

Special Articles

Care Complexity in the General Hospital

Results From a European Study

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There is increasing pressure to effectively treat patients with complex care needs from the moment of admission to the general hospital. In this study, the authors developed a measurement strategy for hospital-based care complexity. The authors' four-factor model describes the interrelations between complexity indicators, highlighting differences between length of stay (LOS), objective complexity (such as medications or consultations), complexity ratings by the nurse, and complexity ratings by the doctor. Their findings illustrate limitations in the use of LOS as a sole indicator for care complexity. The authors show how objective and subjective complexity indicators can be used for early and valid detection of patients needing interdisciplinary care.

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Doctors and nurses working in general hospitals are increasingly confronted with complex patients. The

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high cost of our health care system has resulted in pressure to decrease the relative and absolute number of general hospital beds and the average length of hospital stay (LOS), both in Europe and in the United States. As a result, only the most complex patients who cannot be treated elsewhere are admitted to the hospital, where their treatment is often under heavy time constraints. For a growing proportion of patients, integral treatment strategies should be considered, such as early coordination of care,¹ geriatric interventions,^{2–4} and referral to other medical and paramedical consultation services, such as psychiatry,⁵ psychology,⁶ or social work.⁷ Although the effectiveness of these interventions has been frequently reported in the literature, the use of these services is restricted because an adequate admission screening strategy is not available. Although there are several screening instruments available to detect psychi-

atric symptoms, instruments for identifying patients who may need complex care are scarce or have been developed only in single-site studies.^{13,14,17} Screening instruments for identifying patients who need complex care are especially important when rising costs require reductions in health care use. To develop an adequate screening method, an assessment strategy of care complexity—the degree of difficulty in treating a patient—is needed.

Although much attention has been paid to concepts associated with care complexity, such as severity of illness, psychiatric comorbidity, and frailty, the concept of complexity with respect to general hospital care is mentioned in only a few studies^{8–11} from perspectives that seem difficult to reconcile. Indicators of care complexity include long hospital stay,^{12–13} readmission,^{13–14} admission to nursing home after discharge,^{13,15–16} nonmedical hospital days,¹⁷ and medical complications.¹⁸ Although separately these indicators have been studied extensively, an integrated approach is lacking. We present here an assessment strategy of care complexity whose applicability and generalizability has been tested in a multisample design.

One method of measuring care complexity is by length of stay (LOS). The more difficult it is to treat a patient, the more likely it will be that the patient will stay longer in the hospital. LOS is perhaps the most common measure of hospital functioning, which can be easily and reliably measured and represents both clinical outcome and costs of care.^{19–20} Also, because health care providers have a keen interest in the population of patients who use a disproportionate share of resources, studies have been conducted to show the variables associated with LOS.²¹ LOS is a hospital characteristic related to several patient/disease characteristics, like severity of illness, functional status, and psychiatric comorbidity. However, LOS should not be the sole criterion for determining care complexity because it does not address the difficulty of the treatment, including the number of health care professional involved or the number of interventions conducted. Although it can be argued that difficulty of treatment and LOS are associated,⁸ there are examples where such an association is missing.

Care complexity has also been assessed by means of surveying the health care professionals directly. One example is the use of clinicians' predictions (at admission) of patient risk for nursing home placement.¹⁵ In this study, the researcher found a high agreement between nurses, physicians, and social workers but also a general underestimation of risk for nursing home placement, believed to be caused by not fully appreciating mental and functional impairment as risk factors. In another study,⁸ Kelleher de-

scribed a concept she called difficulty of clinical management. Kelleher had residents rate four aspects of patient admissions: 1) complexity of the case, 2) amount of clinical judgment required, 3) extent to which the management of the patient included uncertainty or unpredictability, and 4) degree to which management of the patient was routine. Difficulty of treatment explained a substantial amount of variance of LOS, independently of DRGs and subjective ratings of severity of illness. In this respect, the addition of ratings by nurses may enhance the validity of the care complexity concept because nurses focus on different aspects of the care delivery process. For example, nurses sometimes seem more proficient than the medical staff in identifying patients with psychiatric disorders.²² These studies all used subjective judgments to detect patients at risk for specific complex care needs. In our study, subjective judgments by doctors and nurses were obtained at discharge to identify retrospectively information about the complexity of the care given during the patient's hospital stay.

A potential weakness of this method, however, is doctor and nurse subjectivity. Therefore, we included objective indicators of care complexity. Complexity in hospital care includes three relevant constructs: 1) uncertainty of the diagnosis or treatment, 2) multiple treatment interventions, and 3) the need for consults by other medical and paramedical specialists. Each of these constructs is related to all participants in the process of hospital-based service delivery.

Uncertainty about diagnosis has been discussed in the literature.⁹ The number of diagnostic and laboratory tests conducted during hospital stays is an indicator of the uncertainty of diagnosis and/or treatment. The literature also shows evidence of an association between multiple diagnoses and health care use²³ and between the results of laboratory tests and LOS, independent of DRGs.²⁴ In particular, requests for further testing during the hospital stay suggests diagnostic uncertainty or a need to monitor progress, which is also less dependent on the policy of hospitals or individual doctors.

Multiple treatments is another construct that indicates care complexity. Multiple treatments complicate care delivery because multiple treatments require more elaborate treatment strategies and collaboration among treatment professionals. Patient medications can be a useful indicator of care complexity. Treatment plans that include a multiple medications have the potential for complex drug interactions and require careful monitoring. In addition, some researchers argue that the number of medications prescribed can be used as an indicator of chronicity of disease,²⁵ which

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is related to both health care use and an increased risk of psychopathology.²⁶⁻²⁷ Specific interventions provided by the nursing staff, such as the use of artificial respiration, oxygen, or intravenous lines, also might serve as an indicator of complex care. Many nursing care interventions reflect the time spent treating a patient and the skill level required and are therefore indicative of resource consumption.²⁸ According to Halloran et al.,²⁹ 20%–30% percent of total hospital expense is attributable to the nursing care. Prescott and colleagues^{11,28} found that their instrument [Patient Intensity for Nursing Index (PINI)] is related to a range of relevant care indicators, including LOS and comorbidity. In particular, nonstandard or additional nursing care may be related to care complexity because it reflects both the time spent and the skills needed to perform treatment.

Finally, we considered the need to consult other medical and paramedical specialists by the ward doctor as an indicator of care complexity. For example, the association between psychiatric consultations and high care complexity has been frequently described in the literature.^{30,31} Patients referred to C-L psychiatry tend to have long hospital stays, often twice as long as patients not referred to C-L psychiatry.^{23,31}

We hypothesize that care complexity can be measured by means of LOS, ratings by doctors and nurses, and a series objective indicators and examined whether an assessment strategy of care complexity using these four concepts is a valid indicator of care complexity in a general internal medical ward. In our two companion articles in this issue, risk factors for care complexity and an instrument to predict care complexity are described.^{32,33}

METHODS

Design

This study was part of the Biomed1 Risk Factor Study,^{34,35} the main goal of which was to improve detection and treatment of patients with combined medical and psychiatric problems. The study had a cohort design: patients were included at their admission and followed through their hospital stay until discharge. At admission, the physician and nurse made a series of ratings about severity of illness and predictions of care complexity. Within the first 3 days of admission, an extensive structured patient interview was conducted by a trained health care professional (i.e., a nurse, medical student, or doctor). At discharge, the physician and nurse made a series of ratings reflecting the complexity of the care that the patient received. The ad-

mission nurse and the discharge nurse were the same person only for a minority of the patients in this study. The admission physician and the discharge physician were the same. The data used in our analyses were collected during hospital stay and at a patient discharge and did not include admission risk variables and patient interview.

Variables

The LOS, number of days with diagnostic procedures, number of days with laboratory tests, number of medications, and number of medical and paramedical consultations were scored from the medical chart based on a scoring protocol. A series of 13 nurse intervention categories was scored daily by the ward nurse based on a list derived from the PINI with adjustments made in collaboration with the head nurses of the Vrije Universiteit Hospital in Amsterdam: 1) patient fully bedridden; 2) patient fully ADL (activities of daily living) dependent; 3) more than standard monitoring (neurological excluded); 4) neurological monitoring; 5) special care for scars and wounds; 6) airway cleaning; 7) artificial respiration; 8) use of nasal oxygen; 9) drains; 10) intravenous lines; 11) nasal tube feeding; 12) hemofiltration; and 13) total parenteral nutrition. All items were scored yes (1) or no (0) and were summed over the total hospital stay. Two subjective complexity ratings were made by the doctor and two by the nurse at discharge on four-point scales (No, Mild, Moderate, Severe; scored 1–4). The first subjective complexity rating was the question: “Has this patient required complex medical or nursing care?” (to the doctor or the nurse, respectively). The second subjective complexity rating was the question: “Has the organization of care during hospital stay been complex?”

Sample

Patients were included who were admitted consecutively to 1 of 11 general internal medical wards of 7 European countries during 1996 and 1997. Patients were included only if they were admitted directly (not through another ward or hospital) and stayed at least one night. Patients who could not be interviewed due to the severity of their illness or because of organizational difficulties and those who did not consent were excluded. Patients who died during admission were removed from the sample, resulting in a sample of 2,158 patients from 7 countries. Figure 1 shows the patient flow chart; a more detailed description of the sample is described elsewhere.³⁵

Data from 166 patients were also added. Of these, no

patient interview was conducted in order to reduce the selection bias due to the interviewability of patients. The resulting total sample was 2,325 patients.

An analysis of the excluded patients was conducted on the patients from the Vrije Universiteit Hospital. We examined whether there were selection biases in obtaining the patients for analysis. Two stages of the selection process were studied: 1) from all patients admitted to those meeting the inclusion criteria, 2) from those meeting the inclusion criteria to those actually studied. For the first step, patients that met the inclusion criteria ($n = 212$) were compared with a random sample of all patients admitted during the year 1995 ($n = 200$) by means of Mann-Whitney *U*-test or chi-square test where appropriate. No differences were found on average LOS, average age, proportion of men to women, or death ratio. Therefore, it seems that the inclusion criteria themselves did not result in selection bias.

For the second selection step, all interviewed patients ($n = 139$), including three who died during hospital stay, were compared with all noninterviewed patients ($n = 73$) by means of Mann-Whitney *U*-test or chi-square test where appropriate. Significant differences were found on three variables: excluded patients had a higher risk of death during stay, they suffered more frequently from a life-threatening illness, and they received more nonstandard nursing care interventions. This is explained by the severity of their illness at admission as a reason for exclusion. In practice, it often proved difficult to distinguish between severity of illness and refusal as reasons for exclusion because sometimes patients refused participation because they were too ill to undergo an interview.

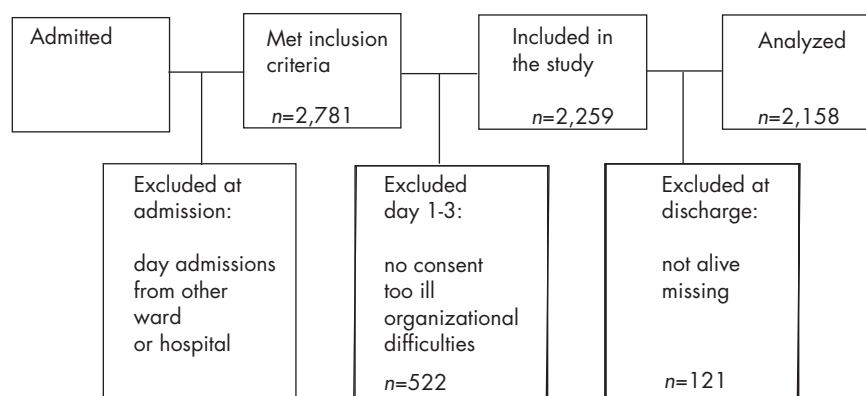
We expect that this bias applies to the other participating centers. In the other centers, it proved difficult to collect data on patients who could not be included in the study. In the Dutch sample, 66% of the patients meeting the inclusion criteria were interviewed. From Figure 1, it can be calculated that in the remaining samples this percentage is 86% $[(2,259-139)/(2,781-212)]$. This much higher percentage does not suggest that more patients were interviewed in the other hospitals but that some of the excluded patients were not counted. Only some of the participating centers were able to provide information about patients not interviewed (in total, $n = 166$). These patients were included in the analyses of the present paper.

Of the total sample, consisting of seven national samples, those countries that had comparable correlations among the complexity indicators were selected. This is a prerequisite for conducting a confirmatory factor analysis. A multisample test of the equality of correlation matrices³⁶ resulted in a selection of three national samples on which the analyses were conducted [Portugal, Germany, and the Netherlands: $\chi^2 = 253.7$; $v = 45$; $\chi^2/v = 2.57$; Comparative Fit Index (CFI) = 0.97] from four hospitals (Amsterdam, Vrije Universiteit; Lisbon, Hospital Amadora-Sintra; Freiburg, Albert Ludwigs Universitaet; Luebeck, Universitaet zu Luebeck, Total $N = 834$).

Data Analysis

By means of confirmatory factor analysis, the correlational structure of the complexity indicators was estimated by specifying latent factors that account for the mea-

FIGURE 1. Patient flow chart



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sured variables. Discussion of the theoretical basis for this can be found elsewhere.³⁷ The program EQS Structural Equations^{36,38} was used to run the analyses, which uses maximum likelihood for the estimation of parameters. A four-factor model was anticipated, consisting of LOS (1 variable), objective complexity (5 variables), subjective complexity–nurse (2 variables), and subjective complexity–doctor (2 variables). Models were tested by means of a multisample testing procedure, which provides information on the cross-sample tenability of the model. Models were evaluated by means of the CFI, which is relatively stable at all sample sizes.³⁹ The CFI reflects the relative goodness of fit compared to a null model, which indicates no mutual influences among variables, and should be at least 0.90. As LOS and the objective complexity indicators had skewed distributions, these variables were recalculated by means of a natural logarithmic transformation, resulting in approximately normal distributions.

RESULTS

Table 1 shows a description of the sample admission data and complexity indicators. The samples are comparable with respect to admission data. The German samples, however, show relatively high scores on the number of days with laboratory and diagnostic tests; in the sample from Luebeck, high scores on the number of nurse interventions and consultations were found.

Table 2 shows the Pearson correlations among the

transformed care complexity indicators over all patients. Significantly positive correlations were found among all indicators. The two complexity ratings by both the doctor and the nurse were strongly associated (0.85 and 0.78). The correlations among the five objective complexity indicators (days with diagnostic tests, days with laboratory tests, medications, nurse interventions, and consultations) range from 0.30 to 0.65. Because LOS is strongly associated to the objective complexity indicators, apart from the proposed four-factor model, the fit of a three-factor model should also be considered where LOS and objective complexity are loading on one factor together.

A restricted four-factor model, in which factor loadings and factor intercorrelations were forced to be equal across samples, fit the data well according to the fit index ($\chi^2=418.6$; $df=114$; $CFI=0.93$). Still, the LaGrange Multiplier Test suggested dropping two equality constraints, both dealing with the factor loadings of consultations. Dropping the two constraints led to a slightly improved fit in terms of the CFI (Table 3). This model highlighted differences in the standardized factor loadings of consultations on the objective complexity factor across the three samples (Dutch sample, 0.55; Portuguese sample, 0.34; German sample, 0.60). Excluding consultations from the objective complexity factor did not lead to an improved fit. Finally, reducing the number of factors to three (subjective complexity–doctor, subjective complexity–nurse, and a factor representing both LOS and objective complexity) resulted in a nonconverging model.

In Figure 2, the standardized factor loadings and in-

TABLE 1. Admission data and complexity indicators

	The Netherlands	Portugal	Germany: Freiburg	Germany: Luebeck	Total
Patients, <i>n</i>	201	117	142	384	844
Admission data					
Age, means \pm SD	58.7 \pm 20.3	55.4 \pm 20.0	54.5 \pm 17.1	63.2 \pm 15.6	59.6 \pm 18.0
Proportion male, %	47	51	45	43	45
Proportion unplanned admissions, %	64	98	51	83	75
Admission from home, %	92	84	84	88	88
Admission from institution, nursing home or mental hospital, %	4	7	2	6	4
Complexity indicators, means \pm SD					
LOS	11.2 \pm 10.3	12.7 \pm 16.2	11.6 \pm 9.9	13.5 \pm 11.3	12.5 \pm 11.7
Complexity of care (doctor)	1.5 \pm 0.8	1.9 \pm 0.9	2.2 \pm 0.9	2.3 \pm 0.9	2.1 \pm 0.9
Complexity of organization (doctor)	1.5 \pm 0.8	1.9 \pm 0.8	2.2 \pm 0.9	2.1 \pm 0.7	2.1 \pm 0.9
Complexity of care (nurse)	1.9 \pm 0.9	1.8 \pm 0.9	2.3 \pm 1.1	2.1 \pm 0.8	2.1 \pm 0.9
Complexity of organization (nurse)	1.7 \pm 0.9	1.7 \pm 0.8	2.3 \pm 0.9	2.3 \pm 0.9	2.0 \pm 0.8
Days with diagnostic tests	2.6 \pm 2.7	2.7 \pm 2.1	6.2 \pm 6.0	5.8 \pm 4.4	4.7 \pm 4.4
Days with laboratory tests	5.3 \pm 3.4	4.1 \pm 2.9	7.4 \pm 6.1	8.5 \pm 7.3	6.9 \pm 6.1
Medications	8.1 \pm 5.3	7.2 \pm 4.5	9.3 \pm 6.7	10.1 \pm 5.8	9.1 \pm 5.8
Nurse interventions	13.8 \pm 20.4	13.8 \pm 16.3	16.4 \pm 19.8	28.8 \pm 28.8	21.1 \pm 25.1
Consultations	1.2 \pm 2.2	1.5 \pm 0.7	2.8 \pm 3.3	10.2 \pm 8.0	5.7 \pm 7.1

tercorrelations of the most restricted four-factor model from Table 2 are presented.

DISCUSSION

Our four-factor model describes the interrelations among a set of 10 hypothesized complexity indicators in three comparable patient samples. As we anticipated, we found a high correlation between LOS and the objective complexity factor in this model. Patients needing many interventions from doctors, nurses, and other medical and paramedical consultants during their hospitalization are likely not to be discharged quickly. We also found, however, that complexity and LOS, though highly correlated, are not the same. The objective complexity indicators together represent something more than simply the duration of care. Interestingly, both the doctors' and the nurses' complexity factors were more strongly associated with the objective complexity factor than with LOS, indicating that the objective complexity factor better described what they felt were complex patients.

The somewhat weaker associations between LOS and the subjective complexity factors can be illustrated by two types of patients. First, consider a patient who attempted suicide but who is only briefly admitted to the hospital. Although this patient was treated intensively and judged to be a difficult patient by doctors and nurses, the patient did not stay very long and was placed in a psychiatric hospital

after acute help for the somatic problem. Then consider a patient with an extended hospital stay that is caused by a placement problem. Although objectively not complicated, the patient cannot leave the hospital because of suboptimal postdischarge care. In addition, the doctor and nurse may not agree here; although the doctor may think this patient requires uncomplicated care, from the nurses' perspective the patient needs complex care related to walking or attending to ADL.

In our study, the doctors' and nurses' complexity factors were not very strongly interrelated, highlighting such different foci of attention. Moreover, the doctors' ratings were more strongly associated with both the objectively measured complexity indicators and with LOS than were the nurses' ratings. Specifically, whereas the doctors ratings were associated with all objective complexity indicators, the correlations between the nurses' ratings with consultations and the number of days on which there were diagnostic procedures were lower than the rest. These differences between their complexity judgments reflect different perspectives on a patient's care, which should be accounted for in a measurement of complexity.

In the introduction, we described the need for an assessment strategy of care complexity. Our findings support a multidimensional model of complexity. The measurement of complexity can not therefore be based on LOS alone. Instead, judgments of complexity by both doctors and nurses and objective criteria assessing complexity

TABLE 2. Correlations among the complexity indicators

	1	2	3	4	5	6	7	8	9	10
1. LOS		0.46	0.43	0.32	0.29	0.69	0.60	0.54	0.45	0.57
2. Complexity of care (doctor)			0.85	0.32	0.32	0.48	0.49	0.40	0.42	0.42
3. Complexity or organization (doctor)				0.32	0.35	0.45	0.49	0.36	0.44	0.39
4. Complexity of care (nurse)					0.78	0.39	0.31	0.38	0.21	0.41
5. Complexity of organization (nurse)						0.36	0.35	0.34	0.26	0.35
6. Days with laboratory tests							0.65	0.54	0.52	0.56
7. Days with diagnostic procedures								0.41	0.67	0.47
8. Medications									0.30	0.51
9. Consultations										0.47
10. Nurse interventions										

Note: All correlations statistically significant when $\alpha = 0.05$

TABLE 3. Goodness-of-fit after dropping equality restrictions

	χ^2/ν	CFI	$\Delta\chi^2$	Δdf	$P(\Delta\chi^2)$
Equal loadings and equal correlations restricted	3.67	0.93	—	—	—
Dropping equality of factor loading consultations of the Portuguese sample	3.5	0.94	23.4	1	<0.01
Dropping equality of factor loading consultations of the Portuguese and Dutch samples	3.34	0.94	21.3	1	<0.01

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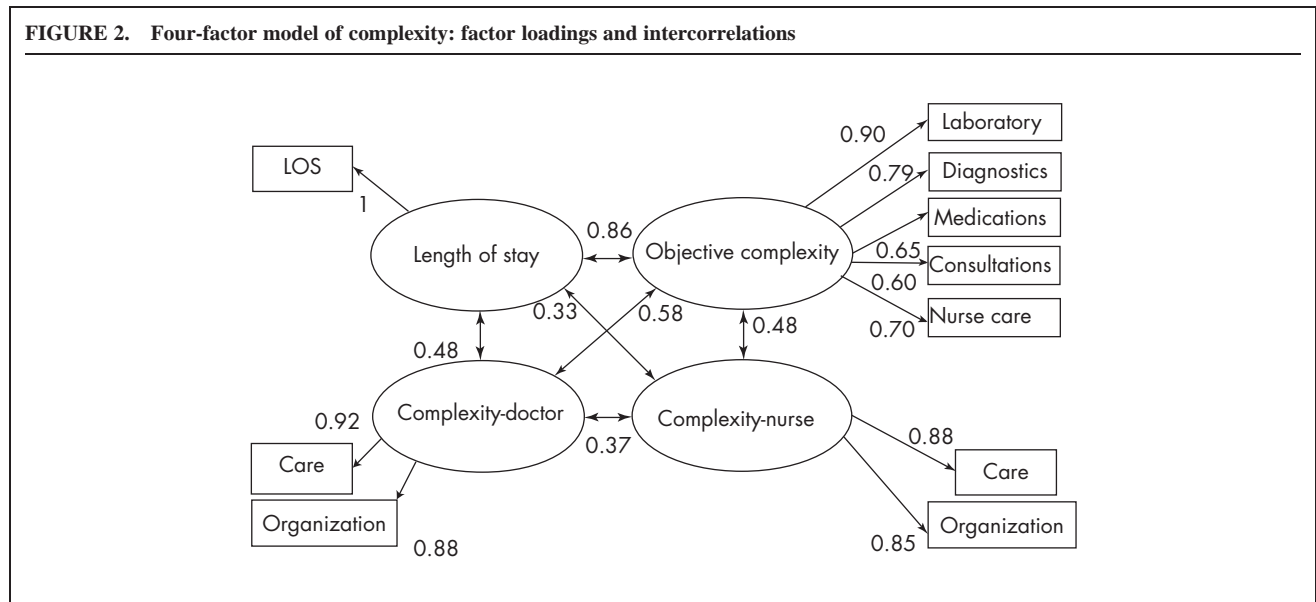
should be used. Because objective care complexity indicators are strongly dependent on a hospital's case mix and policy (for example the availability of specific services like social work or medical psychology or the availability of protocols for complex patients like delirium prevention), such an index might be best developed using local circumstances. In this study we found, for example, after removing those samples from the analyses which we knew showed substantial differences, a differential contribution of the number of consultations to the complexity factor across the samples still existed. When considering the differences between the samples on this variable, this is not surprising.

As we've stated, the relevancy of this measurement model of complexity lies in the detection and treatment of patients who might benefit from interdisciplinary care. Currently, one of two strategies is generally adopted: 1) referral of complex patients by doctors (or nurses) based on their subjective decision, often late and urgent,³¹ resulting in underdetection of psychiatric comorbid cases,⁴⁰ presumably biased toward those patients representing behavioral problems to the health care professionals,⁴¹ or 2) some form of integrated care, such as postdischarge planning,⁴² interdisciplinary rounds,¹ or psychogeriatric care coordination.² Although the second option appears to be the most effective and efficient according to a series of interventions studies, it may be either overconclusive when applied to all patients or simply not used in clinical practice because of the lack of an appropriate screening method. Application of our findings could be done by other insti-

tutions by linking complexity to admission risk variables and in this way create a detection instrument.

With this goal in mind, we performed a subsequent study in which the 10 complexity indicators were used to determine a list of admission risk factors for complexity.^{32,33} From an extensive list of potential risk factors for complexity mentioned in the literature, we developed a risk score, linearly related to all complexity indicators across the national samples. Using this risk score together with a method of integrating diagnostic information,⁴³⁻⁵¹ we present an alternative way of screening for patients requiring complex care in the general hospital.³¹ The main advantages of this approach are that health care becomes preventive and can be planned at admission, as opposed to reacting to patient complications in the course of hospitalization. Perhaps even more importantly, this approach allows for the selection of a relevant patient group in a standardized way, rather than being dependent on subjective referral filters.

In an era where LOS increasingly reflects a hospital's policy rather than a patient's care needs, attention should be paid to the difficulty of managing a patient through the course of hospitalization and the patient's access to post-discharge health care. The conception of care complexity may help in this regard. Although we recognize that our measurement model of care complexity may need refinement to overcome local hospital circumstances, the findings of our study support this model. In addition, our findings shed new light on the process of detecting patients



who might benefit from interdisciplinary health care programs.

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