Geriatric scores as single-handed tools in the risk of 30-day mortality after hip fracture

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Abstract

Background

The 30-day mortality rate after hip fracture surgery has been considered as an indirect indicator of the quality of care. This work aims to validate the Barthel Index, Katz Index, Lawton-Brody Index, and Physical Red Cross Scale analyzed in the Comprehensive Geriatric Assessment at admission as predictors of 30-day mortality after hip fracture surgery.

Methods

Prospective study including 899 hip fracture patients over 65. Bed-ridden, non-surgically treated patients, and high energy trauma or tumoral etiology fractures were excluded. Variables distribution were assessed by χ^2 , and we performed binary logistic regression for risk assessment. $P < 0.05$ was considered statistically significant.

Results

We noted a 30-day mortality rate of 5.9%. We related Barthel Index (OR = 0.986 [0.975–0.996], $p = 0.010$), Katz Index (OR per point = 1.254 [1.089–1.444], $p = 0.002$), Lawton-Brody Index (OR = 0.885 [0.788–0.992], $p = 0.037$), and Physical Red Cross Scale (OR = 1.483 [1.094–2.011], $p = 0.011$) with the 30-day mortality of patients after hip fracture surgery. We also validate the Barthel Index inflection point (0–55) ($OR_{BI(0-55)} = 2.428$ [1.379–4.275], $p = 0.002$) and Katz Index inflection point (A-B) ($OR_{KI(A-B)} = 0.493$ [0.273–0.891], $p = 0.019$) for the assessment of the highest risk patients.

Conclusions

The geriatric scores would be useful multifunctional tools in the assessment of hip fracture patients as singly predictors of 30-day mortality.

Background

One of the most interesting topics in hip fracture management is to clarify indicators to foresee the results of the surgical treatment of this complex group of patients. Once known, these indicators would allow us to establish preventive measures and allocate resources for those patients with a higher risk of mortality.

The treatment of older hip fracture patients requires a multidisciplinary approach carried out in the so-called Orthogeriatric Units. The Comprehensive Geriatric Assessment (CGA) is a key tool throughout the patient admission process reporting on the functional situation of the patients that has been related to

the hip fracture outcome (1). The CGA includes the evaluation of some geriatric scores and geriatric syndromes (2, 3). Barthel Index (BI), Katz Index (KI), and Lawton-Brody Index (LBI) scores are broadly used in a standardized way as part of the CGA. The Physical Red Cross Scale (PCRS) is also a mobility score widely used in Spain.

These geriatric scores, along with clinical information of the patient, elucidate the functional situation of the patient and provides a deeper insight on patients which would help in in-hospital monitoring and later follow-up.

We dispose of a variety of tools to predict the outcome of surgical management of hip fracture patients such as the NHFS, AHFS, or O-Possum (4, 5), although, given the variability between the world population and health-care models, their application could be compromised by the availability of certain resources. Some geriatric scores have been also previously studied as predictors of in-hospital mortality for patients undergoing surgery (6). Our working group demonstrated the usefulness of geriatric scores as predictors of long-term mortality in a limited number of patients (7), being able to establish geriatric score inflection points from which the risk of long-term survival was significantly decreased.

The aim of this work is to validate BI, KI, LBI, and PCRS as predictors of early mortality in older hip fracture patients. We also aim to establish the possible usefulness of the geriatric scores inflection points previously defined on BI, KI, and LBI on the 30-day mortality rate in older hip fracture patients.

Methods

Design and population

We designed a prospective observational study, including all patients 65-years-old and older with hip fracture admitted from January 1 2018 to December 31 2019 in the orthogeriatric unit of the University Hospital of Salamanca (UHS). We excluded bed-ridden patients (PCRS = 5) and those cases that were not surgically treated, as well as all those patients who suffered fractures due to high energy trauma or who showed tumoral etiology. All patients included in the study expressed their consent to participate by signed consent.

Overall, a complete CGA was performed in 919 patients during the study period. We follow-up patients for 30-day mortality, assuming the attrition rate of 2.2%, leading to a cohort of 899 patients undergoing surgery after hip fracture.

Demographic and clinical variables

On admission, sociodemographic variables such as gender, date of birth and admission, and place of residence were collected. We also recorded the type of fracture, the type of surgical procedure, and destination at discharge.

Geriatric Scores

In the UHS Orthogeriatric Unit, the following geriatric scores are used as part of CGA: Barthel Index, Katz Index, Lawton-Brody Index and Physical Red Cross Scale.

The BI (8) collects data on the degree of capability for the development of 10 basic activities of daily living (ADL). For each activity analyzed, a gradual score is applied in 5 points, according to the patient's ability to perform it. BI punctuations go from 0 to 100.

The KI (9) estimates the independence of the patient to perform basic ADL. It analyses 6 functions from which categorization of patients originates, possible situations ranging from the total independence named with the letter A to the total dependence indicated with the letter G.

The LBI (10) evaluates instrumental activities of daily living (IADL). The LBI assigns a score from 0 to 8; the highest score indicates the best functional capability. Due to the characteristics of the IADL analyzed, LBI has been traditionally applied differentiating the gender of the patient and limiting to 4 the maximum score for men (11). At UHS, the whole questionnaire was determined regardless of patient gender.

For these geriatric scores, we have previously described an inflection point from which the survival rate of patients after hip fracture surgery would be significantly abridged (7). The inflection points were determined by the largest mean difference in survival tendency.

The Physical Red Cross Scale (12) evaluates the physical ambulatory ability for the patient, similar to the Functional Ambulation Classification (FAC). The physical-status evaluation of PRCS is concerning 5 levels of ambulatory ability from 0, which indicates full capability, to 5, which indicates any ambulatory capability. This score was also used as an exclusion variable in our study for bed-ridden patients (PCRS = 5).

Statistical analysis

Data were imported into a database for statistical analysis with the IBM® SPSS® Statistics program (v.25). Descriptive statistics included mean and standard deviation, and normality of sample distribution was defined by the Kolmogorov-Smirnoff test. We ascertain the statistically significant differences among groups by χ^2 . The Odds Ratio (OR) was estimated by binary logistic regression. In all cases, a p-value of less than 0.05 was considered statistically significant.

Results

The study population was composed of 899 patients. One in four patients were men and the mean age was greater than 85 years old (Table 1). We noted a 30-day mortality rate of 5.9%. Figure 1 shows the early mortality rates represented over the population on each category of the four geriatric scores analyzed.

We addressed the place of residence of patients, noting that 51.6% of patients were residents from municipalities with more than 12,500 inhabitants and 32.0% of participants were living on an older people specific healthcare institution before admission. A total of 472 patients were institutionalized at discharge – 32.8% of non-institutionalized patients at admission were institutionalized at discharge –. A social worker was involved in 17.6% of cases. Incidence by type of hip fracture was also studied, showing that most cases it was a trochanteric fracture, whose surgical intervention treatment was osteosynthesis-based (Table 1).

The mean time to surgery was 2.94 ± 2.55 days, noting 34.1% of patients operated within the first 48h, and 17.7% of patients operated within the first 24h.

Barthel Index.

The mean punctuation in BI of our population was 72.8 ± 23.44 . We noted significant decreasing BI on aging groups ($p < 0.001$), and lower BI punctuation on women ($p = 0.013$) and institutionalized patients at admission ($p < 0.001$), but no differences on BI were achieved for new institutionalized patients at discharge ($p < 0.05$), or regarding the time to surgery of patients ($< 24h/48h$, $p > 0.05$).

The distributions of BI punctuation regarding the 30-day mortality of patients are shown in Table 2 and represented in Figure 2. BI was significantly related to 30-day mortality (OR per point = 0.986 [0.975-0.996], $p = 0.010$).

The inflection point previously determined for BI (BIIP) was set at 60 points, grouping patients presenting moderate and severe dependence (BI 0-55) and patients showing slight dependence or total independence (BI 60-100). Analyzing the study population by the distribution of BIIP, we observe no differences regarding the gender of patients, new institutionalized patients at discharge or time to surgery ($p > 0.05$, in all cases), but with institutionalized patients at admission ($p < 0.001$) and aging patients ($p < 0.001$). We noted a significantly increased risk for early mortality at this point, noting that moderate or severe dependent patients had double increased risk ($OR_{BI(0-55)} = 2.428$ [1.379-4.275], $p = 0.002$).

Katz Index

The most frequent category of KI on our population was A (31.9%). We noted significant decreasing KI on aging groups ($p < 0.001$) and on institutionalized patients at admission ($p < 0.001$), but no differences on KI were achieved regarding new institutionalized patients at discharge, gender of patients or the early surgery rates ($< 24h/48h$, $p > 0.05$, in all cases).

The distributions of KI punctuation regarding the 30-day mortality of patients are shown in Table 2 and represented in Figure 2. KI was significantly related to 30-day mortality (OR per point = 1.254 [1.089-1.444], $p = 0.002$).

The inflection point previously determined for KI (KIIP) was set at B category, grouping patients displaying high independence (KI A-B) and patients showing any dependency (KI C-G). Analyzing the study

population by the distribution of KIIP, we observe no differences regarding the gender of patients or new institutionalized patients at discharge ($p>0.05$), but a lower independent patient (KI A-B) rate on the institutionalized population at admission ($p<0.001$) and aging patients ($p<0.001$). We noted a greater proportion of independent patients operated within the first 48h ($p=0.018$). We noted a significantly decreased risk for early mortality at this point, noting half the risk for high independent patients ($OR_{KI(A-B)}=0.493$ [0.273-0.891], $p=0.019$).

Lawton-Brody Index

The mean punctuation in the LBI of our population was 3.07 ± 2.74 . We noted significant increasing LBI punctuations on men, on aging groups and institutionalized patients at admission ($p<0.001$, in all cases), but no differences on LBI were achieved regarding new institutionalized patients at discharge or the early surgery rates ($<24h/48h$, $p>0.05$ in all cases).

In Table 3 are shown the distributions of LBI punctuation regarding the 30-day mortality of patients, represented in Figure 2. We showed that LBI distribution was similar in survival and early mortality groups ($p>0.05$), but the single LBI punctuation was significantly related to 30-day mortality (OR per point= 0.885 [0.788-0.992], $p=0.037$).

The inflection point previously determined for LBI (LBIP) was set at 4, distinguishing patients scored 3 or less and patients scored 4 or more. Analyzing the study population by the distribution of LBIP, we observe differences regarding the gender of patients ($p=0.006$), aging patients ($p<0.001$), and the institutionalized population at admission ($p<0.001$), but no for new institutionalized patients at discharge ($p>0.05$). We noted a greater proportion of patients scored 4-8 operated within the first 48h ($p=0.004$). We noted a tendency for early mortality at this point, but no statistical significance was achieved ($OR_{LBIP(0-3)}=1.801$ [0.932-3.480], $p=0.080$).

Physical Red Cross Scale

The mean punctuation in PRCS of our population was 2.0 ± 0.93 . We noted significant increasing PRCS on aging groups ($p<0.001$) and on institutionalized patients at admission ($p<0.001$), but no differences on PRCS were achieved regarding the gender of patients, among hospital-derived institutionalized patients or time to surgery ($<24h/48h$, $p>0.05$, in all cases).

In Table 3 are shown the distributions of PRCS punctuation regarding the 30-day mortality of patients. We showed that PRCS distribution was similar in survival and early mortality groups (Figure 2, $p>0.05$), but the single PRCS punctuation was significantly related to an increased 30-day mortality rate (Figure 1, OR per point= 1.483 [1.094-2.011], $p=0.011$).

Discussion

Our study proposes the use of BI, KI, LBI and PCRS geriatric scores as stand-alone indicators of 30-day mortality after hip fracture surgery, validating the established inflection points as key factors for the hip fracture patients' management. It all allows us to obtain more detailed knowledge about the prognosis of these patients.

Hip fracture in older patients is indeed a highly demanding health problem. Nowadays, the management of older hip fracture patients has significantly improved thanks to the implementation of the Orthogeriatric Units (13–15). It leads into the CGA which grants a better understanding of the functional and clinical situation of each patient and enables the application of the appropriate therapeutic measures to each case (1, 2). The geriatric scores applied in the CGA are a very useful tool in the assessment of patients admitted to Orthogeriatric Units (6, 16). The unveiling of the functional status of patients facilitates, inter alia, the comparison of patient's management and care results.

The 30-day mortality may be an indirect indicator of the quality of care and assistance provided to older patients with hip fracture. Several studies are trying to find out the risk factors related to a worse outcome so that the recognition of these risk factors ensures the availability of health care resources for the patients who need them most. Examples of risk factors related to early mortality include age (17), gender (18), comorbidity (19), or even the waiting time to surgery (20, 21). Further, different multifactorial models have been proposed for the prediction of 30-day mortality, although due to the complexity of older hip fracture patients, it is very challenging to establish a perfect predictive model (5). It would be very useful to have a single multifunctional tool that, in addition to reporting on the functional status of patients, allows us to advance the prognosis of patients in the short term.

Weak information is available relating functional status to 30-day mortality (22), although other studies have shown a relationship with in-hospital mortality (1, 6) and long-term mortality (7, 23–25). The functional status is usually evaluated through the application of geriatric scores that show the ability of patients for personal development in daily life, noting the ADL, IADL, or mobility.

Our population showed slightly higher mean age and slightly lower 30-day mortality rate than other previously reported studies on hip fracture populations (26, 27).

We have analyzed the influence of functional status measured through geriatric scores (BI, KI, LBI, and PCRS) on early mortality. To our knowledge, it is the first time that a statistically significant relationship of these four geriatric scores with 30-day mortality is described in detail. The four scores analyzed show good individual discrimination.

We showed significant correlations of each geriatric score analyzed with 30-day mortality, noting that the better the functional status, the better the prognosis. This relationship was expected, although it had never been quantified as it is now. Despite this, no statistically significant association of the scores with newly institutionalized patients at discharge emerged. These results point to the use of BI, KI, LBI, and PCRS as individual predictors of 30-day mortality of older hip fracture patients. We shall not forget the

asymmetrical distribution of BI, KI, LBI, and PRCS scores concerning the oldest patients and patients who were institutionalized at admission.

Since the punctuation of each geriatric score analyzed is continuous data, in order to facilitate clinical and scientific use, we suggest the use of the inflection points of the geriatric scores to recognize which patients with diverse functional characteristics can benefit from the various levels of care provided. So, we could quantify the increasing risk of early dying regarding the ability to perform ADL before hip fracture. The BIIP (0–55), or otherwise, the KIIP (A-B), showed the best discriminatory ability to predict the 30-day mortality after hip fracture surgery. These results agree with the previous inflection points validation on BI and KI for long-term mortality of hip fracture patients (7).

Likewise, our study presents some limitations: firstly, the common provenance of the studied population, as it is a single-center study; secondly, the limited use of PRCS, which represents a mobility index that is widely used in Spain but not internationally; lastly, we lack other geriatric tools not applied in our center, as part of a CGA addressed in other studies (like geriatric comorbidity index).

Conclusions

The geriatric scores analyzed (BI, KI, LBI and PCRS) are single-handedly related in a statistically significant way to the 30-day mortality after hip fracture surgery. We show key inflection points for BI and KI on ADL that singly could assess the raising 30-day mortality risk after hip fracture surgery.

In our belief, the fact that a commonly used tool, as the geriatric scores are, in the assessment of hip fracture patients can also be used as a singly predictor of 30-day mortality makes them very useful tools. Especially, if we consider that for BI and KI we validate the inflection points from which the prognosis worsens markedly.

Abbreviations

ADL: Activities of daily living; BI:Barthel index; CI:Confidence interval; CGA:Comprehensive geriatric assessment; FAC:Functional Ambulation Classification; IADL:Instrumental activities of daily living; IP:Inflection point; KI:Katz index; LBI:Lawton-Brody index; OR:Odds ratio; PCRS:Physical Red Cross Scale; UHS:University Hospital of Salamanca.

Declarations

Ethics approval and consent to participate

All participants (or their relatives) have given their written informed consent to participate. The whole study was conducted following the Declaration of Helsinki and previously approved by the ethics committee for clinical research (CEIm) of the University Hospital of Salamanca.

Consent for publication

Not applicable.

Availability of data and materials

The data supporting this study are available from the corresponding author upon reasonable request.

Competing interest

The authors have no conflicts of interest to declare.

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Authors' Contributions

CdaC, CPH, and AGR collected patient data and contributed to the database fill-in process. CdaC performed data analysis and contributed to draft the work. JFB designed the study and was responsible for data interpretation. All authors approved the final version of the manuscript.

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Tables

Table 1. Biodemographic and fracture-related features of patients.

Biodemographic features		Fracture-related features	
Gender		Side of fracture	
Female	73.3%	Right	47.6%
Male	26.7%	Left	52.4%
Age (mean $\pm$ SD)		Type of fracture	
65-79 years-old	16.1%	Intracapsular	41.4%
80-89 years-old	51.3%	Basicervical	4.6%
> 90 years-old	32.6%	Trochanteric	44.0%
Residence		Subtrochanteric	6.0%
Town	51.6%	Periprosthetic	4.0%
Rural	48.4%	Surgical procedure	
Institution-living		Osteosynthesis	57.3%
At admission	32.0%	Hemiarthroplasty	40.3%
At discharge*	54.5%	Total hip arthroplasty	2.4%

Data showing absolute percentages on the study population (n=899), unless otherwise specified. * In-hospital exitus are excluded from the analysis (n=866).

	Survival (n=846)	30-day mortality (n=53)	p-value
Barthel Index	73.32±23.34	64.62±23.82	0.008
Grouped BI			0.014
Independent (100)	18.7%	11.3%	
Slight dependence (60-95)	57.3%	45.3%	
Moderate dependence (40-55)	15.2%	32.1%	
Severe dependence (20-35)	7.0%	7.5%	
Complete dependence (<20)	1.8%	3.8%	
BI Inflection Point (0-55)	24.0%	43.4%	0.002
Katz Index			0.033
A	32.7%	18.9%	
B	16.2%	13.2%	
C	18.7%	13.2%	
D	12.5%	17.0%	
E	7.0%	13.2%	
F	8.4%	18.9%	
G	4.5%	5.7%	
KI Inflection Point (A-B)	48.9%	32.1%	0.017

	Survival (n=846)	30-day mortality (n=53)	p-value
Lawton-Brody Index			0.546
0	20.1%	30.2%	
1	14.4%	18.9%	
2	18.9%	20.8%	
3	12.1%	7.5%	
4	5.9%	3.8%	
5	3.8%	3.8%	
6	4.1%	1.9%	
7	9.1%	3.8%	
8	11.6%	9.4%	
LBI Inflection Point (0-3)	65.5%	77.4%	0.076
Physical Red Cross Scale			0.141
Full ambulatory capability (0)	3.9%	1.9%	
Slight difficulty – no technical aids (1)	29.2%	18.9%	
One supporting point (2)	37.0%	34.0%	
Two supporting points (3)	26.2%	37.7%	
Wheel chair (4)	3.7%	7.5%	

Figures

Figure 1

Representation of the study population on each category (ring) of the Barthel Index, Katz Index, Lawton-Brody Index, and Physical Red Cross Scale. Dots are noting the early mortality rate on each category for the four geriatric scores.

Figure 2

Bar chart of the survival and early mortality population for Barthel Index (A), Katz Index (B), Lawton-Brody Index (C), and Physical Red Cross Scale (D).