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Reducing complications and overall healthcare costs of hip fracture management: a retrospective study on the application of a Diagnostic Therapeutic Pathway in the Cosenza General Hospital

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Key words: Hip Fracture, DTP, Esiti
Parole chiave: Frattura femore, PDTA, Outcomes

Abstract

Background. *Diagnostic Therapeutic Pathways (DTPs) are multidisciplinary plans designed by each healthcare organization for a specific category of patients to reduce the variability of professional behaviors and to ensure greater safety and better overall healthcare outcomes. Hip fractures are a frequent traumatic injury, particularly in the elderly, and DTPs recommend early surgical intervention, often not done due to organizational challenges and bureaucracy. Medical conditions suggesting a delay are not frequent, however long waiting times not only increase the risk of complications and mortality, but also increase the number of diagnostic test and physician consultations. This study tried to understand the benefits of performing surgical intervention within 48 hours in terms of cost savings, reduction of complications and better overall outcomes. We performed statistical analyses on data gathered from 130 patients submitted to DTPs, and we evaluated the benefits obtained by operating within 48 hours in terms of resource saving (number of physician consultations, hospitalization days, etc.), reduction in complications reported in the literature.*

Methods. *About 40% of clinical records of femoral fractures from 2015 at the Cosenza General Hospital were used in our statistical analysis taking into account independent variables such as age, sex,surgery waiting times and ASA (e.g. American Society of Anesthesiologists) score. Additionally, dependent variables such as: the type of complications during the hospital stay (e.g. infections, delirium, etc), days of hospitalization, and number of physician consultations were considered.*

Results. *The average waiting time for surgical intervention was 5.48 days (132 hr). Patients with ASA score of 4 had a greater chance of complications (p-value 0.03), whereas patients operated within 48 hours avoided complications, and spent fewer days in the hospital. The ASA score value correlated positively with the number of physician consultation, as the ASA score increased in number, so did the number of physician consultations. Moreover, each additional day of waiting increased the possibility of physician consultation by approximately 13%.*

Conclusions. *The lack of available hospital beds and staff shortages are the main reasons for the delay in performing surgery, this situation does not allow an efficient treatment and timely release of patients from the healthcare system. Therefore, there is an important need to implement standardized orthopedic and geriatric pathways (DTPs), inspired by the collaboration between healthcare system management, orthopedic and geriatric specialists, and physical therapists, to drive shorter days of hospitalization and better overall patient health outcome by performing surgery as soon as possible.*

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Introduction

Diagnostic Therapeutic Pathways (DTPs) are multidisciplinary plans designed by each healthcare organization for a specific category of patients.The utilization of DTPs is tracked by means of performance, process and outcome indicators (1-4).

The main purpose of the DTPs is to improve the processes, identifying the inefficiencies and reduce variability in procedural outcomes, while ensuring multidisciplinary input and continuity of care to better respond to individual patient situations.

Guidelines related to a disease or clinical situation in a local healthcare organization can be applied to available resources, this also allows the company to formulate a practical treatment plan for the disease or clinical situation within a specific organization.

Clinical governance represents an opportunity to revise the practices of care and assistance by reviewing relationships between different healthcare professionals, to allow the strengthening / integration / coordination of their activities (5).

From the application of DTPs we can reasonably expect a significant decrease in variability of treatments by healthcare professionals, an increase in productivity and also an improvement of overall patient healthcare outcomes (e.g. reduction of complications).

The design of DTPs and its evaluation indicators are one of the tools used to quickly check the specification of treatment paths and possible deviations between the reference path and the actual. Improvements will need to be discussed and adopted during clinical audits to improve the quality of services provided by enforcing the best evidence-based practices.

One particular DTP is related to hip fracture: this traumatic event is very common in senior women, particularly those with severe osteoporosis and neurological diseases and senior males. This results in a higher socio-economic burden for society than that caused by cardiovascular disease and cancer in later life.

The international Guidelines agree that the optimal treatment of hip fractures is immediate surgery for the reduction of the fracture and prosthetic replacement, that enhances the probability of better patient recovery, through the return of full limb function after early physical therapy (e.g. mobilization, load and ambulation (6)).

Unfortunately,in many cases, the surgery was performed only several days after the patient's admission to hospital(average time to surgery 5.48 days).Seldom the delay was attributable to clinical reasons (7), and is more reasonably due to organizational challenges and bureaucracy.

Several studies have shown that long waiting times before intervention,often unjustified, corresponded to an increase in mortality (8) and complications (9) for patients, including facility related infections,loss of muscle mass, onset of delirium. In case of complications in the post-operative period, the 6-month mortality increaseds by about 30% for each additional day of delay and, if delirium appeared, the prognosis would be even further unfavorable (10). It is reported that clinical assessment of delirium must be recognized as a complication and not treated as an independent event (11).

Furthermore, another negative consequence is that prolonged hospitalization raises the number of diagnostic tests to which the patient will be exposed to. This testing is often performed for the simple purpose of "coroner defense", resulting in bad resource utilization and considerable increase in hospital stay (12).

Besides the aspects mentioned above, the outcome of a timely treatment of the patient, in purely rehabilitative terms,will prove to be significantly better than patients who undergo delayed surgery (13). In the light of this, it is recommended that patients with hip

fractures are operated on within 48 hours of hospital admission (14).

Epidemiological studies have identified a variety of factors that are able to influence outcomes in the short and long term: a patient's age, the functional status of the limb before the fracture, the cognitive status, and comorbidities (15, 16).

It is therefore essential to grant immediate attention to the patient, upon admission to the emergency room, providing pain control and avoiding pressure fractures, followed by the anesthesiological assessment and quick stabilization of the vital conditions, to prepare the patient for the intervention within the first 48 hours.

Hip fractures are observed to a large extent in the elderly, therefore geriatric interventions with multidimensional evaluations are needed to address individual patient's needs (17).

Unstable medical conditions increase the risk of potentially fatal complications in the postoperative period, in particular clinical and laboratory delays further increase the risk of these incidences (18) and are effectively "wasting time". In fact, an echocardiographic assessment was not needed in about 30% of case, and in half of the cases it did not alter the course of therapy (19). In cases of unstable of angina or recent heart attack an intensive medical treatment or eventual surgery may take place after hip surgery (20). In cases of emergency a patient would be sent directly to the operating room.

Hip fracture DTPs was used to assess what potential benefits on resource savings, reduction of complication rates and overall cost, could be achieved by operating on the patient within the first 48 hours of admission to the hospital.

Methods

A retrospective survey was conducted on 132 clinical records of patients who were admitted with hip fractures and were treated on, in the year 2015. Approximately 40% of these were used in our statistical analysis taking into account independent variables such as age, sex, surgery waiting times and *ASA score*. The ASA score is a classification, after anesthesia consultation that indicates diseases and therapies that may interfere with anesthesia and therefore influences anesthesia and/or surgical technique (21).

These independent variables were analyzed and correlated to other dependent variables such as the onset of complications during the hospital stay (e.g. infections, delirium, etc), days of hospitalization,and number of physician consultations.

The data processing and analysis was performed the public domain statistical software R-project (www.r-project.org-R version 3.2.5)

Results

The indicators, the relative standards and the values obtained relative to the timing of surgery and early patient mobilization are shown below in table 1.

Our analysis showed that only 32% of the patients underwent surgery within 48 hours, compared to an expected 70%. The average waiting time for surgery was 5.48 days (132 hr), whereas in 2014 the national average was 3 days (72 hr), with an average hospital stay of 11.27 days (22).

We identified three key parameters based on the available data:

1. The **occurrence of complications** (e.g. onset of delirium or infection) depends on the time between hospital admission and eventual operation, when factors such as age, sex and initial clinical conditions of the patient are considered. Therefore, this data allows to asses if a delay of the operation is a risk factor.

2. The **time between admission and the operation itself**, when factors such as

Table 1 - Indicators DTP hip fracture

Indicators	Parameter	Expected value	Obtained value	Source
1st indicator	Percentage of patients operated on during a 48 hour period (Performance Indicators)	≥70%	32%	Medical Records
2nd indicator	Average preparation time of patients who come to the Emergency Room (Performance Indicators)	≤ 36 Hours	34 Hours	Medical Records
3rd indicator	Average Patient waiting time: preparation until access to the operating room	≤ 12 Hours	2.5 Hours	Medical Records
4th indicator	Percentage of patients with hip fracture mobilized within the first 24 hours after surgery	≥ 85%	> 85%	Medical Records

age, sex and initial clinical conditions of the patient are considered. This includes the possible waste of resources (additional hospitalization days) generated by a physician referrals.

3. The **number of physician consultations** was primarily driven by the two previous key points of the occurrence of complications and the time between admission and the operations itself.

The dependent variable of this model is a binary (complications or no complications), the other two dependent variables of the other models are counting variables (0, 1, 2, 3, … days of hospitalization or number of physician consultations), this means that in the first model we must assume that the dependent variable is a binomial, in other cases the most suitable distribution is a Poisson distribution. The independent variables were the same for all three models, as follows:

1. Sex (dichotomous variable): was considered as a coefficient to indicate whether it contributes significantly to the dependent variable.

2. ASA score: is a non-parametric variable with 5 discrete values. Importantly, the authors have excluded the scores 1 and 5 for the following reasons:

Elderly patients with comorbidities, which are captured within an ASA score of 1, not did not occur within the analyzed data set. Also patients with an ASA score of 5, who by definition are the most serious were also excluded because, regardless of the interventional possibilities, they already had a higher complication rate and where outside the scope of this analysis. Therefore, the study was limited to patients with an ASA score of 2, 3, and 4.

A score of 2 was considered the reference group, consequently a score of 3 or 4 was used to explain a higher rate of complications, number of hospitalization days, and number of physician consultations relative to their occurrences' in patients with an ASA score of 2.

3. Age is a continuous variable, but there was no linear correlation between age and the three key parameters. Therefore it was inserted as a smooth variable into the model, hence age showed a non-linear correlation with respect to the various independent variables.

4. Delay in the operation is a continuous variable and was handled the same way as the variable age.

In both cases this allows the model to better reflect the variability of the data.

Table 2 - Coefficients regarding parametric variables related to complications

	Estimate	Standard error	z-value	p-value
Intercept	-2.64256	0.71418	-3.70015	0.00022
Sex	0.61431	0.57524	1.06791	0.28556
ASA 3	0.80098	0.61570	1.30092	0.19329
ASA 4	1.88664	0.91235	2.06788	0.03865

A p-value of above 0.1 was considered not statistically significant. The variable of in-hospital complications became only statistically significant when only the data from patients with an ASA score of 4 was (see Table 2).

Age showed no statistical significance and/or trends. The solid line was always within the confidence intervals (left graph in figure 1). Regarding the delay in the operation (right graph in figure 1) there was a positive impact only in the first few days (the initial data points were below zero followed by a linear increase up to about day 5.48, after which there was no relation observed).

The data in table 3 shows that there was no single variable (with a linear correlation) which is important to explain the number of hospital days as a key parameter effecting overall patient outcome.

It can be seen from figure 2 (left panel) that age did not show a correlation with respect to days of hip-operation wait

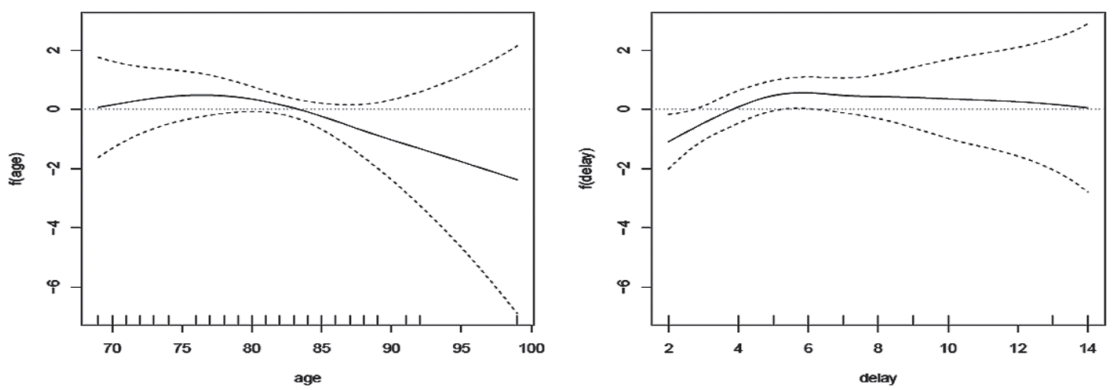

Fig. 1 - Age Report and delayed intervention in relation to complications

Table 3 - Coefficients regarding parametric variables related to hospital days

	Estimate	Standard Error	*z*	*p*
Intercept	1.61289	0.10168	15.86236	0.00000
Sex	0.01555	0.09251	0.16811	0.86650
ASA 3	0.10093	0.09023	1.11857	0.26332
ASA 4	0.17840	0.16804	1.06167	0.28839

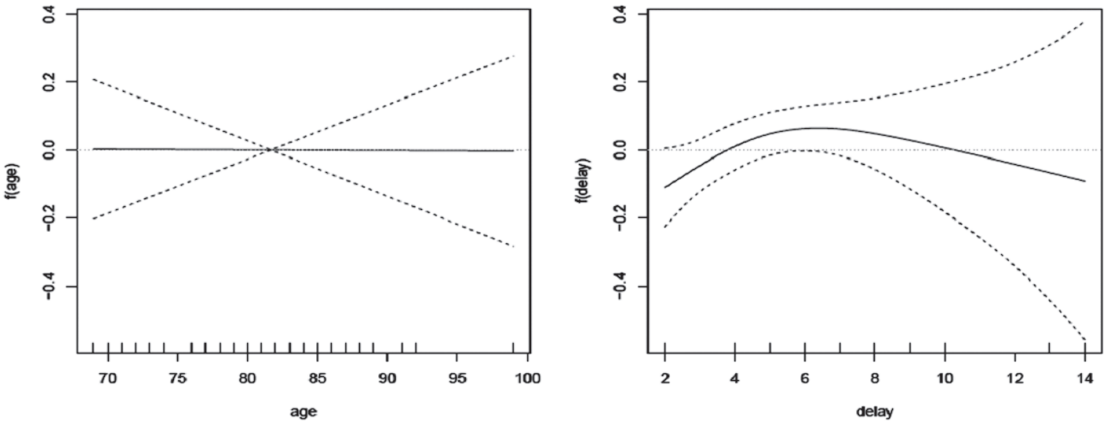

Fig. 2 - Age Report and delayed intervention in relation to the propensity to increase the days of hospitalization

times. Similarly, as in the previous model, only the initial days had a positive impact (the initial data points were below zero followed by a linear increase up to about day 5.48, after which there was no positive relation observed).

Table 4 shows that sex did not influence the statistical model (p-value 0.35461). ASA scores 3 and 4 on the other hand were statistically significant (p-value 0.00145 and 0.01320, respectively). In particular, the coefficients associated with an ASA score of 3 and 4 showed a positive correlation which means that the number of physician consultations had the propensity to increase by changing from an individual with ASA score of 2 to an individual with ASA scores of 3 or 4.

Again, age did not show any correlation. In regard to the delay of the operation we found a linear relationship that can be interpreted the following way: a correlation coefficient of 0.12 means[1] that each day of waiting added about 13% more likelihood of an additional physician consultation. This correlation was highly statistically significant (p-value 0.00034). Interestingly, within the first 5 days of the operation the number of consultations decreased, while in the 5 days after operation the number of consultation increased (Figure 3).

Conclusion

The lack of beds and the chronic shortage of medical staff are the main causes of surgery delays, moreover it should be

Table 4 - Coefficients regarding parametric variables related to the number of consultations

	Estimate	Standard Error	z-value	p-value
Intercept	-1.92395	0.53734	-3.58053	0.00034
Sex	-0.26318	0.28431	-0.92569	0.35461
ASA 3	1.65735	0.52046	3.18441	0.00145
ASA 4	1.57210	0.63431	2.47846	0.01320

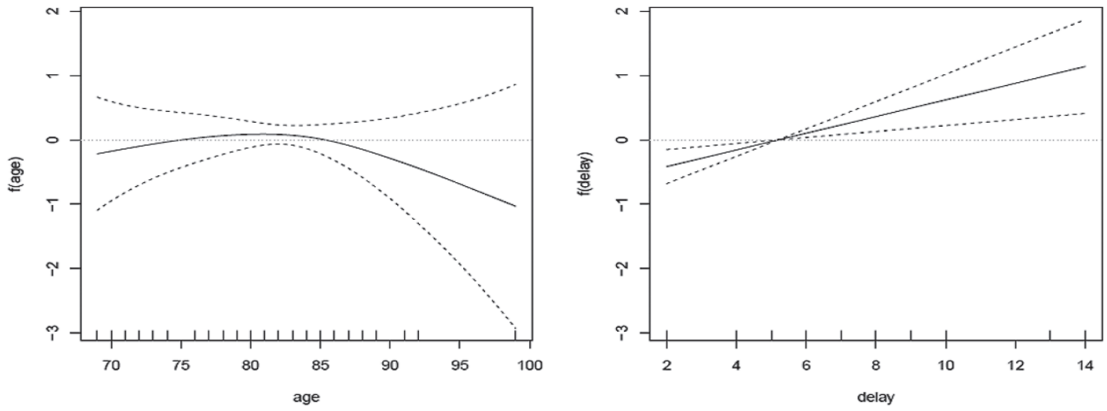

Fig. 3 - Age Report and delayed intervention in relation to the propensity of increased consultations

noted that many patients are first admitted to the emergency room, a department (or ward) that is already under resourced and overallocated.

Furthermore it is clear that the failure to apply the appropriate organizational paths leads to increases in days of hospitalization, additional uses of economic resources (increases in physician consulting and pharmaceutical spending) as well as surges of major complications with negative outcomes (morbidity and mortality).

Our analysis together with national and international experiences, stresses the need to identify an entity called "orthogeriatic patient", which takes into account the comorbidity and fragility of hip fracture patients.

Hence, here the need to identify an organizational and logistical appropriate pathway going forward. This orthogeriatric pathway which starts with hospital admission and covers the first 48-72hr of post-operation needs to be inspired by the collaboration between healthcare system management, orthopedic specialists, geriatric specialist and physical therapists, to drive shorter days of hospitalization and better overall patient health outcome by performing surgery as soon as possible.

This approach constitutes a true "cultural revolution" because it promotes a new concept of timely clinical management for the elderly as well as an approach clinical improvement determined by the fact that we observed that early surgery reduced hospitalization days and problems associated with it (infection syndrome assets, delirium, etc.,) while increasing chances of functional recovery. A patient who is followed and assisted by a multi-disciplinary and cross-functional team leads to a more cost-effective overall healthcare management while allowing for efficient resource utilization of all functions within the organization.

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Riassunto

Riduzione delle complicanze e razionalizzazione dei costi nella frattura di femore: uno studio retrospettivo sull'applicazione del PDTA della frattura di femore nell'Azienda Ospedaliera di Cosenza

Razionale. I percorsi diagnostico terapeutici assistenziali (PDTA) sono piani multidisciplinari relativi ad una specifica categoria di pazienti all'interno di un'azienda sanitaria atti a ridurre la variabilità dei comportamenti dei

professionisti e garantire maggiore sicurezza e migliori esiti. La frattura del femore è un evento traumatico molto frequente soprattutto negli anziani, e l'applicazione di un PDTA inerente a tale patologia prevede l'esecuzione di un precoce intervento chirurgico che spesso non avviene per cause imputabili all'organizzazione. I criteri di non operabilità sono minimi e lunghe attese determinano un aumento del rischio di mortalità e di complicazioni oltre ad accrescere il numero di esami diagnostici e consulenze. Pertanto in questo PDTA si è cercato di capire quali vantaggi si possano ottenere operando entro 48 ore in termini di risparmio di risorse, riduzione di complicanze e quindi migliori *outcomes*.

Metodi. È stato analizzato un campione di circa il 40% di cartelle cliniche di pazienti con frattura di femore ricoverati nell'anno 2015 nell'Azienda Ospedaliera di Cosenza ed è stata condotta un'analisi statistica che ha tenuto conto di alcune variabili indipendenti come il sesso, l'età, il tempo di attesa prima dell'operazione e *l'ASA score*. Tali variabili indipendenti sono state correlate ad altre variabili dipendenti come l'insorgenza di complicanze nel decorso ospedaliero (infezioni e delirium. ect), giornate di degenza e numero di consulenze a cui è stato sottoposto il paziente.

Risultati. La media dei giorni di attesa per l'effettuazione dell'intervento chirurgico è di 5,48. Avere un *ASA score* pari a 4 implica maggior possibilità di complicanze (p value: 0,03), essere operati nei primi giorni ne evita l'insorgenza così come riduce le giornate di degenza. Il valore dell'*ASA score* è in modo statisticamente significativo correlato al numero di consulenze: in particolare,queste ultime hanno la tendenza ad aumentare se si passa da un paziente con *ASA* uguale a 2 ad uno con *ASA* uguale a 3 (p value: 0,001) o uguale a 4 (p value: 0,01); inoltre, ogni giorno di attesa determina circa il 13% in più di propensione ad avere una consulenza, dato che si registra a partire dalla quinta giornata di degenza prima dell'operazione.

Conclusioni. Constatato che la mancanza di posti letto e la carenza di personale sono le principali cause che portano al ritardo nell'effettuazione dell'intervento chirurgico, sembra ormai ineludibile la necessità di implementare un percorso ortogeriatrico sia logistico che di spazi, ispirato alla ricerca di una gestione univoca che coinvolga le figure professionali dell'ortopedico, del geriatra e del fisiatra al fine di garantire al più presto l'intervento chirurgico.

References

1. Woolf S. Practice guidelines: a new reality in medicine. I. Recent developments. Arch Intern Med 1990; 1811-1818.doi:10.1001/archinte.1990.00390200025005.
2. Canadian Medical Association Care Maps and Continuous Quality Improvement. Ottawa: NRGH Library, 1995.
3. Pearson SD, Goulart-Fisher D, Lee TH. Critical pathways as a strategy for improving care: problems and potential. Ann Intern Med 1995; 123(12): 941-948.
4. Dwyer AJ, Becker G, Hawkins C, et al. Engaging medical staff in clinical governance: introducing new technologies and clinical practice into public hospitals. Aust Health Rev 2012; 36: 43-8. doi: 10.1071/AH10952.
5. Compagni A, Tediosi F, Tozzi V. L'integrazione tra ospedale e territorio nelle aziende sanitarie. Milano: Rapporto Oasi, Egea, 2010.
6. National Institute for Clinical Excellences. The management of hip fracture in adults. London (UK): NICE clinical guidelines CG124. London: National Institute for Health and Care Excellence, 2011. Available from: http://guidance.nice.org.uk/CG124 [Last accessed: 2017, Sept 8].
7. Donegan DJ, Gay AN, Baldwin K, et al. Use of medical comorbidities to predict complications after hip fracture surgery in the elderly. J Bone Joint Surg Am 2010; 92(4): 807-13. doi: 10.2106/JBJS.I.00571.
8. Sheehan KJ, Sobolev B, Chudyk A, et al. Patient and system factors of mortality after hip fracture: a scoping review. BMC Musculoskelet Disord 2016; 17(1): 166. doi: 10.1186/s12891-016-1018-7.
9. Vidán MT, Sánchez E, Gracia Y, et al. Causes and effects of surgical delay in patients with hip fracture: a cohort study. Ann Intern Med 2011; 155(4): 226-33. doi: 10.7326/0003-4819-155-4-201108160-00006.
10. Bellelli G, Mazzola P, Morandi A, et al. Duration of postoperative delirium is an independent predictor of 6-month mortality in older adults after hip fracture. J Am Geriatr Soc 2014; 62(7): 1335-40. doi: 10.1111/jgs.12885. Epub 2014 Jun 2.
11. Holly C, Rittenmeyer L, Weeks SM. Evidence-based clinical audit criteria for the prevention and management of delirium in the postoperative patient with a hip fracture. Orthop Nurs 2014; 33(1):27-34; quiz 35-6. doi: 10.1097/NOR.0000000000000020.
12. Hommel A, Ulander K, Bjorkelund KB, et al. Influence of optimised treatment of people with hip fracture on time to operation, length of hospital stay, reoperations and mortality within 1 year.

Injury 2008; 39(10): 1164-74. doi: 10.1016/j.injury.2008.01.048. Epub 2008 Jun 13.
13. Maggi S, Siviero P, Wetle T, et al. A multicenter survey on profile of care for hip fracture: predictors of mortality and disability. Osteoporos Int 2010; 21(2): 223-31. doi: 10.1007/s00198-009-0936-8. Epub 2009 May 5.
14. Moja L, Piatti A, Pecoraro V, et al. Timing matters in hip fracture surgery: patients operated within 48 hours have better outcomes. A meta-analysis and meta-regression of over 190,000 patients. PLoS One 2012; 7(10): e46175. doi: 10.1371/journal.pone.0046175. Epub 2012 Oct 3.
15. Hu F, Jiang C, Shen J, et al. Preoperative predictors for mortality following hip fracture surgery: a systematic review and meta-analysis. Injury 2012; 43(6): 676-85. doi: 10.1016/j.injury.2011.05.017. Epub 2011 Jun 17.
16. Smith T, Pelpola K, Ball M et al. Pre-operative indicators for mortality following hip fracture surgery: a systematic review and meta-analysis. Age Ageing 2014; 43(4): 464-71. doi: 10.1093/ageing/afu065. Epub 2014 Jun 3.
17. Watne LO, Torbergsen AC, Conroy S, et al. The effect of a pre- and postoperative orthogeriatric service on cognitive function in patients with hip fracture: randomized controlled trial (Oslo Orthogeriatric Trial). Oslo: BMC Med 2014; 12: 63. doi: 10.1186/1741-7015-12-63.
18. McLaughlin MA, Orosz GM, Magaziner J, et al. Preoperative status and risk of complications in patients with hip fracture. J Gen Intern Med 2006; 21(3): 219-25. Epub 2005 Dec 22. doi:10.1111/j1525-1497.2006.00318.x.
19. Ricci WM, Della Rocca GJ, Combs C, Borrelli J. The medical and economic impact of preoperative cardiac testing in elderly patients with hip fractures. Injury 2007; 38(Suppl3): S49-52. http://dx.doi.org/10.1016/j.injury.2007.08.011.
20. Lee A. Fleisher, Joshua A, et al. ACC/AHA 2007 Guidelines on Perioperative Cardiovascular Evaluation and Care for Noncardiac Surgery. Circulation 2007; 50(17): e159-241.
21. American Society of Anesthesiologists, 2014. Available from: https://www.asahq.org/resources/clinical-information/asa-physical-status-classification-system [Last accessed: 2017, Sept 8].
22. Agenas, 2014. Available from: http://95.110.213.190/PNEed15/risultati/tipo3/intr_struasl3.php?ind=40&tipo=3&area=5 [Last accessed: 2017, Sept 8].

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