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REVIEW ARTICLE

Which is the optimal orthogeriatric care model to prevent mortality of elderly subjects post hip fractures? A systematic review and meta-analysis based on current clinical practice

J. Moyet[1] · G. Deschasse[1] · B. Marquant[1] · P. Mertl[2] · Frédéric Bloch[1,3]

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Abstract

Background While there is a general consensus of the impact of an orthogeriatric organisation in terms of elderly patient mortality post hip fracture, it is unclear which, among these various care models, is the most optimal.

Methods A systematic review of the literature was undertaken using the keywords "Femoral fractures or total hip replacements or Accidental, falls" and "Aged, 80 and over" and "Mortality". The review is presented following PRISMA guidance.

Results Eighteen studies were identified, published between 1988 and 2015. The number of elderly subjects participating in these studies was between 37 and 951; their mean age was 82.6 ± 7.4 years, and average mortality in these studies was 17.7%.

The odds ratio (OR) and 95% CI for association between implementation of the orthogeriatric model and mortality in all patients studied were 0.85 (0.74–0.97). In the analysis by subgroup on the type of orthogeriatric model, the group "Orthogeriatric ward" gave homogenous results, with ORs and 95% CIs of 0.62 (0.48–0.80) unlike other models: "Shared care by orthopaedists and geriatricians "and "Geriatric advice in orthopaedic ward".

Conclusions Elderly patients with hip fracture admitted early into any sort of orthogeriatric models or more specifically to a dedicated orthogeriatric ward had reduced long-term mortality. This study has to be completed by RCT showing the efficacy of orthogeriatric ward compared to other models using outcomes such as quality of life or functional recovery.

Keywords Orthogeriatric care model · Systematic review · Mortality · Meta-analysis

Introduction

Hip fracture is a frequent consequence of falls in the elderly. It increases annually and may reach exponentially to 6.3 million cases in the world by 2050 according to some projections [1]. It is an important cause of mortality and functional dependence but may also significantly impair quality of life [2].

As almost all patients presenting with hip fracture are older than 65 years and average age at the time of the fracture is 80 years, surgery is becoming a medical challenge for the anaesthetist. Indeed, older adults are typically high-risk candidates for surgery mainly due to the frequent and numerous comorbidities encountered. A large proportion also presents with pre-existing functional deficits that may limit recovery after surgery [3].

Despite advances in surgical techniques and anaesthesia, the mortality rate remains between 15 and 30% in the year following the fracture, and the rate of functional recovery of fractures remains below 70% [4].

Various care models have been proposed over the years in order to reduce in-patient and long-term mortalities, hospital complications, and length of stay and improve functional prognosis after hip fracture. The randomised trial of Gilchrist et al. [5], evaluating the effectiveness of a geriatric consultation within an orthopaedic department, was the first to show a positive effect of what can be termed an orthogeriatric care model.

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✉ Frédéric Bloch
bloch.frederic@chu–amiens.fr

[1] Department of Geriatric medicine, University Hospital of Amiens-Picardie, Amiens, France

[2] Department of Orthopaedic Surgery, University Hospital of Amiens-Picardie, Amiens, France

[3] Department of Gerontology, University Hospital Amiens-Picardie - Hôpital Nord, Place Victor Pauchet, 80054 Amiens Cedex 1, France

This term refers to the different possible interventions: the care can take place within an orthopaedic ward with the geriatrician being either an integral part of the orthopaedic team with team involvement and shared responsibility or a consultant. Alternatively, care may take place within a geriatric ward with the orthopaedic surgeon acting as a consultant. While these interventions appear to be an improvement over standard care, it is still unclear which care model may work best.

The objectives of this current study therefore were to carry out a systematic review of the literature and perform a meta-analysis in order to evaluate the impact of orthogeriatric organisations in terms of mortality in elderly patients following hip fracture and to carry out a stratified analysis of each care model with the aim of identifying the most effective orthogeriatric model in terms of mortality reduction.

Material and methods

Search strategy and selection of articles

The systematic review was conducted according to PRISMA guidelines [6]. A PICOS research question was developed to define the literature search. The research question for the literature review was, for femoral fractures in the elderly population (Population), what is the effect of various orthogeriatric interventions (Intervention) compared to classic intervention (Comparison), on mortality (Outcome). A computerised comprehensive literature search was conducted using three databases Embase, PubMed, and the Cochrane Library to collect original peer-reviewed articles.

We performed an advanced search using the Boolean operators "AND" and "OR". The research equation with the MeSH terms was as follows: "Femoral fractures or total hip replacements or Accidental, falls" and "Aged, 80 and over or frail elderly or geriatric or health services for the aged or geriatric assessment or process assessment or delivery of health care" and "Mortality". No publication date limit was set. The search was confined to published literature in the English or French language. A manual search for the articles cited within the previously identified publications completed the compilation.

Articles were selected if (i) they concerned hip fracture of patients over the age of 60 years, (ii) they are within a unit that could meet the criteria for an orthogeriatric care model and (iii) if one of the objectives of the study was to measure mortality. Studies in other languages than English or French, letters to the editor, commentaries, editorials and meta-analyses were not selected.

Data extraction and quality assessment

Two readers (JM and GD) independently selected all the abstracts of articles derived from the search. Discrepancies were resolved by consensus with a third party if necessary (FB). The kappa coefficient between the two readers was 0.86.

Included studies were assessed for quality using a validated scale derived from the recommendations of Cook et al. [7]. This scale gave a level of proof in terms of methodology, study power, quality of randomisation if appropriate, population and loss of follow-up, quality of data collection, and other biases according to the situation. The study was stated level 1 proof, synonym of good quality, if all principles were fully respected with satisfactory achievement, level 2 and 3 if principles were partially respected or insufficiently described and level 4 which was of insufficient quality if at least one principle was unapplied or with inappropriate realisation.

The extracted data from each study included the study characteristics (type, size, comparison), outcome measures (in-patient hospital care, 3-month, 6-month and 1-year mortality) and definition of the orthogeriatric care models. Three of them were identified: (a) a geriatric consultation taking place within the orthopaedic ward in which the geriatrician is a consultant, (b) an orthogeriatric ward in which orthopaedic surgeons were acting as consultants and (c) shared care where both the orthopaedic surgeon and the geriatrician share responsibility for patient care.

For qualitative variables, the following frequencies were collected: mortality with orthogeriatric intervention and with the usual care model, and total number of patients treated with the orthogeriatric intervention and with the usual care model.

Subgroup analyses were conducted for the outcome, separating long-term (from 6 months to 1 year) and short-term mortality (in-hospital and upon 3-month mortality) according to the orthogeriatric care models and according to the quality of included studies (levels 1 and 2 versus level 3).

Statistical analysis

A meta-analysis was performed. The odds ratio (OR) and confidence interval of 95% were estimated for each study and globally to assess the mortality associated with each intervention. The fixed-effects method of Mantel-Haenszel [8] was used. Heterogeneity between studies was assessed using the I^2 statistic [9]. A value of I^2 less than 25% indicates that heterogeneity was low, between 25 and 50% that heterogeneity was moderate and greater than 50% that heterogeneity was high. Regardless of the statistical significance of the Q test [10], we applied a random effects model which allows meta-analysis to take between-study variation into consideration. Stratified analysis on characteristics or analyses of sensitivity based on the methodological quality of studies were conducted. We also used Begg's funnel plots [11] and Egger's test [12] to detect possible publication bias. All statistical tests were conducted with the Review Manager (RevMan) software suite (Version 5.0. Copenhagen: The Nordic Cochrane Centre, The

Cochrane Collaboration, 2008). Statistical significance was defined as $p < 0.05$.

Results

Trial flow

Figure 1 shows the flow chart of our study. The computerised search strategy carried out on August 31, 2016, identified 4537 articles published from 1964 to 2016 to which were added 15 references from the manual search. We excluded 3252 articles, retaining only 110 articles. After verifying the data and removing duplicates, 18 studies presenting statistics on mortality of elderly subjects post hip fracture according to an orthogeriatric care model compared to standard care were included [3, 5, 13–28].

Characteristics of the included studies

The 18 articles were published between 1988 and 2015. The number of elderly subjects participating in these studies was between 37 and 951, and the number of deceased patients was between three and 259; this represents mortality ranging from less than 3% to more than 40% (i.e. an average mortality of 17.7% in these studies). The mean age of the included patients was 82.6 ± 7.4 years (75 to 86 years). Ten studies had in-hospital mortality as one of their outcomes, three studies had one to three months mortality, two studies had six month mortality and seven studies had one year mortality.

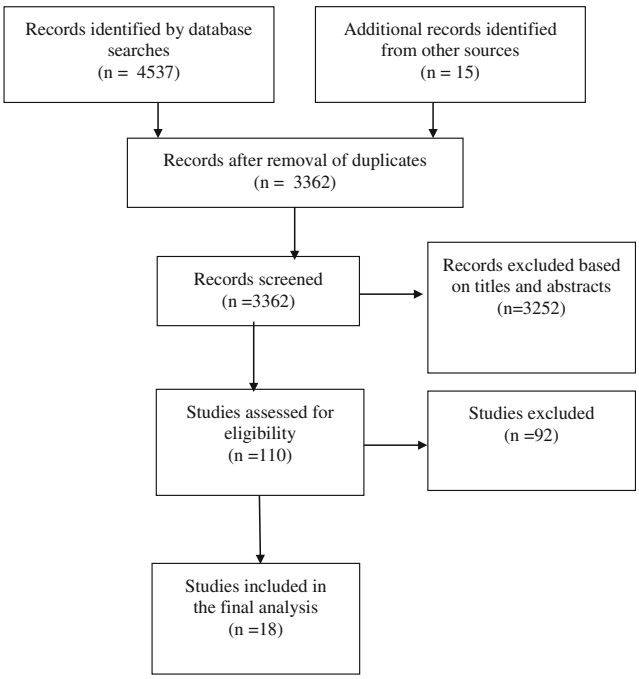

Fig. 1 Flow chart showing systematic search and selection process

The care model described was shared care by orthopaedists and geriatricians in five studies [13, 14, 18, 19, 25] and geriatric advice within an orthopaedic ward in six studies [16, 17, 21, 23, 24, 26] and within an orthogeriatric ward in seven studies [3, 5, 15, 20, 22, 27, 28].

Study quality

From the methodological characteristics selected, four studies selected were RCT of high power [5, 23, 26, 27]; six studies were case-control studies in which three were retrospective [13, 18, 28] and three prospective studies [3, 16, 21]. Eight studies had adopted a controlled before-and-after design where observations are made before and after the implementation of an intervention, either prospectively (three studies [14, 24, 25]) or retrospectively (three studies [15, 19, 22]) or both, i.e. data collection was made retrospectively for the phase before and prospective after the implementation of the orthogeriatric model (two studies [17, 20]). None of the studies were cross-sectional.

One study was ranked as level 1 of evidence [27] and six studies were ranked as level 2—either case-control studies with low risk of bias for all key domains or controlled trial with unclear condition of randomisation [3, 5, 18, 23, 26, 28]. Eleven studies were ranked level 3, either because of their controlled before-and-after design or because of unclear selection bias [13–17, 19–22, 24, 25].

The "funnel plots" of each meta-analysis representing the estimated values of the OR according to the size of the population were distributed symmetrically showing that the publication bias was low (shown as Supplementary Material).

Meta-analysis results

The odds ratio (OR) and 95% CI for association between implementation of the orthogeriatric model and mortality in all patients studied were 0.85 (0.74–0.97). This result was statistically moderately homogeneous, with $I^2 = 48\%$.

Subgroup analyses were conducted for the outcome, separating long-term and short-term mortality and according to the orthogeriatric care models, and are presented in Table 1. In the group of studies where short-term mortality was used as an outcome, ORs and 95% CIs were 0.94 (0.75–1.18) versus 0.79 (0.68–0.93) in studies where long-term mortality was used as outcome.

In the analysis by subgroup on the type of orthogeriatric models, the group "Orthogeriatric ward" had homogenous results, with ORs and 95% CIs of 0.62 (0.48–0.80), whereas ORs and 95% CIs were respectively for the groups "Shared care by orthopaedists and geriatricians" and "Geriatric advice in orthopaedic ward" of 1.00 (0.81–1.23) and 0.87 (0.67–1.12). The meta-analysis for association between implementation of the orthogeriatric model

Table 1 Pooled odds ratios (OR) and subgroup sensitivity Analysis for mortality post hip fracture

Study characteristic	Number	Mortality post hip fracture OR (95% CI)
No. of studies		18
No. of subjects		7285
Population	18	0.85 [0.74–0.77][b]
Evaluation criteria:		
Long-term mortality	10	0.79 [0.68–0.93]
Short-term mortality	13	0.94 [0.75–1.18][b]
Type of care model:		
Orthogeriatric ward	7	0.62 [0.48–0.80][a]
Geriatric advice in orthopaedic ward	6	0.87 [0.67–1.12][a]
Shared care by orthopaedists and geriatricians	5	1.00 [0.81–1.23]

CI confidence interval

[a] Good homogeneity with $I^2 < 25\%$

[b] Moderate homogeneity with $25 \leq I^2 < 50\%$

and mortality with subgroup analysis according to the orthogeriatric care models is presented in Fig. 2.

We conducted an analysis by subgroup according to the level of quality of the studies showing no change in the direction of the intervention: 0.73 (0.60, 0.90) and 0.93 (0.78, 1.12) respectively for the group of studies ranked level 1 or 2 and the one ranked level 3.

Discussion

The results of our meta-analyses show the benefit in terms of mortality reduction in orthogeriatric models versus standard care, whatever the type of intervention.

Indeed, this mode of intervention, whatever the organisation between geriatricians and orthopaedists which remains heterogeneous, integrates a number of key elements that form a common base and contribute to the success of care. For the geriatrician, it includes paying attention for instance to the prevention and management of delirium, screening and treatment of malnutrition, analysis of drug therapy or pain management. It also integrates an appropriate anaesthesia protocol, shortened delay for surgical procedures and a short rehabilitation circuit [29].

It confirms the recent meta-analysis of Grigoryan et al. who found a very similar OR ratio showing impact of these care systems in terms of intra-hospital mortality on a frail elderly population [30].

Our data also confirms additionally the beneficial effect of this orthogeriatric model compared to the standard system on reducing long-term mortality that remains significant contrary to short-term mortality for which the beneficial effect is less visible. But our study, unlike this previous one by Grigoryan et al. [30], has the advantage of having included a sufficient number of studies on the three models identified to carry out analyses on subgroups.

This is, thus, the first time that a study has revealed which of the models is the one that gives the clearest results. Indeed, the OR significantly favours the orthogeriatric ward within the three models. It confirms the assumptions of Pepersack who argued that the best system in terms of intra-hospital morbidity and mortality would be orthogeriatric ward where frail subjects admitted for hip fracture can benefit from a comprehensive multidisciplinary management [31]. The interest of orthogeriatric ward, in fact, is the pooling of medical and paramedical skills in the same place for the benefit of the patient, in order to be more effective in preventing the occurrence of post-operative complications (pressure sores, pain, acute urine retention) and in taking charge of the main geriatric syndromes (cognitive disorders, malnutrition, posture and gait troubles), as well as in taking care of problems related to hip surgery (pain, scar care and bandages, transfusion, etc.). This period also allows an etiological investigation of the fall that resulted in the fracture and the earliest return to normal posture and walking [3].

The study of care models makes it less easy to use RCT, explaining the variety of methodologies used with varying degrees of quality. In order to increase the sample size of our meta-analyses, we needed to include primary studies with levels 1, 2 and 3 of evidence in the present review and not to restrain it only to RCT. Of course, biases may be present in our meta-analysis, partly caused by biased results in the trials included. Another limitation may be related to publication bias because, as in any systematic review, our work can only deal with data published in the literature.

However, our method using a comprehensive approach to assess any potential bias may guarantee their reduction to the point where the reliability of our results could have been affected, leading to flawed conclusions.

Almost 30 years separate the first and last studies included in our review. The organisation between geriatricians and orthopaedists remains also very heterogeneous as the age limit to define an elderly subject (over the age of 60 years to over the age of 75 years in the studies retained in our review). This partly explains the more or less important heterogeneity that we obtained. We thus tried to reduce the risk of heterogeneity by performing meta-analyses on individual data i.e. mortality was estimated based on baseline databases for each study, calculated from the results published in each article.

It may therefore be assumed that our results provide encouraging evidence for evaluation of care models and raise several issues which should be considered when making decisions about the best model for collaboration between geriatricians and orthopaedists. Finally, this study can be considered as a foundation for future work.

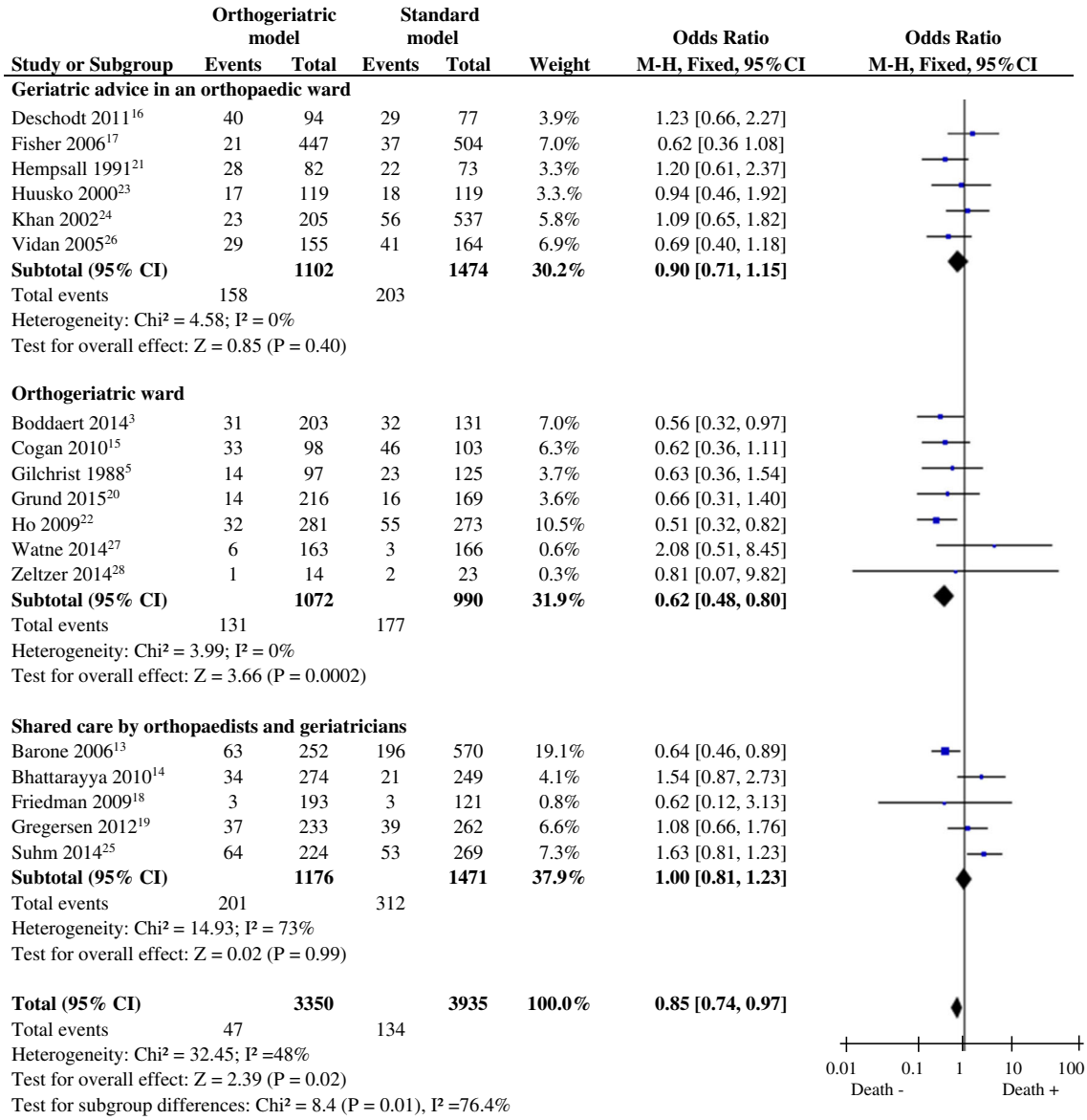

Fig. 2 Meta-analysis for association between implementation of the orthogeriatric model and mortality with subgroup analysis according to orthogeriatric care model

It should be recognised that meta-analyses often correspond to an accumulation of data which can frequently lead to a significance that does not solve the problem of the clinical relevance, and should be accompanied, wherever possible, by additional clinical studies of the significant factors obtained. Rather than viewing meta-analyses in opposition to prospective studies, these two approaches should be viewed as complementary. This is why additional research will be required to further elaborate our thinking within this field. We need to confirm by prospective studies comparing different models that the orthogeriatric ward is the best way to coordinate a multidisciplinary intervention with an orthopaedist and a geriatrician in order to reduce mortality, keeping in mind that many other different factors may affect the mortality rate, such as delay from injury to surgery and initial frailty or vulnerability of subjects.

Nevertheless, the fundamental purpose in hip fracture repair is not just to avoid death but also to effectively restore preoperative functional and motor states.

Using mortality as a primary endpoint in studies comparing orthogeriatric care models with each other or with standard care is therefore too simplistic. Unfortunately, orthogeriatric collaboration to prevent and treat medical problems and to optimise rehabilitation and recovery of function is not, at present, measured with sufficient standardisation to come to reliable conclusions. Randomised controlled trials (RCT) using a more uniform approach with standardised orthogeriatric protocols should, in the future, therefore look at other outcomes in order to evaluate the efficacy of the orthogeriatric ward compared to other models or traditional care in terms of

quality of life, long- and short-term functional recovery, reduced risk of institutionalisation, prevention of delirium and loss of autonomy.

The organisation of the care model as an orthogeriatric ward will only be able to prove its daily efficiency and ability to incorporate many advantages for both the older patients with hip fracture and the hospital organisation, if it demonstrates itself to be a practical alternative well adapted to the local needs.

In conclusion, we observed, with a moderate quality of evidence of studies, that elderly patients with hip fracture admitted early into any sort of orthogeriatric care model or more specifically to a dedicated orthogeriatric ward had reduced long-term mortality.

Compliance with ethical standards

Competing interests Pr. Bloch and Drs. Deschasse, Marquant and Moyet declare no conflict of interest. Pr. Mertl reports personal fees from Stryker, personal fees from De Puy, personal fees from Zimmer, personal fees from X-Nov and personal fees from Adler, outside the submitted work.

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