A mong elderly patients, hip fracture is associated with a one-year mortality rate ranging from 14% to 36% and also with profound temporary and sometimes permanent impairment of independence and quality of life. As the elderly population increases, the annual number of hip fractures globally is expected to exceed 7 million over the next 40 to 50 years. Current guidelines indicate that surgery for hip fracture should be performed within 24 hours of injury, as earlier surgery has been associated with better functional outcome, shorter hospital stay, shorter duration of pain and lower rates of nonunion, postoperative complications and mortality. Proponents of early treatment argue that this approach minimizes the length of time a patient is confined to bed rest, thereby reducing the risk of associated complications, such as pressure sores, deep vein thrombosis and urinary tract infections. However, those favouring a delay believe it provides the opportunity to optimize patients’ medical status, thereby decreasing the risk of perioperative complications. A further challenge to resolving the debate is the lack of an accepted definition of early surgery. Uncertainty exists about whether 24, 48 or 72 hours, or a longer period, should be considered to represent an “unacceptable delay” for hip fracture surgery.

We undertook a systematic review and meta-analysis to inform this debate. More specifically, we addressed the following question: Among patients 60 years of age or older who underwent surgery for hip fracture, what was the effect of early surgery, relative to delayed surgery, on all-cause mortality and postoperative complications?

**Methods**

**Eligibility criteria**

Studies fulfilling the following criteria were eligible for inclusion: target population consisting of patients 60 years of age or older who underwent surgery for a low-energy hip fracture, evaluation of preoperative surgical delay, consideration of all-cause mortality as an outcome and prospective design. We imposed no language restrictions.

**Results**

We identified 1939 citations, of which 16 observational studies met our inclusion criteria. These studies had a total of 13,478 patients for whom mortality data were complete (1764 total deaths). Based on the five studies that reported adjusted risk of death (4208 patients, 721 deaths), irrespective of the cut-off for delay (24, 48 or 72 hours), earlier surgery (i.e., within the cut-off time) was associated with a significant reduction in mortality (relative risk [RR] 0.81, 95% confidence interval [CI] 0.68–0.96, \( p = 0.01 \)). Unadjusted data indicated that earlier surgery also reduced inhospital pneumonia (RR 0.59, 95% CI 0.37–0.93, \( p = 0.02 \)) and pressure sores (RR 0.48, 95% CI 0.34–0.69, \( p < 0.001 \)).

**Interpretation:** Earlier surgery was associated with a lower risk of death and lower rates of postoperative pneumonia and pressure sores among elderly patients with hip fracture. These results suggest that reducing delays may reduce mortality and complications.
Identification of studies
We used multiple strategies to identify potentially eligible studies. With the help of a professional librarian, we searched the electronic databases MEDLINE and EMBASE for relevant articles in any language that were published up to and including Feb. 8, 2008. The complete search strategies are shown in Appendix 1 (available at www.cmaj.ca/cgi/content/full/cmaj.092220/DC1). One reviewer (N.S.) also hand-searched the archives of annual meetings of the Orthopaedic Trauma Association (1996–2007), the International Society of Orthopaedic Surgery and Traumatology (2003–2007), the Canadian Orthopaedic Association (2006–2007), the European Federation of National Associations of Orthopaedics and Traumatology (2005–2007), the Mid-America Orthopaedic Association (2005–2007), the Piedmont Orthopaedic Society (2005–2007), the Association of Bone and Joint Surgeons (2005–2007) and the American Academy of Orthopaedic Association (2005–2007), the Canadian Orthopaedic Association (2006–2007), the Euro- pean Federation of National Associations of Orthopaedics and Traumatology (2005–2007), the Mid-America Orthopaedic Association (2005–2007), the Piedmont Ortho-
Assessment of eligibility
One reviewer (N.S.) screened the titles and abstracts of the studies from the electronic search to identify all citations that might contain the comparison of interest. Two review-

Screening and assessment of eligibility
One reviewer (N.S.) screened the titles and abstracts of the studies to determine eligibility. Two reviewers (N.S., S.S.) independently evaluated these studies, as well as studies identified by hand-searching of reference lists and abstracts from meetings, to determine final inclusion (Figure 1).

Disagreements were resolved through a consensus process that required the reviewers to discuss the rationale for their decisions and come to an agreement. We recruited additional reviewers with an epidemiologic background and competence in various languages to apply the eligibility criteria to all non-English papers (one article in French, eight in German, three in Dutch and two in Hebrew). Study selection was not blinded, as blinding has been shown to have no significant statistical or clinical effect on the final results of systematic reviews.13

Assessment of methodologic quality
Two reviewers, both with methodologic expertise (N.S., S.S.) and one with content expertise (S.S.), independently graded the methodologic quality of each included study using an adapted version of the Newcastle–Ottawa Scale for Cohort Studies.14 This scale, which is intended to assess for selection and attrition bias, grades the reporting of studies on the basis of the selection, applicability and comparability of study groups; whether ascertainment of the exposure and outcome of interest was biased; and the adequacy of follow-up (ideally > 80%).15 We deemed one item (“demonstration that outcome of interest was not present at start of study”) irrelevant and removed it from the quality assessment because our primary outcome, all-cause mortality, was unequivocal. As a result, the maximum score was 8, and the minimum score was 0. We specified a priori that a score of 7 or more indicated high methodologic quality, a score of 5 or 6 indicated moderate quality, and a score of 4 or less indicated low quality. The reviewers resolved discrepancies for each item through discussion and, when necessary, re-evaluation of the study methodology until they reached consensus.

Extraction of data
When data for a study were unclear or missing from the article or abstract, we attempted to contact the authors. For all but one of the included studies, data had been collected prospectively for the purpose of answering a specific research question. The exception16 was a study that used prospectively collected data that had previously been entered into a hospital database. We confirmed with the authors of that study that the data had been collected accurately and consecutively for every eligible patient who had presented to two teaching hospitals, an approach that would have minimized the potential for selection bias.

Assessment of agreement
We used the κ (kappa) statistic to examine the extent of agreement between the individuals who determined study eligibility. We used the intraclass correlation coefficient to evaluate interobserver agreement in methodologic quality scores. We chose an a priori criterion of $\kappa \geq 0.65$ to indicate adequate agreement.
Statistical analysis
We included in our primary meta-analysis those studies that adjusted the mortality results for potentially confounding variables at any follow-up time. We included in our secondary meta-analyses studies with unadjusted estimates of mortality and postoperative complications.

When frequency data were available, we calculated the relative risk (RR) and 95% confidence interval [CI] for the primary outcome (all-cause mortality) between the groups who underwent early and delayed surgery as assessed in hospital or at 30 days, at three to six months, and at one year. We grouped the data for in-hospital and 30-day follow-up on the basis of a sensitivity analysis that showed no statistical difference in mortality rates between follow-up assessments at these times. We considered adjusted estimates of mortality appropriate for the primary analysis if the authors had adjusted for at least patient age and type or severity of illness.

In the absence of frequency data, we collected the reported RR, odds ratio or hazard ratio. We converted odds ratios and hazard ratios to RRs using the methods proposed by Zhang and Yu16 or the following formula: relative risk = 1 – e^{-hazard ratio}\times\{1 – P_o\}/P_o, where P_o is the outcome incidence in the non-exposed group.

Where appropriate, we pooled the outcome measures using the random-effects model of DerSimonian and Laird,17 which is based on the inverse variance method. We weighted all pooled estimates by study size. We quantified heterogeneity between studies using the $I^2$ statistic,18 which represents the percentage of total variation across trials that is due to heterogeneity rather than to chance.19

To assess publication bias, we constructed funnel plots to examine sample size versus exposure effect across included studies. This method plots the magnitude of the exposure effect relative to the weight of the study.

Evaluation of heterogeneity
Given the potential for heterogeneity in effect sizes, we performed stratified analyses and used a statistical test of interaction20 to evaluate the extent to which subgroup results differed from each other. We hypothesized that heterogeneity might be due to differences in the reasons for surgical delay (administrative or non-administrative), the date of publication of the study (before the year 2000 or in the year 2000 or later) or methodologic features (low quality v. moderate or high quality).

To control for multiple testing and inflation of type I error, we defined a significant difference between subgroups as $p < 0.01$. We considered $F < 25\%$ to indicate low heterogeneity and $F > 75\%$ to indicate high heterogeneity.21 Tests of significance for treatment effects were two-tailed, and a $p$ value of less than 0.05 was considered significant.

Results

Studies included
Our literature search identified 1939 potentially relevant citations: 1908 from the electronic search, 22 from hand searches of the articles that remained after initial screening ($n = 98$) and nine abstracts. Sixteen of these citations proved eligible for inclusion8,12,15,22–34 (Figure 1). Two studies were possible duplicates, but we included both in our analysis because one assessed long-term mortality23 and the other assessed short-term mortality.23 The weighted $k$ for overall agreement between reviewers for the final eligibility decision was 0.85 (95% CI 0.47–1.00).

Study characteristics
The sample sizes of the included studies ranged from 65 to 3628 patients (Table 1). The cut-off times for operative delay were 24 hours,8,12,15,22,23,27,28,30,33 48 hours,24,25,30,31,32 72 hours4 and five days.26 The preoperative interval was recorded from the time of injury to surgery in five studies,12,15,22,24,26,29 and from the date of admission to surgery in the remaining 11 studies. Eight studies reported the reasons for surgical delay, the most common being the unavailability of an operating room and/or surgical personnel,12,24,25,27,31,32,34 and investigation and stabilization of the patient’s preoperative medical condition.27,32,33,34

Mortality
Of the 14 171 patients analyzed in all 16 studies, complete mortality data were available for 13 478. In five studies ($n = 4208$ patients), the researchers computed adjusted odds ratios or hazard ratios for mortality at 30 days,22 six months8 or one year23,31 (721 total deaths) by means of a multivariable logistic regression model or multivariable Cox proportional hazards model. Those five studies most commonly adjusted for American Anesthetists Society score (a measure of a patient’s fitness for surgery), age and sex. On the basis of the pooled adjusted estimates, early surgery was associated with a 19% risk reduction in all-cause mortality, irrespective of the time of the outcome assessment (RR 0.81, 95% CI 0.68–0.96, $p = 0.01, F = 0\%$).

All 16 studies provided unadjusted estimates of mortality. The unadjusted estimates also suggested that early surgery significantly reduced the risk of one-year mortality by 45% (RR 0.55, 95% CI 0.40–0.75, $p < 0.001, F = 71\%$; Figure 2). Heterogeneity in the unadjusted one-year mortality rate could not be explained by the reason for surgical delay, the cut-off for delay, study quality, date of publication or length of follow-up. Funnel plots showed no evidence of publication bias.

Time to surgery did not significantly affect mortality at 30 days ($n = 3485$; RR 0.90, 95% CI 0.71–1.13, $p = 0.86, F = 0\%$) or at three to six months ($n = 1650$ patients; RR 0.87, 95% CI 0.44–1.72, $p = 0.68, F = 87\%$) (Figure 2). However, the removal of a single study evaluating only medically ill patients27 removed most of the between-study differences and
Table 1: Characteristics of prospective observational studies included in systematic review of early surgery after hip fracture (part 1 of 2)

| Study*                | Country   | No. of patients | Age, mean (SD), yr | Sex, % female, and fracture type | Cut-off for delay | Outcomes       | Total mortality | Time of outcome assessment | NOS quality index*† | Reasons for delay                                                                 |
|-----------------------|-----------|-----------------|--------------------|---------------------------------|-------------------|-----------------|-------------------|------------------------|---------------------|---------------------------------------------------------------------------------|
| Davie et al.          | Scotland  | 200             | ≥ 70 (73%)         | 79% Hip                         | 24 h              | Mortality       | 19/200            | 30 d                   | 4                   |                                                                                |
| Davis et al.          | UK        | 230             | 80.6 (9.9)         | 82.6% Intertrochanteric         | 48 h              | Mortality POC   | 55/230            | 3 mo                   | 4                   |                                                                                |
| Harries et al.        | UK        | 80              | 82.3               | 90% Proximal femur             | 24 h              | Mortality LOS   | 6/80              | In hospital           | 1                   |                                                                                |
| Mullen et al.         | USA       | 360             | NR                 | NR Hip                          | 24 h              | Mortality       | 28/60             | 6 mo                   | 4                   | Delayed presentation, unavailability of OR and/or surgeon                      |
| Parker et al.         | USA       | 468             | 81                 | 82.7% Proximal femur           | 48 h              | Mortality POC   | 19/468            | 30 d                   | 3                   | Delayed presentation, unavailability of OR and/or surgeon                      |
| Zuckerman et al.      | USA       | 367             | ≥ 85 (72%)         | 79.3% Femoral neck or intertrochanteric | 72 h              | Mortality POC   | 99/367            | 1 yr                   | 7                   | Patient’s health status, surgeon’s preference, unavailability of OR             |
| Beringer et al.       | Ireland   | 265             | 82.5               | 100% Femoral neck              | 24 h              | Mortality LOS   | 99/203            | 1 yr                   | 6                   | Patient’s health status, delayed patient consent, unavailability of OR and/or anesthetist |
| Smektala et al.       | Germany   | 161             | 83.7               | 90% Femoral neck               | 24 h              | Mortality       | 12/161            | In hospital           | 5                   | Patient’s health status, secondary fracture of dislocated femoral neck after conservative treatment, administrative |
| Dorotka et al.        | Austria   | 182             | 78.3 (12.2)        | 75.8% Basocervical or pertrochanteric or subtrochanteric | 24 h              | Mortality POC   | 30/182            | 6 mo                   | 4                   | Administrative, secondary referral, secondary evidence of fracture, delayed presentation, delayed patient consent, unavailability of OR and/or surgical personnel |
| Elliott et al.        | Ireland   | 1780            | 78                 | 76.7% Femoral neck             | 24 h              | Mortality       | 39/1780           | 1 yr                   | 6                   |                                                                                |
| Doruk et al.          | Turkey    | 65              | 76.0 (7.5)         | 65% Intertrochanteric or colum femoris | 5 d               | Mortality LOS   | 15/65             | 1 yr                   | 3                   |                                                                                |
Research resulted in a significant benefit at three to six months with earlier surgery (n = 1590 patients, RR 0.66, 95% CI 0.50–0.88, p = 0.005, I² = 7%).

Postoperative complications
Four studies reported on the number of individual postoperative complications for a total of 5777 patients. These data were not adjusted for potentially confounding surgical factors. Two of the studies evaluated pneumonia (n = 2793 patients, 101 total events) and demonstrated an overall unadjusted risk reduction of 41% among patients who underwent early surgery (< 24 or 48 hours) relative to those whose surgery was delayed (RR 0.59, 95% CI 0.37–0.93, p = 0.02, I² = 0%; Figure 3). In three studies, early surgery was associated with a 52% reduction in the risk of pressure sores (n = 3023 patients, 174 total events; RR 0.48, 95% CI 0.34–0.69, p = 0.001; Figure 3). Two of the studies evaluated deep venous thrombosis (n = 4679 patients, 56 total events; RR 0.34–0.69, p = 0.004; Figure 3). Thromboembolism (n = 2827 patients, 40 total events) and mortality (n = 1590 patients, 19 total events) were not influenced by the timing of surgery (Figure 3).

Interpretation
Our primary meta-analysis suggested that early surgical treatment of hip fracture (< 24, < 48 or < 72 hours) was associated with a significant reduction in mortality. Earlier surgery was also associated with a reduced risk of pneumonia and pressure sores. Some authors have argued that an important contributing factor (if not the main factor) affecting mortality is that these patients tend to be sicker on admission, and are therefore more likely to die, than those whose surgery is delayed. Our study suggested that early surgery has a significant effect on the outcome of patients whose surgery is delayed. Nonetheless, our primary meta-analysis showed a significant influence of surgical delay on mortality, even after adjustment for confounding preoperative factors. Further study is needed to examine the differences in outcomes between medically fit and medically unfit patients and to determine whether increasing the availability of surgical resources will yield cost-effective benefits.

Table 1: Characteristics of prospective observational studies included in systematic review of early surgery after hip fracture (part 2 of 2)

| Study* | Country | No. of patients | Age, mean (SD), yr | Sex, % female | Fracture type | Cut-off for delay | Outcomes | Total mortality | Time of outcome assessment | NOS quality index | Reasons for delay |
|--------|---------|-----------------|-------------------|--------------|---------------|-----------------|----------|----------------|--------------------------|----------------|-----------------|
| Orosz et al.* | USA | 1178 | 82 (8.8) | 80.6% | Femoral neck (48%) | 24 h | Mortality | POC LOS | 206/1178 | 6 mo | 8 |
| Siegmeth et al.* | UK | 3628 | 81 (8.06) | 80.8% | Intracapsular or extracapsular | 48 h | Mortality | POC LOS | 262/3628 | 1 yr | 5 |
| Moran et al.* | UK | 2660 | 80 | About 76% | Femoral neck | 48 h | Mortality | POC | 206/2354 | 30 d | 6 |
| Rae et al.* | Australia | 222 | 79 | 72.1% | Femoral neck | 48 h | Mortality | POC | 16/222 | 30 d | 8 |
| Smektala et al.* | Germany | 2325 | 83.2 (7.4) | 80.3% | Femoral neck or pertrochanteric | 24 h | Mortality | POC | 301/2238 | 1 yr | 7 |

Note: LOS = length of stay, NOS = Newcastle-Ottawa Scale, NR = not reported, OR = operating room, POC = postoperative complications, SD = standard deviation.

*Ordered chronologically by date of publication.
†Unless indicated otherwise.
‡Value of 7 or 8 = high quality, 5 or 6 = moderate quality, less than 5 = low quality.
a delay of more than 48 hours was associated with increased mortality among patients with hip fracture. 

However, that systematic review had methodologic limitations, including a restriction to English-language articles and inclusion of retrospective studies, which are often more prone to bias (e.g., recall bias, selection bias) and which may therefore lead to overestimation of treatment effects. Our wider eligibility criteria and search identified 11 prospective observational studies (10 in English and one in German) additional to those in the study by Shiga and colleagues. Using the selection criteria that were used by Shiga and colleagues, we identified four additional prospective studies.

Limitations
Our meta-analysis had some limitations. It is likely that our estimates of postoperative complications were subject to publication bias because we restricted data collection for that analysis to the 16 studies with data on mortality rates for patients undergoing early or delayed surgery. Our findings that early surgery may reduce the risk of pneumonia and pressure sores should therefore be interpreted with caution. In addition, we identified unexplained heterogeneity in our analysis of the unadjusted one-year mortality outcome.

The most notable limitation of this review was its restriction to observational studies, which reflects the state of current evidence. Observational studies are prone to selection, performance, attrition and detection bias. Unadjusted analyses are certainly confounded, and although we used adjusted ratios for our primary meta-analysis, the results may still be subject to confounding bias where our study may be missing other unknown or unmeasured factors potentially relevant to prognosis for a patient with hip fracture. These factors may limit the conclusions.

Conclusion
On the basis of current evidence, surgery conducted before 24–72 hours is associated with lower mortality and lower rates of certain postoperative complications among elderly

| Timeframe and study | Early surgery, N | Delayed surgery, N | RR (95% CI) |
|---------------------|------------------|-------------------|-------------|
| **Short-term**      |                  |                   |             |
| Davie et al.        | 105              | 95                | 0.66 (0.28–1.56) |
| Harries et al.      | 40               | 40                | 1.00 (0.21–4.71) |
| Parker et al.*      | 290              | 178               | 0.68 (0.28–1.65) |
| Smektala et al.*    | 139              | 22                | 0.79 (0.19–3.33) |
| Moran et al.*       | 982              | 1372              | 0.98 (0.75–1.28) |
| Rae et al.*         | 137              | 85                | 0.62 (0.24–1.59) |
| Overall             | 1693             | 1792              | 0.90 (0.71–1.13) |
| **Medium-term**     |                  |                   |             |
| Davis et al.*       | 45               | 185               | 0.80 (0.43–1.50) |
| Mullen et al.†      | 8                | 52                | 2.17 (1.42–3.31) |
| Dorotka et al.*     | 158              | 24                | 0.42 (0.21–0.84) |
| Orosz et al.        | 398              | 780               | 0.70 (0.50–0.97) |
| Overall             | 609              | 1041              | 0.87 (0.44–1.72) |
| **Long-term**       |                  |                   |             |
| Zuckerman et al.*   | 267              | 100               | 0.58 (0.35–0.99) |
| Beringer et al.     | 133              | 70                | 0.54 (0.39–0.75) |
| Elliott et al.      | 169              | 1611              | 0.35 (0.21–0.59) |
| Doruk et al.*       | 38               | 27                | 0.36 (0.14–0.92) |
| Siegmeth et al.*    | 3454             | 174               | 0.50 (0.34–0.74) |
| Smektala et al.*    | 609              | 1629              | 0.90 (0.71–1.15) |
| Overall             | 4670             | 3673              | 0.55 (0.40–0.75) |

Figure 2: Stratified analysis by time of death. Forest plot of unadjusted relative risks for the effect of early compared with delayed surgery for hip fracture on all-cause mortality assessed in hospital or at 30 days (short-term), at three to six months (medium-term) or at one year (long-term) (random-effects model based on inverse variance method). Studies used a cut-off for delay of 24 hours, except as indicated otherwise. *Study used a cut-off of 48 hours for delay. †Data based on patients who had medical illness in combination with hip fracture. ‡Study used a cut-off of 72 hours for delay. §Study used a cut-off of 5 days for delay. CI = confidence interval, RR = relative risk.
patients with hip fracture. When potential confounding preoperative factors are taken into account, this effect is not as large, but its direction is maintained. Given the challenges in interpreting observational data, there is a need for additional well-designed prospective studies or a randomized trial to offer clear insights into the effects of early surgery in this patient population.

This article has been peer reviewed.

**Competing interests:** Mohit Bhandari has received research grants from Smith and Nephew, Stryker, Zimmer, the Canadian Institutes for Health Research, the Osteosynthesis and Trauma Care Foundation, the AO (Arbeitsgemeinschaft für Osteosynthesefragen) Foundation, the National Institutes of Health, the US Department of Defense and the Orthopedic Trauma Association. None declared for Nicole Simunovic, P.J. Devereaux, Sheila Sprague, Gordon Guyatt, Emil Schemitsch and Justin DeBeer.

**Contributors:** Nicole Simunovic contributed substantially to the conception and design of the study and to the acquisition, analysis and interpretation of the data; she also drafted the manuscript. P.J. Devereaux, Gordon Guyatt, Emil Schemitsch and Justin DeBeer contributed substantially to the conception and design of the study and revised the article for important intellectual content. Mohit Bhandari contributed substantially to the conception and design of the study and the interpretation of the data and revised the article for important intellectual content. All authors gave final approval of the version to be published.

**Funding:** No external funding was received for this paper.

**REFERENCES**

1. Zuckerman JD. Hip fracture. *N Engl J Med* 1996;334:1519-25.
2. Johnell O, Kanis JA. An estimate of the worldwide prevalence, mortality and disability associated with hip fracture. *Osteoporos Int* 2004;15:897-902.
3. Parker M, Johansen A. Hip fracture. *BMJ* 2006;333:27-30.
4. Hip & pelvis (acute & chronic) [guideline]. Corpus Christi (TX): Work Loss Data Institute; 2006. Available: www.guideline.gov/content.aspx?id=12672 (accessed 2010 June 14).
5. Bottle A, Aylin P. Mortality associated with delay in operation after hip fracture: observational study. *BMJ* 2006;332:947-51.
6. Grieses JP, Gregoire PM, Noveck H, et al. The effects of pre-op timing on mortality and morbidity in patients following hip fracture. *Ann Med Surg* 2010;21:702-9.
7. Manninger J, Kazar G, Fekete G, et al. Significance of urgent (within 6h) internal fixation in the management of fractures of the neck of the femur. *Injury* 1989;20:101-5.
8. Orosz GM, Magaziner J, Hanlan EL, et al. Association of timing of surgery for hip fracture and patient outcomes. *JAMA* 2004;291:1738-43.
9. Perez JV, Warwick DJ, Case CP, et al. Death after proximal femoral fractures — an autopsy study. *Injury* 1995;26:237-40.
10. Rogers FB, Shackford SR, Keller MS. Early fixation reduces morbidity and mortality in elderly patients with hip fractures from low-impact falls. *J Trauma* 1995;39:261-5.
11. Villar RN, Allen SM, Barnes SJ. Hip fractures in healthy patients: operative delay versus prognosis. *BMJ (Clin Res Ed)* 1986;293:1203-4.
12. Donotka R, Schneckenher H, Buchinger W. [Influence of nocturnal surgery on mortality and complications in patients with hip fracture.] *Unfallchirurg* 2003;106:287-91. Article in German.
13. Berlin JA. Does blinding of readers affect the results of meta-analyses? University of Pennsylvania Meta-analysis Blinding Study Group. *Lancet* 1997;350:185-6.
14. Wells GA, Shea B, O’Connell D, et al. The Newcastle-Ottawa Scale (NOS) for assessing the quality of nonrandomised studies in meta-analyses. Ottawa (ON): Ottawa Health Research Institute; 2009. Available: www.ohri.ca/programs/clinical_epidemiology/oxford.htm (accessed 2010 June 1).
15. Elliott J, Bringer T, Kee F, et al. Predicting survival after treatment for fracture of the proximal femur and the effect of delays to surgery. *J Clin Epidemiol* 2003;56:788-95.

**Figure 3:** Forest plot of unadjusted relative risks for the effect of preoperative timing on specific postoperative complications assessed in hospital (random-effects model). Studies used a cut-off for delay of 24 hours, except as indicated otherwise. *Study used a cut-off of 48 hours for delay. CI = confidence interval, RR = risk ratio.
16. Zhang J, Yu KF. What’s the relative risk? A method of correcting the odds ratio in cohort studies of common outcomes. JAMA 1998;280:1690-1.
17. DerSimonian R, Laird N. Meta-analysis in clinical trials. Control Clin Trials 1986;7:177-88.
18. Higgins JPT, Thompson SG. Quantifying heterogeneity in a metaanalysis. Stat Med 2002;21:1539-58.
19. Devereaux PJ, Beattie WS, Choo PTL, et al. How strong is the evidence for the use of perioperative β blockers in non-cardiac surgery? Systematic review and meta-analysis of randomised controlled trials. BMJ 2005;331:313-21.
20. Altman DG, Bland JM. Interaction revisited: the difference between two estimates. BMJ 2003;326:219.
21. Higgins JPT, Green S, editors. Cochrane handbook for systematic reviews of interventions. Version 5. The Cochrane Collaboration; 2008. Available: www.cochrane-handbook.org (accessed 2010 June 1).
22. Smektala R, Wenning M, Luka M. Early surgery after hip para-articular femoral fracture. Results of a prospective study of surgical timing in 161 elderly patients. Zentralbl Chir 2000;125:744-8.
23. Mullen JO, Mullen NL. Hip fracture mortality: a prospective, multifactorial study to predict and minimize death risk. Clin Orthop Relat Res 1992;280:214-22.
24. Siegemeth AW, Gurusamy K, Parker MJ. Delay to surgery prolongs hospital stay in patients with fractures of the proximal femur. J Bone Joint Surg Br 2005;87:1123-6.
25. Parker MJ, Pryor GA. The timing of surgery for proximal femoral fractures. J Bone Joint Surg Br 1992;74:203-5.
26. Doruk H, Mas MR, Yildiz C, et al. The effect of the timing of hip fracture surgery on the activity of daily living and mortality in elderly. Arch Gerontol Geriatr 2004;39:179-85.
27. Beringer TR, Crawford VL, Brown JG. Audit of surgical delay in relationship to outcome after proximal femoral fracture. Ulster Med J 1996;65:32-8.
28. Davie IT, MacRae WR, Malcolm-Smith NA. Anesthesia for the fractured hip. Anaesth Analg 1970;49:165-70.
29. Davis TR, Sher JL, Porter BB, et al. The timing of surgery for intertrochanteric femoral fractures. Injury 1988;19:244-6.
30. Harries DJ, Eastwood H. Proximal femoral fractures in the elderly: Does operative delay for medical reasons affect short-term outcome? Age Ageing 1991;20:41-4.
31. Moran CG, Wenn RT, Skandal M, et al. Early mortality after hip fracture: Is delay before surgery important? J Bone Joint Surg Am 2005;87:483-9.
32. Rae HC, Harris IA, McDvly L, et al. Delay to surgery and mortality after hip fracture. Aust NZ J Surg 2007;77:889-91.
33. Smektala R, Endres H, Dasch B, et al. The effect of time-to-surgery on outcome in elderly patients with proximal femoral fractures. BMC Musculoskelet Disord 2008;9:171.
34. Zuckerman JD, Skovron ML, Koval KJ, et al. Postoperative complications and mortality associated with operative delay in older patients who have a fracture of the hip. J Bone Joint Surg Am 1995;77:1551-6.
35. Hamlet WP, Lieberman JR, Freedman EL, et al. Influence of health status and the timing of surgery on mortality in hip fracture patients. Am J Orthop 1997;26:621-7.
36. Hardin GT. Timing of fracture fixation: a review. Orthop Rev 1990;19:861-7.
37. Shiga T, Wajima Z, Ohe Y. Is operative delay associated with increased mortality of hip fracture patients? Systematic review, meta-analysis, and meta-regression. Can J Anaesth 2008;55:146-54.
38. Hulley SB, Cummings SR, Browner WS, et al. Designing clinical research. 3rd ed. Philadelphia (PA): Lippincott Williams and Wilkins; 2007.

Correspondence to: Nicole Simunovic, CLARITY Orthopaedic Research, 293 Wellington St. N, Suite 110, Hamilton ON L8L 8E7; simunon@mcmaster.ca