 (31.0)	22 (64.7)	5 (71.4)	<.001*
	Instability	62 (49.6)	30 (35.7)	27 (79.4)	5 (71.4)	<.001*
	Cognitive impairment	15 (12.0)	1 (1.2)	8 (23.5)	6 (85.7)	<.001*
	Inanition	39 (31.2)	21 (25.0)	13 (38.2)	5 (71.4)	.023*
	Polypharmacy	50 (40.0)	25 (29.8)	19 (55.9)	6 (85.7)	.001*
	Irritability/ Depression	41 (32.8)	24 (28.6)	12 (35.3)	5 (71.4)	.063
	Sensorial Impairment	95 (76.0)	58 (69.0)	31 (91.2)	6 (85.7)	.032*
	Irritable colon	26 (20.8)	11 (13.1)	13 (38.2)	2 (28.6)	.008*
	Impoverishment	7 (5.6)	5 (6.0)	0	2 (28.6)	.011*
	Social isolation	6 (4.8)	2 (2.4)	1 (2.9)	3 (42.9)	<.001*
	Swallowing disorder	8 (6.4)	1 (1.2)	7 (20.6)	0	<.001*
Num. of geriatric resources, mean (SD)		5.5 (2.0)	6.14 (1.8)	4.4 (1.7)	2.43 (1.0)	<.001*
Geriatric resources	Physical resources	65 (52.0)	60 (71.4)	5 (14.7)	0	<.001*
	Good living conditions	84 (67.2)	54 (64.3)	24 (70.6)	6 (85.7)	.452
	Social resources	106 (84.8)	75 (89.3)	27 (79.4)	4 (57.1)	.044*
	Financial resources	69 (55.2)	52 (61.9)	17 (50.0)	0	.005*
	Spiritual resources	64 (51.2)	44 (52.4)	16 (47.1)	4 (57.1)	.827
	Motivational resources	46 (36.8)	38 (45.2)	8 (23.5)	0	.010*
	Emotional resources	75 (60.0)	53 (63.1)	20 (58.8)	2 (28.6)	.198
	Competence-related resources	58 (46.4)	52 (61.9)	6 (17.6)	0	<.001*
	Intellectual resources	94 (75.2)	72 (85.7)	21 (61.8)	1 (14.3)	<.001*

(Continues)

TABLE 1 (Continued)

	Total N = 125	MPI 1 N = 84 (67.2%)	MPI 2 N = 34 (27.2%)	MPI 3 N = 7 (5.6%)	*P*-value†
GR (%) > GS (%), n (%)	106 (84.8)	83 (98.8)	22 (64.7)	1 (14.3)	<.001*

Note: The analysis of the number of GPC per patient per quarter the 2 years of observation were taken.
Abbreviations: GR, geriatric resources; GS, geriatric syndromes; IQR, interquartile range; MPI, multidimensional prognostic index; SD, standard deviation.
*Significant at significant level alpha of .05.
†One-way ANOVA for mean, Kruskal-Wallis for median, Chi-squared or Fisher's exact test for frequencies.

3.3 | Adverse outcomes at follow-up

Of 122 patients who completed the 1-year follow-up, 11 died (Table 2). The MPI was significantly associated with adverse outcome occurrence at follow-up (Table 2, $P < .001$). Similarly, the long-lasting management by the same physician during life and his prognosis judgement were significantly associated to the occurrence of adverse outcomes at follow-up (Table 2, $P < .001$).

As displayed in Figure 1, the MPI reached overall an area under the curve (AUC) of 77.5%, showing a similar predictive power than the GP physician (80.4%, $P = .4$).

3.4 | Number of GP contacts (GP)

The average number of GPC in the 1 year prior to baseline evaluation was significantly associated with the MPI ($P = .028$) and the GP physician's judgement ($P = .011$). On average, 10.4 visits performed per patient at follow-up (Table 3) were also significantly associated with the MPI ($P = .045$).

A decimal point increase on MPI (+0.1) implied an increase of 12.9% ($P = .011$) in the number of GPC at 1 year, adjusting for gender, age, level of educational requirement and main diagnosis at baseline.

For each increasing year of age, an increase of 2.1% on mean GPC per quarter ($P = .028$) as well as an increase of GPC of 9.7% ($P < .001$) for each additional diagnosis were observed, adjusted for gender and level of educational requirements.

4 | DISCUSSION

The main result of the present investigation is that the CGA-based MPI is significantly associated with adverse outcomes after one year in older adults taken care of in a GP setting. Notably, the MPI is also strongly associated to number of GPC—both in the year preceding and following the evaluation—supporting the high accuracy and sensitivity of this instrument and its punctual ability to describe

TABLE 2 Adjusted probability of poor outcomes according to MPI and GP practitioner's judgement

		Outcomes of interest						
Prognostic tool		Mortality n = 11/122	Hospitalisation n = 27/111	Fall n = 22/111	Use of home care services n = 6/111	GC n = 27/111	Nursing home admission n = 9/111	Overall Adverse Outcome‡ n = 66/122
MPI, (%)	Low n = 83	5.3	17.6	15.6	2.2	6.1	2.2	39.7
	Moderate n = 32	7.8	36.0	28.0	12.5	51.0	11.6	83.2
	High n = 7	14.6	56.0	14.3	0	100	26.5	100
P-value†		.636	.063	.385	.052	<.001*	.054	<.001*
GP practitioner's judgement, (%)	Low n = 60	2.9	14.0	19.2	1.8	2.9	3.2	34.6
	Moderate n = 30	6.9	33.1	12.5	6.6	27.0	4.8	56.5
	High n = 32	13.5	36.8	23.8	9.3	57.4	11.3	91.1
P-value†		.190	.058	.547	.367	<.001*	.326	<.001*

Note: For this analysis only the prospective 1 y follow-up was considered for the GPC.
Abbreviations: GC, grade of care; GP, general practitioner; MPI, multidimensional prognostic index.
*Significant at level alpha of 0.05.
†*P*-values were referred to a logistic regression adjusted for age, gender and level of educational requirement.
‡Including mortality, hospitalisation, fall, use of home care services, GC, nursing home admission.

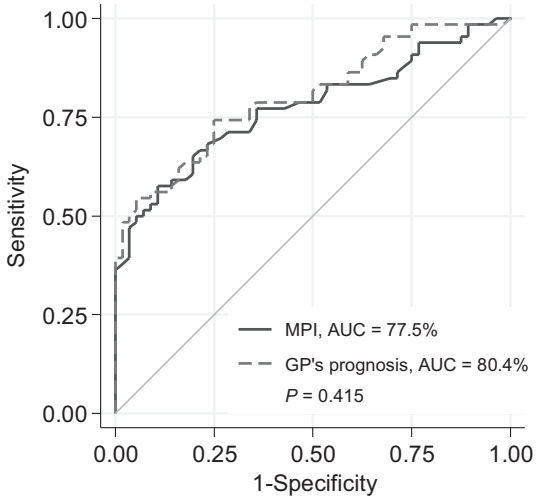

FIGURE 1 ROC curves for prediction of adverse outcomes at 1-y follow-up by the MPI and by the GP. No significant differences were observed

with fidelity and exactness the multidimensional health status of the older person.

The MPI is largely validated and is known as a reliable, feasible prognosis calculation tool in hospitalised patients,[12,16,20,22,23,25,34-36] also considering that the present study is one of the very few MPI investigations on outpatients. (Reviewer 2: #5) Although inpatient (Reviewer 1: #1) assessment instruments are not automatically useful in general practice[2] and the MPI-assessment represents just a snapshot in time, it is remarkable that its performance in this study is equally predictive for adverse outcomes as the judgement of a long-term treating GP physician. General practitioners as co-ordinators of care and "gate keepers" have usually a profound knowledge of the long-term patient's history. The present observations strongly support the use of the MPI as a structured, rater-independent tool able to provide accurate information about the patient even in the absence of detailed patients medical records.[37] Further multicentric studies are needed to show whether the MPI in a larger collective of GP patients is suitable for timely identification of seniors at risk. In the few existing studies exploring the power of the GP physician's judgement on adverse outcomes, very different accuracies have been shown,[38,39] suggesting that physicians' personal attitudes may impact on the quality of diagnosis and treatment as any other inter-rater variability. Drewes et al stated that a GP-based assessment might be a promising instrument to select older people for geriatric care.[38] Similarly, the MPI could serve as a GP-based structured, systematic multidimensional evaluation. This way, the treating physician could focus on those MPI-screened patients displaying high risk of poor outcomes. On the contrary, the routine evaluation of the MPI may enable the disclosure of potentially dangerous conditions which would remain uncovered without a targeted interview.[39] Further studies are needed to explore the question if a GP physician's early identification of high-risk older adults by means of MPI is feasible.

TABLE 3 Adjusted number of GPC accord ing to MPI and GP practitioner's judgement

Adjusted mean number of GPC per patient, per year	Total	Prognostic tool					
		MPI			GP practitioner's judgement		
		MPI 1	Mod. risk	MPI 3	Low risk	Mod. risk	High risk
In the 1 year prior to evaluation, mean (95%CI)	9.4 (8.2-10.5)	8.3 (7.1-9.5)	9.2 (7.0-11.3)	11.4 (5.7-17.0)	7.9 (6.5-9.3)	9.2 (7.0-11.3)	12.5 (9.6-15.3)
P-value[†]	–	.028[*]			.028[*]		
In the 1 year of follow-up, mean (95%CI)	10.4 (9.3-11.5)	9.5 (8.3-10.8)	10.3 (8.1-12.4)	9.2 (5.1-13.3)	9.4 (7.9-10.9)	10.3 (8.1-12.4)	12.3 (9.8-14.8)
P-value[†]	–	.045[*]			.131		

Note: For this analysis only the 111 patients who did not die during the follow-up were considered.
Abbreviations: GPC, general practitioner contacts; MPI, multidimensional prognostic index; SD, standard deviation.
[*]Significant at level alpha of 0.05.
[†]*P*-values were referred to a multiple linear regression adjusted for age, gender and level of educational requirement.

Previous studies testing other predictive geriatric tools in GP showed limited value,[39-45] for example the ISCOPE-score[40] or the Easy-Care TOS[46]. The systematic performance of the MPI clearly overcomes the limit of interrater variability and displays here independence from long-lasting clinical experience.

Possible applications for the use of the MPI in an outpatient setting might be after recent doctor change, before committal to an unfamiliar doctor or after critical, life-changing events. It may be a help for clinical decision making to identify patients at risk for adverse outcomes quickly and channelling prevention through patient-centred and goal-orientated early care.

The average number of GPC per year, 9.4 in the year prior to evaluation and 10.4 in the year of follow-up, observed in the present study is in agreement with estimates published in previous studies.[7] However, we could not confirm, as previously shown,[6] that the number of GPC falls with age, or that women visit the doctor more often than men. While Tille et al explained the smaller (Reviewer 1: #2) utilisation of GP with increasing age by the so-called "satisfaction paradox" (the objectively increased burden of disease displays subjectively a minor reason for a GP visit),[6] it is likely that the participants in our study benefited from the high social support typically provided in a rural area. This possible reason is indeed supported by the high percentage of the patients in our study displaying social resources (Table 1). On the other hand, the correlation between number of GPC and age observed in our study does not allow the achievement of any particular conclusion, being chronological age, because of heterogeneity,[47] often disjoint from biological age and its multidimensional aspects—those in fact addressed by the MPI.

The observation that the number of GPC is significantly correlated to the MPI enables the assumption that high GPC frequency is an alarm signal for upcoming adverse outcomes. Further studies on GP are necessary to investigate the role of the MPI for monitoring the number of GPC.

The MPI is significantly associated with nursing needs as assessed by GC as well as with absolute numbers of GS and GR and their reciprocal relationship also in the GP setting, confirming previous observations in the inpatient setting.[22,25]

One strength of the study is that it may be used for power calculations for following confirmatory studies in different settings. (Reviewer 1: #3) Although we were able to show that the main diagnosis was significantly associated with the MPI (Table 1, $P < .001$), the number of main diagnosis groups was relatively low. Similarly, the number of persons with respiratory diseases was relatively low (five patients), which could be because of underdiagnosis. Additionally, the term "cardiovascular disease" covered patients of different severities of this disease in the absence of subgroups, so for further studies it might be useful to differentiate between severity degrees of both diseases and syndromes. (Reviewer 1: #4).

Our study has three major limitations. First, the study sample with 125 patients was relatively low, creating small subgroups for MPI. However, the highly significant observations obtained for the first time allow a reliable interpretation as a basis for future large-scale (confirmatory) studies. Second, the GP physician in our study works since more than 30 years in this rural setting—because this is a rarity, results of the accuracy of this GP physician's judgement cannot be transferred to every GP setting. The third limitation was the homogeneity of the patient sample as far as lifestyle and socioeconomic conditions are concerned, as most patients lived in the countryside for years. A multicentre study on several GPs in different areas would be needed to pave the way to similar conclusions representative of the general population.

5 | CONCLUSION

In summary, the MPI is significantly associated with adverse outcomes in GP patients with a higher number of GPC being a potential alarm signal for poor prognosis, suggesting a feasible way to overcome the "know-do gap" used to describe shortcomings in the CGA performance.[48] An early MPI calculation in an outpatient setting to identify patients at risk for adverse outcomes, in fact, might be helpful to prevent hospitalisation and unnecessary diagnostic or therapeutic interventions to lower healthcare costs by a targeted, goal-orientated and personalised care-approach.[12,18] Additionally, we confirmed that GC and the number of GS and GR are also associated with prognosis, therefore their assessment seems imperative. Within this frame, the present study confirms the enormous potential of shifting the focus of diagnosis and tailored interventions in old age from disease to the reciprocal relationship between geriatric syndromes and resources. The latter—personal resources of the older adult-,[25] in particular, represent a very powerful, though up to date neglected and dramatically underused, lever to improve self-competence and ability from the side of patients to accompany clinical decision making (shared decision making) on one side and enhance the success of planned interventions on the other side. The overall aim of systematically assessing individual multidimensional health status by means of structured best quality tools is to improve patients' trajectories and smoother, also cost-effective transitions across healthcare settings.

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DISCLOSURES

For each author there were no conflicts of interests, including all relevant financial interest in any company or institution that might benefit from the publication.

AUTHOR CONTRIBUTIONS

AMM, MCP and IB conceived and designed the clinical trial. AMM and TBet performed the experiments. AMM and GS analysed the

data. AMM wrote the paper. AMM and MCP conceived the manuscript. AMM, GS, IB, TBet, AWB, JWR, OK, TBen, AP and MCP critically revised the manuscript.

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