Effect of early surgery after hip fracture on mortality and complications: systematic review and meta-analysis
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CRD summary
This well-conducted review found that early surgery after hip fracture was associated with lower mortality and lower rates of postoperative pneumonia and pressure sores for elderly patients, suggesting benefits in reducing surgical delays. A significant effect remained after taking account of patients' preoperative medical status. The limited quality of the included studies should be considered.

Authors' objectives
To assess the effect of early surgery on the risk of death and common postoperative complications in elderly patients (60 years or older) with a hip fracture.

Searching
MEDLINE and EMBASE were searched, with the help of a professional librarian, for studies included up to February, 2008. The complete search strategy was given in an online appendix and no language restrictions were applied. A range of relevant conference proceedings, which were listed, was handsearched; experts were consulted for additional studies; reference lists of eligible studies were searched; and the “related study” feature in PubMed was used for eligible studies.

Study selection
Studies were eligible if they were primary, had a prospective design, included patients of 60 years or older who were undergoing surgery for a low-energy hip fracture, and evaluated preoperative surgical delay and all-cause mortality.

The cut-off time for operative delay was 24 hours in nine studies, 48 hours in five studies, 72 hours in one study, and five days in another. Most studies recorded the preoperative interval from admission to surgery, while five studies recorded it from injury to surgery. Half of the studies recorded the reasons for surgical delay, the most common of which were the unavailability of an operating room, surgical personnel, or both, and the investigation and stabilisation of the patient's preoperative medical condition. Where reported, the mean age of patients was between 76 and 84 years.

One reviewer screened the titles and abstracts identified in the electronic searches; relevant studies and those identified through the supplementary searches were then independently evaluated by two reviewers to determine the final inclusion. Disagreements were resolved by consensus.

Assessment of study quality
Three reviewers (two method experts and a content expert) independently evaluated the study quality, using an adapted version of the Newcastle-Ottawa scale for cohort studies (assessing the selection, applicability and comparability of study groups, biases in ascertainment of exposure and outcomes, and adequacy of follow-up). The maximum score was eight and the minimum was zero; seven or more was defined as high quality, five or six was moderate quality, and four or less was low quality. Discrepancies in evaluations were resolved by discussion and consensus.

Data extraction
Where frequency data were available for all-cause mortality, these were converted to relative risks (RR) and 95% confidence intervals (CIs) as assessed in hospital, at 30 days, three-to-six months, and one year of follow-up. In the absence of frequency data, the reported relative risk, odds ratio (OR), or hazard ratio (HR) was recorded.

Two reviewers independently extracted the data and where there were missing or unclear data, attempts were made to contact the authors.
Methods of synthesis
Outcome measures were pooled using a DerSimonian and Laird random-effects model. These pooled estimates were weighted by study size. The primary meta-analysis included studies that adjusted their mortality results for potentially confounding variables, such as patient age (all studies) and type or severity of illness, at each follow-up. Secondary meta-analyses were conducted for the unadjusted estimates of mortality and postoperative complications. Any reported odds ratios and hazard ratios were converted to relative risks, using the method described by Zhang and Yu.

Heterogeneity was assessed using the $I^2$ statistic. To explore heterogeneity, subgroup analyses were carried out for the reasons for surgical delay, the cut-off time used to define a delay, the length of follow-up, the year of publication, and the study quality. Publication bias was assessed using funnel plots.

Results of the review
Sixteen studies were included, with 14,171 patients (range 65 to 3,628). Four studies were judged to be of high quality, five of moderate quality, and seven of low quality.

Early surgery was associated with a 19% reduction in all-cause mortality, irrespective of the time of outcome assessment (adjusted estimates; five studies; RR 0.81, 95% CI 0.68 to 0.96; $I^2=0\%$).

When using unadjusted mortality estimates, early surgery significantly reduced the one-year mortality by 45% (RR 0.55, 95% CI 0.40 to 0.75; six studies; $I^2=71\%$). The heterogeneity could not be explained by the reason for surgical delay, the cut-off for delay, the study quality, the year of publication, nor the length of follow-up. There was no evidence of publication bias. The heterogeneity in analyses of mortality at 30 days (six studies) and at three-to-six months (four studies) was not significantly affected by the time to surgery, but the removal of one study of only medically ill patients removed most of the heterogeneity and resulted in a significant benefit at three-to-six months with early surgery (RR 0.66, 95% CI 0.50 to 0.88; $I^2=7\%$).

Four studies reported postoperative complications (unadjusted). The data from two studies suggested a 41% reduction in risk of pneumonia with early surgery (RR 0.59, 95% CI 0.37 to 0.93; $I^2=0\%$). In three studies, early surgery was associated with a 52% reduction in the risk of pressure sores (RR 0.48, 95% CI 0.34 to 0.69; $I^2=0\%$). Two studies reported deep vein thrombosis and two reported pulmonary embolisms; no significant differences were found between early and late surgery.

Authors' conclusions
Early surgery within 24 to 72 hours of hip fracture was associated with lower mortality and lower rates of postoperative pneumonia and pressure sores for elderly patients, suggesting benefits in reducing surgical delays. A significant effect remained after taking account of patients' preoperative medical status.

CRD commentary
The review question was clearly stated, with appropriate inclusion criteria. Several relevant sources were searched and the full search strategy was provided. The search relied heavily on index terms rather than a search of free text. Some efforts were made to reduce language bias, and the formal assessment of publication bias found no evidence of it. Efforts were made to reduce error and bias throughout the review process. Methodological quality was assessed.

The statistical analysis was appropriate and subgroup analyses were carried out. Adjustment for preoperative confounding factors suggested that increased mortality with longer delays to surgery was not just due to surgery being delayed more for patients who were sicker on admission. The authors pointed out that the interpretation of the results for postoperative complications should be cautious, as studies were only included if they also reported mortality. There was also some unexplained heterogeneity in the unadjusted mortality analysis. It should be noted that the data were from observational studies, which are prone to multiple biases and almost half of these studies were of poor quality.

The authors’ conclusions followed from the data presented, but the limitations of these data should be borne in mind.
Implications of the review for practice and research

**Practice:** The authors made no specific recommendations for practice.

**Research:** The authors stated that further study was needed to examine the differences in outcomes between medically fit and medically unfit patients and to determine whether increasing the availability of surgical resources was cost-effective. They also suggested that, given the difficulties in interpreting observational data, there was need for further well-designed prospective studies or a randomised controlled trial of the effects of early surgery for elderly patients after a hip fracture.

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