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ORIGINAL ARTICLE

Perioperative adverse outcomes in elderly patients with hip fracture before and after the implementation of an orthogeriatric protocol

Desenlaces adversos perioperatorios en adultos mayores con fractura de cadera antes y después de la implementación de un protocolo de ortogeriatría

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Abstract

Introduction: Hip fracture in elderly patients is a major health concern, as it is associated with increased morbidity and mortality. For this reason, orthogeriatric protocols have been created to approach it, reporting favorable outcomes.
Objective: To evaluate perioperative adverse outcomes in elderly patients with hip fractures before and after the implementation of a comprehensive geriatric assessment (CGA) protocol.
Methodology: Case-control study performed on 136 patients (cases: 43; controls: 93) >65 years old with a hip fracture, who were treated at a referral hospital between 2020 and 2021 (cases) and 2015 and 2017 (controls). Differences between groups were determined through bivariate analysis using Fisher's chi-square or exact tests on categorical variables, and Student's t-test or Wilcoxon signed-rank test on continuous variables depending on the distribution of the data.
Results: Perioperative adverse outcomes occurred in 62.7% of cases and 84.0% of controls (p=0.007; OR:0.32; 95%CI:0.13-0.73). The median length of hospital stay was 10 and 17 days in cases and controls, respectively (IQR: 8-14; IQR 11-26), while the time between ED admission and surgery was 7 days (IQR:5-11) and 11 days (IQR:8-17), respectively (p=0.002).
Conclusions: The implementation of the CGA protocol reduced adverse outcomes associated with hip fracture, mainly length of hospital stay and time between admission and surgery, in which statistically significant differences were observed between both groups.
Keywords: Aged; Hip Fractures; Geriatric Assessment; Geriatrics (MeSH).

Resumen

Introducción: la fractura de cadera en adultos mayores constituye un problema de salud importante, ya que está asociada a mayor morbilidad y mortalidad. Por esta razón, se han creado protocolos de ortogeriatría para su abordaje, los cuales reportan resultados favorables.
Objetivo: evaluar los desenlaces adversos perioperatorios en adultos mayores con fractura de cadera antes y después de la implementación de un protocolo de evaluación geriátrica integral (EGI).
Metodología: estudio de casos y controles realizado en 136 pacientes (casos: 43; controles: 93) >65 años con fractura de cadera que fueron atendidos en un hospital de referencia entre 2020 y 2021 (casos), y 2015 y 2017 (controles). Se determinaron diferencias entre grupos mediante un análisis bivariado usando las pruebas de chi cuadrado o exacta de Fisher en variables categóricas, y las pruebas t de *student* o de Wilcoxon de los rangos con signo en variables continuas según la distribución de los datos.
Resultados: los desenlaces adversos perioperatorios ocurrieron en el 62,7% de los casos y el 84,0% de los controles (p=0,007; OR:0,32; IC95%:0,13-0,73). La mediana de duración de la estancia hospitalaria fue 10 y 17 días en los casos y controles, respectivamente (RIQ: 8-14; RIQ 11-26), mientras que el tiempo entre el ingreso a urgencias y la cirugía fue 7 días (RIQ:5-11) y 11 días (RIQ:8-17), respectivamente (p=0.002).
Conclusiones: la implementación de la EGI redujo los desenlaces adversos por fractura de cadera, principalmente la duración de la estancia hospitalaria y el tiempo entre el ingreso y la cirugía tuvieron diferencias estadísticamente significativas.
Palabras clave: Adulto mayor; Fractura de cadera; Evaluación geriátrica; Geriatría.

Introduction

Hip fracture is a major public health concern in the elderly population, as the prevalence of this type of fracture is expected to rise significantly due to the aging of the population and increased life expectancy.[1] Although epidemiological data vary among countries, it is estimated that these fractures affect about 18% of women and 6% of men worldwide.[2] Furthermore, estimates show that the number of hip fracture cases worldwide could reach 4.5 million by 2050.[1,3] It should also be kept in mind that hip fractures can reduce quality of life and significantly increase morbidity and mortality if they are not adequately treated.[1]

Hip fractures are important because they are linked to higher mortality, which is estimated to be 30% one year after the fracture, and morbidity, which includes functional dependency and mobility impairment and is influenced by socioeconomic factors.[4,5] Cognitive or neurological changes, cardiopulmonary disorders, venous thrombosis, infections, bleeding, electrolyte imbalances, and anemia are the most common medical complications of hip fracture surgery. Due to the relative frequency of these complications, it is crucial to identify them early since doing so can shorten hospital stay, improve patient functionality, and lower mortality in these patients.[6,7]

Regarding mortality, Sanz-Reig *et al.*,[8] in a study conducted between 2011 and 2014 in Spain, reported an in-hospital mortality rate of 11.4%. This figure is significantly higher than the data reported in previous studies conducted in similar populations, which describe mortality rates between 4.5% and 6.5% in fractures of the proximal femur.[9,10]

Due to the presence of comorbidities in these patients, as well as the high frequency of medical complications associated with hip fracture, each of these cases involves medical care by various specialties to ensure a comprehensive approach to the patient that will determine the factors that are related to higher mortality.[11] To this end, orthogeriatrics programs have been developed in many countries, as well as standardized protocols, to ensure a marked decrease in the medical outcomes associated with hip fracture in older adults. In this regard, it has been reported that older adults undergoing a comprehensive geriatric assessment (CGA) had better outcomes in terms of clinical frailty, functionality, and occurrence of complications, thus reducing the costs of care.[12]

Given the foregoing, the objective of this study is to evaluate perioperative adverse outcomes in elderly patients with hip fractures before and after the implementation of a CGA protocol.

Methodology

Study type and population

Case-control study conducted in patients over 65 years of age with hip fracture who consulted a tertiary care referral hospital in Bucaramanga, Colombia. The study included patients who, in the case group, took part in an CGA between June 2020 and June 2021, and in the control group, did not undergo a CGA but were treated at the hospital between January 2015 and December 2017. The ratio of controls to cases was 2:1, respectively. Patients with incomplete medical records, lack of data on more than 20% of the variables, suspicion of hip fracture of non-osteoporotic origin, and/or presence of hip fracture associated with polytrauma, or high-energy trauma were excluded.

Comprehensive geriatric assessment

Upon admission to the emergency department and having determined the presence of a hip fracture (intracapsular or intertrochanteric), the patient was evaluated by the orthopedics service to confirm and classify the fracture, and an assessment by the geriatrics service was requested. Within 24 and 48 hours, the patient underwent the CGA protocol, which included physical, functional, mental, and social aspects.

Preoperative physical status was assessed using the American Society of Anesthesiologists (ASA) classification. Functionality was measured before and after fracture using the Barthel Index and the Lawton Instrumental Activities of Daily Living Scale. In addition, the Mini Nutritional Assessment (MNA) and the blood albumin test were used for nutritional evaluation. The presence of sarcopenia and pre-existing clinical frailty were assessed using the SARC-F questionnaire and the FRAIL questionnaire and the Clinical Frailty Scale, respectively. A rapid cognitive screen and assessment of the presence of delirium were also performed using the Mini-Mental State Examination (MMSE) and/or Mini-Cog instruments, as well as the Confusion Assessment Method (CAM) tool. Complementary tests included evaluation of calcium metabolism using the colorimetric calcium assay, parathyroid hormone test, and 25-hydroxy vitamin D test.

Furthermore, the medical records of cases and controls were reviewed throughout the hospital stay in order to identify the occurrence of the following adverse outcomes:

- Anemia: defined as a hemoglobin or hematocrit level two standard deviations below the average levels for the patient's age and sex on admission, and follow-up blood count or transfusion requirement during hospitalization.
- Hydroelectrolytic disorder: defined as decreased sodium and potassium levels in admission and follow-up laboratory tests.
- Urinary tract infection: defined as the presence of urinary symptoms, signs of systemic inflammatory response syndrome, and detection of bacterial isolate in urine culture greater than 100 000 CFU/mL that required in-hospital antimicrobial treatment.
- Delirium: for cases, the need for assessment by the psychiatry service or the need for antipsychotics during hospitalization was analyzed in the medical record. For controls, the presence of delirium was defined based on the results of the administration of the CAM tool included in the CGA.
- Pneumonia: defined as the presence of respiratory symptoms, signs of systemic inflammatory response syndrome, and radiological findings suggestive of pulmonary involvement.
- Cellulitis: defined as acute inflammation in the subcutaneous tissue secondary to skin lesions.
- Deep vein thrombosis or pulmonary embolism: defined as the presence of pain in the lower limbs associated with changes in color, temperature and edema in the affected limb, as well as the presence of dyspnea and/or associated chest pain.
- Gastrointestinal bleeding: defined as the presence of hematemesis and/or rectal bleeding, and signs of low cardiac output.
- Acute myocardial infarction: defined as symptoms of myocardial ischemia associated with changes in electrocardiogram and cardiac enzyme levels.
- Decompensated heart failure: defined as acute onset of symptoms and signs of abnormal cardiac function.
- Pressure ulcers: defined as areas of skin injured by remaining in the same position for a prolonged period of time.
- Surgical reoperation requirement: defined as the need for a new surgical intervention during hospital stay.

- Shock: defined as a clinical condition in which the body's organs receive insufficient blood flow. It may be hypovolemic, cardiogenic, anaphylactic, neurogenic, or septic depending on its cause.

Statistical analysis

Data were entered into a database created in Microsoft Excel for subsequent analysis in Stata 12 statistical analysis software. Qualitative variables are described using absolute and relative frequencies, and quantitative variables are described with means and standard deviations or medians and interquartile ranges, depending on the distribution of the data (Shapiro-Wilk test).

Subsequently, quantitative variables were stratified taking into account biological plausibility criteria, and bivariate analyses were performed to determine differences between groups (cases and controls) using, depending on the distribution of the data, Chi-square or Fisher's exact tests for categorical variables and Student's t-tests or Wilcoxon signed-rank test for continuous variables. Moreover, to determine differences in the presence of perioperative adverse outcomes, odds ratios (OR) and their respective confidence intervals (CI) were calculated for statistically significant variables. A statistical significance level of $p<0.005$ was considered.

Ethical considerations

This research followed the ethical principles for the conduct of biomedical studies involving human subjects established in the Declaration of Helsinki[13] and the scientific, technical and administrative standards for health research set forth in Resolution 8430 of 1993 issued by the Colombian Ministry of Health.[14] In addition, the study was approved by the Research Ethics Committee of the Hospital Universitario de Santander through Minutes No. 3 of March 22, 2019.

Results

In total, 136 patients were included in the study, divided into 43 cases and 93 controls. The mean age of the participants was 79 years (±7.93 years) for the case group and 81 years (±8.46) for the control group. In both groups, hip fracture was more frequent in women (cases: 74.4%; controls: 62.3%) and the rural area was the most common place of origin (cases: 86.0%; controls: 84.9%). Regarding the type of fracture, the extracapsular type was more frequent in both the case group (65.1%, n=28) and the control group (68.8%, n=64). Table 1 shows the main characteristics of the patients included in the present study.

Table 1. Characteristics of the patients included in the study.

Variable	Cases (n=43)	Controls (n=93)	p-value
Sex			
Female	32 (74.4%)	58 (62.3%)	0.167
Age (in years)			
Mean	79	81	0.1526
Standard deviation	± 7.93	± 8.46	
Place of origin			0.792
Rural	6 (13.9%)	14 (15.0%)	
Urban	37 (86.0%)	79 (84.9%)	
Type of fracture			0.664

Table 1. Characteristics of the patients included in the study. (Continued)

Variable	Cases (n=43)	Controls (n=93)	p-value
Extracapsular	28 (65.1%)	64 (68.8%)	
Intracapsular	15 (34.8%)	29 (31.1%)	
Length of hospital stay (in days)			0.0002
Median	10	17	
Interquartile range	8 –14	11 – 26	
Time between emergency room admission and surgery (in days)			0.0002
Median	7	11	
Interquartile range	5 –11	8 –17	

Source: Own elaboration.

The most frequent comorbidity was high blood pressure (cases: 58.1%; controls: 64.5%) and the most commonly used treatments were antihypertensive drugs (cases: 48.8%; controls: 46%). Table 2 presents the comorbidities and medications reported in cases and controls.

Table 2. Comorbidities and medications in study participants.

Variable	Cases (n=43)	Controls (n=93)	p-value
Comorbidities and history of disease			
Diabetes mellitus	8 (18.6%)	17 (18.2%)	0.969
Chronic kidney disease	2 (4.6%)	15 (16.1%)	0.092
Acute myocardial infarction	3 (6.9%)	4 (4.3%)	0.681
Heart failure	2 (4.6%)	13 (13.9%)	0.142
Pulmonary disease	5 (11.6%)	20 (21.5%)	0.163
Solid tumor	4 (9.3%)	2 (2.1%)	0.077
Cerebrovascular disease	2 (4.6%)	6 (6.4%)	1.000
Dementia	8 (18.6%)	12 (12.9%)	0.426
Peripheral arterial disease	1 (2.3%)	2 (2.1%)	1.000
Peptic acid disease	1 (2.3%)	6 (6.4%)	0.427
High blood pressure	25 (58.1%)	60 (64.5%)	0.524
Atrial fibrillation	1 (2.3%)	5 (5.3%)	0.664
Osteoporosis	1 (2.3%)	16 (17.2%)	0.012
Hypothyroidism	9 (20.9%)	6 (6.4%)	0.011
Epilepsy	2 (4.6%)	1 (1.0%)	0.232
Smoking	9 (20.9%)	31 (33.3%)	0.004
Use of medications			
Antihypertensives	21 (48.8%)	44 (47.3%)	0.825
Diuretics	3 (6.9%)	0 (0.0%)	0.029
Anticoagulants	1 (2.3%)	2 (2.1%)	1.000
Insulin	3 (6.9%)	7 (7.5%)	1.000
Oral antidiabetic agents	5 (11.6%)	10 (10.7%)	1.000
Acetylsalicylic acid	4 (9.3%)	19 (20.4%)	0.142
Statins	4 (9.3%)	9 (9.6%)	1.000
Benzodiazepines	3 (6.9%)	1 (1.0%)	0.091
Anticonvulsants	3 (6.9%)	3 (3.2%)	0.378
Antipsychotics	3 (6.9%)	5 (5.3%)	0.706
Antidepressants	1 (2.3%)	4 (4.3%)	1.000
Systemic corticosteroids	2 (4.6%)	2 (2.1%)	0.590
Proton pump inhibitors	3 (6.9%)	3 (3.2%)	0.378

Source: Own elaboration.

The median length of hospital stay for cases and controls was 10 days (interquartile range [IQR]=8-14) and 17 days (IQR=11-26), respectively, and a statistically significant difference was found between the two groups (p=0.0002). On the other hand, the time between admission to the emergency department and surgery was shorter in the case group (median: 7 days; IQR=5-11) than in the control group (median: 11 days; IQR=8-17), and there was a statistically significant difference between these groups (p=0.0002).

Regarding preoperative physical status, 53.4% (n=23) of the patients in the case group and 44.0% (n=41) of the participants in the control group had an ASA 3 score. Moreover, severe functional dependency (Barthel index ≥35) was found before fracture in 23.6% (n=10) of the patients in the control group. It should be noted that the Barthel Index was only assessed in 14 patients of the case group, of whom 5.7% (n=5) had severe dependency prior to the fracture.

62.7% (n=27) of cases and 84.0% (n=79) of controls had perioperative adverse outcomes (p=0.007; OR: 0.32; 95%CI: 0.13-0.73). The most common conditions were anemia, urinary tract infection, delirium, and hydroelectrolytic disorders (Tables 3 and 4).

Table 3. Perioperative adverse outcomes presented by the patients included in the study.

Variable	Cases (n=43)	Controls (n=93)	p-value
Anemia	21 (48.8%)	62 (66.6%)	0.026
Pneumonia	2 (4.6%)	13 (13.9%)	0.142
Urinary tract infection	8 (18.6%)	35 (37.6%)	0.019
Operative site infection	1 (2.3%)	1 (1.0%)	0.540
Cellulitis	2 (4.6%)	3 (3.2%)	0.649
Deep vein thrombosis or pulmonary embolism	1 (2.3%)	1 (1.0%)	0.547
Gastrointestinal bleeding	0 (0%)	7 (7.5%)	0.096
Acute myocardial infarction	0 (0%)	4 (4.3%)	0.304
Pressure ulcers	3 (6.9%)	6 (6.4%)	1.000
Delirium	4 (9.3%)	23 (24.7%)	0.037
Hydroelectrolytic disorder	6 (13.9%)	49 (52.6%)	<0.001
Decompensated heart failure	1 (2.3%)	2 (2.1%)	1.000
Surgical reoperation	3 (6.9%)	5 (5.3%)	0.709
Shock of any kind	1 (2.3%)	9 (9.6%)	0.168
Mortality	3 (6.9%)	4 (4.3%)	0.679
Perioperative adverse outcomes	27 (62.7%)	79 (84.0%)	0.006

Source: Own elaboration.

Table 4. Analysis of the most common adverse perioperative outcomes.

Variable	OR	p-value	CI
Anemia	2.31	0.027	1.10 - 4.89
Urinary tract infection	2.78	0.022	1.15 - 6.69
Delirium	3.34	0.037	1.07 - 10.39
Hydroelectrolytic disorder	6.57	<0.001	2.53 - 17.07

Source: Own elaboration.

Finally, mortality was 6.98% in cases and 4.35% in controls, and there was no statistically significant difference between groups (p=0.679).

Discussion

This observational study found a lower incidence of perioperative adverse outcomes after the implementation of the CGA. This result is similar to those previously described in other studies and could be explained by the early identification of high-risk patients and their individualized care.[15] Furthermore, a multidisciplinary approach to hip fracture (geriatrics, orthopedics, anesthesiology, rehabilitation, nursing, and social work) helps to reduce the incidence of in-hospital complications.[16]

Another relevant result of the present study was the decrease in the length of hospital stay in the group of patients in whom the CGA was implemented (cases), which is similar to that described in other studies that have documented the benefit of the implementation of orthogeriatric care during the care of patients with hip fractures.[17,18] Shorter length of hospital stay and, therefore, decreased health care costs have also been reported in patients with non-traumatic illnesses who underwent CGA in acute geriatric care services.[19]

Likewise, in the present study, the time between admission to the emergency department and surgery was shorter in the case group compared to the control group (7 days versus 11 days), which is consistent with the findings of different studies where a shorter time between admission and surgery was associated with a geriatric intervention.[16,20] In this sense, the implementation of care by the orthogeriatrics service in the approach to hip fracture generates benefits in terms of reduced health care costs.[21,22]

Concerning mortality indicators, previous studies suggest that the implementation of the CGA results in a decrease in the mortality rate among patients with hip fracture.[17,23] However, in this study, no statistically significant association in mortality reduction was found, which may be explained by the high mortality of patients in the control group who did not receive surgery and were excluded from the study population, since in-hospital mortality associated with hip fracture in this referral hospital has previously been estimated at 17.69%.[24]

It should be noted that, at the time of completion of this study, there were few local studies evaluating the impact of CGA on the postoperative outcome of hip fracture in older adults. However, there are reports of the benefit of implementing this assessment in patients operated on for non-traumatic conditions[25] and in those with elective surgeries, since the CGA can be used as a tool to identify patients at high risk of mortality and decrease the length of hospital stay and the occurrence of adverse events.[26] It is also relevant to consider that the benefits of the implementation of orthogeriatric care in the treatment of hip fractures are also reflected in the reduction of other indicators such as the ability to perform activities of daily living, health care costs,[27-29] and the recovery of mobility,[30] which is why strengthening these services in health care institutions is considered very important.

The main strength of this study is the analysis and reporting of data from the local context that can be used to improve health care processes for older adults, strengthen multidisciplinary work in health institutions, and establish comprehensive health care services that benefit this population. However, our study has some limitations. On the one hand, since this is a retrospective study, information bias may occur; for this reason, the selection criteria for cases and controls were rigorously met. On the other hand, a longitudinal study was not performed to assess 1-year outcomes in terms of functionality or post-discharge mortality, nor were rehabilitation strategies included in the orthogeriatrics protocol. Nevertheless, these findings emphasize the importance of the creation of orthogeriatric units in referral hospitals, as this generates significant benefits during the care of hip fractures.

Conclusions

The findings of this study suggest that the implementation of the CGA protocol in the approach to hip fracture in older adults is beneficial for these patients, as it may reduce the incidence of perioperative adverse outcomes and indicators of care such as the time between admission to the emergency department and surgery.

Conflicts of interest

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References

1. Lu Y, Uppal HS. Hip Fractures: Relevant Anatomy, Classification, and Biomechanics of Fracture and Fixation. Geriatr Orthop Surg Rehabil. 2019;10: 2151459319859139. https://doi.org/jwt2.
2. Veronese N, Maggi S. Epidemiology and social costs of hip fracture. Injury. 2018;49(8):1458–60. https://doi.org/gd5cz5.
3. Negrete-Corona J, Alvarado-Soriano J, Reyes-Santiago LA. Fractura de cadera como factor de riesgo en la mortalidad en pacientes mayores de 65 años. Estudio de casos y controles. Acta Ortop. Mex. 2014;28(6):352–62.
4. Uribe Rios A, Castaño Herrera DA, García Ortega AN, Pardo Aluma EE. Morbilidad y mortalidad en pacientes mayores de 60 años con fractura de cadera en el Hospital Universitario San Vicente Fundación, de Medellín, Colombia. Iatreia. 2012;25(4):305–13.
5. Alarcon T, González-Montalvo JI. Fractura de cadera en el paciente mayor. Rev Esp Geriatr Gerontol. 2010;45(3):167–70. https://doi.org/ctc3dr.
6. Carpintero P, Caeiro JR, Carpintero R, Morales A, Silva S, Mesa M. Complications of hip fractures: A review. World J Orthop. 2014;5(4):402–11. https://doi.org/gmwd36.
7. Bessissow A, Chaudhry H, Bhandari M, Devereaux PJ. Accelerated versus standard care in hip fracture patients: does speed save lives? J Comp Eff Res. 2014;3(2):115–8. https://doi.org/jwt3.
8. Sanz-Reig J, Salvador Marín J, Pérez Alba JM, Ferrández Martínez J, Orozco Beltrán D, Martínez López JF. Risk factors for in-hospital mortality following hip fracture. Rev Esp Cir Ortop Traumatol. 2017;61(4):209–15.
9. Belmont Jr PJ, Garcia EJ, Romano D, Bader JO, Nelson K, Schoenfeld AJ. Risk factors for complications and in-hospital mortality following hip fractures: a study using the National Trauma Data Bank. Arch Orthop Trauma Surg. 2014;134:597–604. https://doi.org/jwt4.
10. Chatterton BD, Moores TS, Ahmad S, Cattell A, Roberts PJ. Cause of death and factors associated with early in-hospital mortality after hip fracture. Bone Joint J. 2013;97(18):246–51. https://doi.org/gndmtg.
11. Koso R, Sheets C, Richardson WJ, Galanos AN. Hip Fracture in the Elderly Patients: A Sentinel Event. Am J Hosp Palliat Care. 2018;35(4):612–9. https://doi.org/gk5gsc.
12. Friedman SM, Mendelson DA, Bingham KW, Kates SL. Impact of a Comanaged Geriatric Fracture Center on Short-term Hip Fracture Outcomes. Arch Intern Med. 2009;169(18):1712–7. https://doi.org/dpnt25.
13. World Medical Association (WMA). WMA Declaration of Helsinki – Ethical principles for medical research involving human subjects. Fortaleza: 64th WMA General Assembly; 2013.
14. Colombia. Ministerio de Salud. Resolución 8430 de 1993 (octubre 4): Por la cual se establecen las normas científicas, técnicas y administrativas para la investigación en salud. Bogotá D.C.; octubre 4 de 1993 [cited 2023 Feb 13]. Available from: https://bit.ly/31gu7do.

15. Vidán M, Serra JA, Moreno C, Riquelme G, Ortiz J. Efficacy of a comprehensive geriatric intervention in older patients hospitalized for hip fracture: a randomized, controlled trial. J Am Geriatr Soc. 2005;53(9):1476–82. https://doi.org/bhq4pb.
16. Wallace R, Angus LDG, Munnangi S, Shukry S, DiGiacomo JC, Ruotolo C. Improved outcomes following implementation of a multidisciplinary care pathway for elderly hip fractures. Aging Clin Exp Res. 2019;31(2):273–8. https://doi.org/ggcsrc.
17. Baroni M, Serra R, Boccardi V, Ercolani S, Zengarini E, Casucci P, et al. The orthogeriatric comanagement improves clinical outcomes of hip fracture in older adults. Osteoporos Int. 2019;30(4):907–16. https://doi.org/ggcsrt.
18. Kusen JQ, Schafroth B, Poblete B, van der Vet PCR, Link BC, Wijdicks FJG, *et al*. The implementation of a Geriatric Fracture Centre for hip fractures to reduce mortality and morbidity: an observational study. Arch Orthop Trauma Surg. 2019;139(12):1705–12. https://doi.org/gh34vr.
19. Soejono CH. The impact of "comprehensive geriatric assessment (CGA)" implementation on the effectiveness and cost (CEA) of healthcare in an acute geriatric ward. Acta Med Indones. 2008;40(1):3–10.
20. González-Montalvo JI, Alarcón T, Mauleón JL, Gil-Garay E, Gotor P, Martín-Vega A. The orthogeriatric unit for acute patients: A new model of care that improves efficiency in the management of patients with hip fracture. Hip Int. 2010;20(2):229–35. https://doi.org/jw95.
21. Viveros-García JC, Rodríguez-Sánchez B, Baldenebro-Lugo LS, Guillermo-Nuncio EA, Nieto-Sandoval HR, Vázquez-Cantero E. Costos por la demora quirúrgica en la fractura de cadera por fragilidad. Orthotips. 2021;17(4):195–201. https://doi.org/jw96.
22. Eamer G, Saravana-Bawan B, van der Westhuizen B, Chambers T, Ohinmaa A, Khadaroo RG. Economic evaluations of comprehensive geriatric assessment in surgical patients: a systematic review. J Surg Res. 2017;218:9–17. https://doi.org/gnwjhn.
23. Pajulammi HM, Pihlajamäki HK, Luukkaala TH, Jousmäki JJ, Jokipii PH, Nuotio MS. The Effect of an In-Hospital Comprehensive Geriatric Assessment on Short-Term Mortality During Orthogeriatric Hip Fracture Program—Which Patients Benefit the Most? Geriatr Orthop Surg Rehabil. 2017;8(4):183–91. https://doi.org/jw97.
24. Romero M, Cadena MO, Santamaria Y, Osma J, Márquez K, Parra N. Mortalidad intrahospitalaria en pacientes con fractura de cadera en el Hospital Universitario de Santander entre 2012 y 2017, en Bucaramanga, Colombia. Rev argent endocrinol metab. 2022;59(1):69–75.
25. Lee YH, Oh HK, Kim DW, Ihn MH, Kim JH, Son IT, et al. Use of a comprehensive geriatric assessment to predict short-term postoperative outcome in elderly patients with colorectal cancer. Ann Coloproctol. 2016;32(5):161–9. https://doi.org/f9jmxn.
26. Kim K il, Park KH, Koo KH, Han HS, Kim CH. Comprehensive geriatric assessment can predict postoperative morbidity and mortality in elderly patients undergoing elective surgery. Arch Gerontol Geriatr. 2013;56(3):507–12. https://doi.org/gjjwwj.
27. Lin SN, Su SF, Yeh WT. Meta-analysis: Effectiveness of Comprehensive Geriatric Care for Elderly Following Hip Fracture Surgery. West J Nurs Res. 2020;42(4):293–305. https://doi.org/jw98.
28. Middleton M, Wan B, da Assunçao R. Improving hip fracture outcomes with integrated orthogeriatric care: A comparison between two accepted orthogeriatric models. Age Ageing. 2017;46(3):465–70. https://doi.org/gm26dx.
29. Dakhil S, Thingstad P, Frihagen F, Johnsen LG, Lydersen S, Skovlund E, *et al*. Orthogeriatrics prevents functional decline in hip fracture patients: report from two randomized controlled trials. BMC Geriatr. 2021;21(1):1–8. https://doi.org/jw99.
30. Prestmo A, Hagen G, Sletvold O, Helbostad JL, Thingstad P, Taraldsen K, *et al*. Comprehensive geriatric care for patients with hip fractures: A prospective, randomised, controlled trial. Lancet. 2015;385(9978):1623–33. https://doi.org/f27mzb.