

Corrigendum

Risk of reoperation due to surgical site infection in 74,771 hip fracture patients: a Danish nationwide cohort study

Nicolai K KRISTENSEN^{1,3}, Jeppe LANGE^{1,3}, Trine FRØSLEV², and Alma B PEDERSEN^{2,3}

¹ Department of Orthopaedic Surgery, Horsens Regional Hospital; ² Department of Clinical Epidemiology, Aarhus University Hospital, Aarhus; ³ Department of Clinical Medicine, Aarhus University, Aarhus, Denmark
Correspondence: nicokris@rm.dk

Corrigendum of Acta Orthop 2022; 93: 760–766. doi: DOI 10.2340/17453674.2022.4580



The authors have unfortunately discovered that the originally published version of this article contains errors due to an error in inclusion of the specific combination of codes (KNFU 0–99 with T84.1) into definition of reoperation due to surgical site infection. This error leads to changes in most numeric result

and in one of the conclusions, and therefore the article needed to be corrected. In this corrigendum, we supply the corrected data in Abstract, Results, Discussion sections, Table 1 and 4, as well as Figure 1 and Figure 2.

The authors apologize for any inconvenience caused.

In the Abstract, the following sentences are changed

Original paragraphs

Results — Overall, the 1-year net risk of reoperation due to SSI was 2.7%. The HR was lower for patients undergoing total/hemiarthroplasty surgery versus internal fixation (HR = 0.6; 95% CI 0.5–0.6) and for patients with per-/sub-trochanteric fracture versus femoral neck fracture (HR = 0.7; CI 0.6–0.8). The risk of reoperation due to SSI decreased over time; HR was 0.6 (CI 0.5–0.7) for 2015–2016 compared with 2005–2006. Risk of reoperation decreased with increasing age; the HR was 0.6 (CI 0.6–0.7) in the more than 85-year-olds compared with 65–74-year-old patients.

Interpretation — The net risk of reoperations due to SSI in our study was higher than previously assumed. We identified several risk factors for increased risk of reoperation due to SSI, most noticeably treatment with internal fixation vs. arthroplasty, as well as younger age and femoral neck fracture diagnosis.

Corrected paragraphs

Results — Overall, the 1-year net risk of reoperation due to SSI was **1.6%**. The HR was **higher** for patients undergoing total/hemiarthroplasty surgery versus internal fixation (**HR = 1.5; 95% CI 1.3–1.8**) and lower for patients with per-/sub-trochanteric fracture versus femoral neck fracture (**HR = 0.6; CI 0.6–0.7**). The risk of reoperation due to SSI decreased over time; HR was **0.7 (CI 0.5–0.8)** for 2015–2016 compared with 2005–2006. Risk of reoperation decreased with increasing age; the HR was **0.8 (CI 0.7–1.0)** in the more than 85-year-olds compared with 65–74-year-old patients. **Charlson Comorbidity Index of ≥ 3 was associated with a higher risk of reoperation due to SSI, HR was 1.3 (CI 1.1–1.6).**

Interpretation — The net risk of reoperations due to SSI in our study was **lower** than previously assumed. We identified several risk factors for increased risk of reoperation due to SSI, most noticeably treatment with **arthroplasty vs. internal fixation**, as well as younger age, **high comorbidity burden**, and femoral neck fracture diagnosis.

In the Results, the following sentences are changed

Original paragraphs

Reoperation due to SSI: time trend

Within 1 year of primary surgery, 1,688 of 74,771 hip fracture patients had undergone reoperation due to SSI, corresponding to a net risk of reoperation of 2.7%. During the study period, the net risk of reoperation due to SSI decreased from 3.4% in 2005–2006 to 2.1% in 2015–2016, corresponding to an adjusted HR of 0.6 (CI 0.5–0.7) (Table 4) and absolute reduction of 1.3%. A similar decrease in adjusted HRs was observed for follow-up periods 0–15, 0–30, and 0–90 days after hip fracture surgery. Overall, crude risk of reoperation was 2.3%, decreasing from 2.8% to 1.8% over the study period (Table 4).

Risk factors for reoperation due to SSI (Figures 1 and 2)

Sex and CCI were not risk factors for reoperation due to SSI within 1 year of hip fracture surgery. The HRs for reoperation due to SSI within 1 year decreased with increasing age. Thus, the HRs were 0.6 (CI 0.6–0.7) and 0.8 (CI 0.7–0.8) for patients aged above 85 and patients aged 75–84 years compared with the youngest age group (65–74 years), respectively. Similar results were obtained within 90 days of surgery.

The HR for reoperation due to SSI within 1 year was 0.7 (CI 0.6–0.8) for patients sustaining the per-/subtrochanteric fracture compared with patients sustaining femoral neck fractures. The HR at 90 days post-surgery was 0.6 (CI 0.6–0.7).

The HR was 0.6 (CI 0.5–0.6) within 1 year for patients undergoing total/hemiarthroplasty compared with patients undergoing internal fixation. However, at 90 days, HR was 0.9 (CI 0.8–1.1) for total/hemiarthroplasty compared with internal fixation.

Corrected paragraphs

Reoperation due to SSI: time trend

Within 1 year of primary surgery, **996** of 74,771 hip fracture patients had undergone reoperation due to SSI, corresponding to a net risk of reoperation of **1.6%**. During the study period, the net risk of reoperation due to SSI decreased from **1.9%** in 2005–2006 to **1.3%** in 2015–2016, corresponding to an adjusted HR of **0.7** (CI 0.5–**0.9**) (Table 4) and absolute reduction of **0.6%**. A similar decrease in adjusted HRs was observed for follow-up periods 0–15, 0–30, and 0–90 days after hip fracture surgery. Overall, crude risk of reoperation was **1.3%**, decreasing from **1.6%** to **1.1%** over the study period (Table 4).

Risk factors for reoperation due to SSI (Figures 1 and 2)

Sex was not risk factors for reoperation due to SSI within 1 year of hip fracture surgery. **High comorbidity burden was a risk factor for reoperation due to SSI within 1 year of hip fracture surgery with an adjusted HR of 1.3 (CI 1.1–1.6) for patients with high CCI (CCI ≥3 points) compared with low CCI. Similar result was seen at 90 days after surgery.** The HRs for reoperation due to SSI within 1 year decreased with increasing age. Thus, the adjusted HRs at 1 year was **0.8 (CI 0.7–1.0)** for patients aged above 85 years compared with the youngest age group (65–74 years) and **0.9 (CI 0.8–1.1)** within 90 days of surgery.

The HR for reoperation due to SSI within 1 year was **0.6** (CI 0.6–**0.7**) for patients sustaining the per-/subtrochanteric fracture compared with patients sustaining femoral neck fractures. The HR at 90 days post-surgery was 0.6 (CI **0.5–0.7**).

The HR was **1.5 (CI 1.3–1.8)** within 1 year for patients undergoing total/hemiarthroplasty compared with patients undergoing internal fixation. At 90 days, HR was **2.4 (CI 2.0–3.0)** for total/hemiarthroplasty compared with internal fixation.

In the Discussion, the following sentences are changed

Original paragraphs

This study shows 1-year net risk of reoperation due to SSI for all types of hip fractures over a 10-year period of 2.7%. There was a 45% decrease in reoperation due to SSI over time with the most recent 1-year net risk of reoperation being 2.1% in 2015–2016.

Our study finds an almost 50% lower rate of reoperations due to SSI within 1 year when hip fractures are treated with total or hemiarthroplasty compared with osteosynthesis. This somehow contradicts our other finding that per-/subtrochanteric fractures are associated with a lower risk of reoperation due to SSI than femoral neck fractures.

There is clearly a lower reoperation risk in the elderly patients above 85 years of age compared with the younger group. A low virulent infection (e.g., biofilm) could go undetected by the decreased immune response in the elderly (17), explaining the lower risk of reoperation with increasing age. Further, SSI symptoms typically occur within the first 2 years of surgery, and it is likely that older patients die before developing SSI symptoms (18).

In this large cohort study of 74,771 patients, the net risk of reoperation due to SSI within 1 year for all types of hip fractures treated in the period 2005–2016 was 2.7%. It is noteworthy that the highest risk of revision due to SSI were in the internal fixation group, compared with the arthroplasty treated patients.

There was a 45% decrease in reoperation due to SSI over time from 2005 to 2016 and we identified several risk factors for increased risk of reoperation due to SSI, including younger age and femoral neck fracture.

Corrected paragraphs

This study shows 1-year net risk of reoperation due to SSI for all types of hip fractures over a 10-year period of **1.6%**. There was a **33%** decrease in reoperation due to SSI over time with the most recent 1-year net risk of reoperation being **1.3%** in 2015–2016.

Our study finds an almost **54% higher** rate of reoperations due to SSI within 1 year when hip fractures are treated with total or hemiarthroplasty compared with osteosynthesis. This **is in line with** our other finding that per-/subtrochanteric fractures are associated with a lower risk of reoperation due to SSI than femoral neck fractures.

There is a lower reoperation risk in the elderly patients above 85 years of age compared with the younger group. A low virulent infection (e.g., biofilm) could go undetected by the decreased immune response in the elderly (17), explaining the lower risk of reoperation with increasing age. Further, SSI symptoms typically occur within the first 2 years of surgery, and it is likely that older patients die before developing SSI symptoms (18). **It is also likely that patients who are older than 85 years are somehow selected and our results are due to “healthy survival bias”.**

In this large cohort study of 74,771 patients, the net risk of reoperation due to SSI within 1 year for all types of hip fractures treated in the period 2005–2016 was **1.6%**. It is noteworthy that the highest risk of revision due to SSI were in the **arthroplasty-treated patients, compared with the internal fixation group.**

There was a **33%** decrease in reoperation due to SSI over time from 2005 to 2016 and we identified several risk factors for increased risk of reoperation due to SSI, including younger age, **high CCI (CCI \geq 3 points)**, and femoral neck fracture.

In the Tables, the following is changed

Original Table 1

Original Table 1. Diagnosis and reoperation codes from the Danish National Patient Register used to identify reoperations due to surgical site infections

<p>Operation codes</p> <p>KNFC 0–99 (= secondary arthroplasty in hip joints): Needs to be combined with the ICD-10 codes (minus T84.1)</p> <p>KNFW49 (= reoperation for cicatrice rupture following operation in hip or thigh): Needs to be combined with the ICD-10 codes</p> <p>KNFW59 (= reoperation at superficial surgical site infection following operation in hip or thigh): Does NOT require combination with ICD-10 codes but can be combined with the ICD-10 code</p> <p>KNFW69 (= reoperation at deep surgical site infection following operation in hip or thigh): Does NOT require combination with ICD-10 codes but can be combined with the ICD-10 code</p> <p>KNFU 0–99 (= removal of prosthesis): Needs to be combined with the ICD-10 codes</p> <p>KNFG 09–59 (= joint resection, arthroplasties, arthrodesis, in hip joint): Needs to be combined with the ICD-10 codes</p> <p>KNFS19, KNFS29, KNFS49, KNFS59, KNFS99: Does not require combination with ICD-codes</p> <p>Diagnosis codes (based on ICD-10 codes)</p> <p>T84.5</p> <p>T84.6</p> <p>T84.1 (not in combination with KNFC 0–99)</p> <p>T84.7</p> <p>T81.4</p> <p>T81.3</p>
ICD codes = International Classification of Diseases codes.

Corrected Table 1

Corrected Table 1. Diagnosis and reoperation codes from the Danish National Patient Register used to identify reoperations due to surgical site infections (we have marked with red color differences compared with original Table 1)

<p>Operation codes</p> <p>KNFC 0–99 (= secondary arthroplasty in hip joints): Needs to be combined with the ICD-10 codes (minus T84.1)</p> <p>KNFW49 (= reoperation for cicatrice rupture following operation in hip or thigh): Needs to be combined with the ICD-10 codes</p> <p>KNFW59 (= reoperation at superficial surgical site infection following operation in hip or thigh): Does NOT require combination with ICD-10 codes but can be combined with the ICD-10 code</p> <p>KNFW69 (= reoperation at deep surgical site infection following operation in hip or thigh): Does NOT require combination with ICD-10 codes but can be combined with the ICD-10 code</p> <p>KNFU 0–99 (= removal of internal fixation or prosthesis): Needs to be combined with the ICD-10 codes (minus T84.1)</p> <p>KNFG 09–59 (= joint resection, arthroplasties, arthrodesis, in hip joint): Needs to be combined with the ICD-10 codes</p> <p>KNFS19, KNFS29, KNFS49, KNFS59, KNFS99: Does not require combination with ICD-codes</p> <p>Diagnosis codes (based on ICD-10 codes)</p> <p>T84.5</p> <p>T84.6</p> <p>T84.1 (not in combination with KNFC 0–99 or KNFU 0–99)</p> <p>T84.7</p> <p>T81.4</p> <p>T81.3</p>
ICD codes = International Classification of Diseases codes.

Corrected Table 4

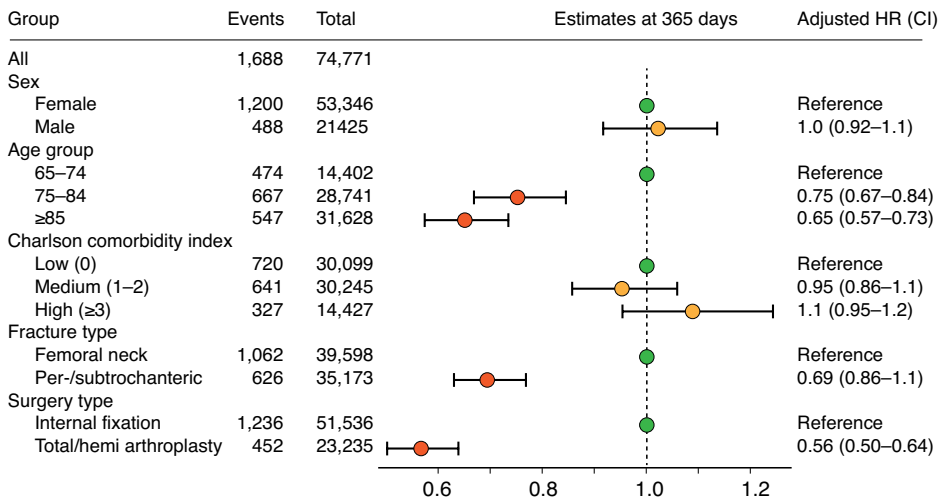
Corrected Table 4. Association between calendar time and risk of reoperation due to surgical site infection after hip fracture surgery, Denmark, 2005–2016. All data (except number of patients, which were correct) has been replaced

Follow-up period	Calendar period of diagnosis	No. of patients	No. of infections	Cumulative incidence, % (95% CI)	Kaplan–Meier risk, % (95% CI)	Crude hazard ratio (HR) (95% CI)	Adjusted ^a hazard ratio (HR) (95% CI)
0–15 days of surgery							
	2005–2006	12,453	30	0.24 (0.17–0.34)	0.26 (0.18–0.36)	Reference	Reference
	2007–2008	13,236	20	0.15 (0.10–0.23)	0.16 (0.10–0.25)	0.63 (0.36–1.10)	0.62 (0.35–1.09)
	2009–2010	12,724	16	0.13 (0.08–0.20)	0.13 (0.08–0.21)	0.52 (0.28–0.96)	0.52 (0.28–0.95)
	2011–2012	12,706	18	0.14 (0.09–0.22)	0.15 (0.09–0.24)	0.59 (0.33–1.06)	0.58 (0.32–1.04)
	2013–2014	12,285	25	0.20 (0.14–0.30)	0.22 (0.14–0.32)	0.84 (0.49–1.43)	0.83 (0.49–1.41)
	2015–2016	11,367	15	0.13 (0.08–0.21)	0.14 (0.08–0.23)	0.54 (0.29–1.01)	0.53 (0.29–0.99)
	2005–2016	74,771	124	0.17 (0.14–0.20)	0.18 (0.15–0.21)		
0–30 days of surgery							
	2005–2006	12,453	72	0.58 (0.46–0.72)	0.63 (0.49–0.78)	Reference	Reference
	2007–2008	13,236	63	0.48 (0.37–0.61)	0.52 (0.40–0.66)	0.82 (0.59–1.15)	0.82 (0.58–1.15)
	2009–2010	12,724	62	0.49 (0.38–0.62)	0.53 (0.41–0.68)	0.84 (0.60–1.18)	0.84 (0.60–1.18)
	2011–2012	12,706	67	0.53 (0.41–0.67)	0.58 (0.45–0.73)	0.92 (0.66–1.28)	0.91 (0.65–1.28)
	2013–2014	12,285	85	0.69 (0.56–0.85)	0.75 (0.60–0.92)	1.19 (0.87–1.64)	1.18 (0.86–1.62)
	2015–2016	11,367	47	0.41 (0.31–0.55)	0.45 (0.33–0.59)	0.71 (0.49–1.03)	0.70 (0.49–1.02)
	2005–2016	74,771	396	0.53 (0.48–0.58)	0.57 (0.52–0.63)		
0–90 days of surgery							
	2005–2006	12,453	136	1.09 (0.92–1.29)	1.22 (1.03–1.43)	Reference	Reference
	2007–2008	13,236	116	0.88 (0.73–1.05)	0.98 (0.82–1.17)	0.80 (0.63–1.03)	0.80 (0.62–1.03)
	2009–2010	12,724	122	0.96 (0.80–1.14)	1.07 (0.90–1.28)	0.88 (0.69–1.12)	0.88 (0.69–1.12)
	2011–2012	12,706	118	0.93 (0.77–1.11)	1.05 (0.87–1.25)	0.86 (0.67–1.10)	0.85 (0.67–1.09)
	2013–2014	12,285	129	1.05 (0.88–1.24)	1.16 (0.98–1.38)	0.96 (0.76–1.23)	0.95 (0.75–1.21)
	2015–2016	11,367	93	0.82 (0.67–1.00)	0.91 (0.74–1.11)	0.74 (0.57–0.97)	0.74 (0.57–0.96)
	2005–2016	74,771	714	0.95 (0.89–1.03)	1.07 (0.99–1.15)		
0–365 days of surgery							
	2005–2006	12453	199	1.60 (1.39–1.83)	1.87 (1.62–2.14)	Reference	Reference
	2007–2008	13,236	171	1.29 (1.11–1.50)	1.52 (1.31–1.76)	0.81 (0.66–0.99)	0.81 (0.66–0.99)
	2009–2010	12,724	169	1.33 (1.14–1.54)	1.56 (1.34–1.81)	0.84 (0.68–1.03)	0.83 (0.68–1.02)
	2011–2012	12,706	164	1.29 (1.11–1.50)	1.52 (1.30–1.77)	0.82 (0.66–1.01)	0.81 (0.66–0.99)
	2013–2014	12,285	169	1.38 (1.18–1.59)	1.58 (1.36–1.84)	0.86 (0.70–1.06)	0.85 (0.69–1.04)
	2015–2016	11,367	124	1.11 (0.93–1.32)	1.28 (1.07–1.52)	0.69 (0.55–0.86)	0.67 (0.54–0.85)
	2005–2016	74,771	996	1.34 (1.25–1.42)	1.56 (1.46–1.66)		

^a Hazard ratio adjusted for age, sex, and comorbidity by the Charlson comorbidity index; CI = confidence interval; Cumulative incidence = crude risk of reoperation; Kaplan–Meier risk = net risk of reoperation.

In the Figures, Events and Adjusted HRs (CI) are changed

Original Figure 1



Corrected Figure 1

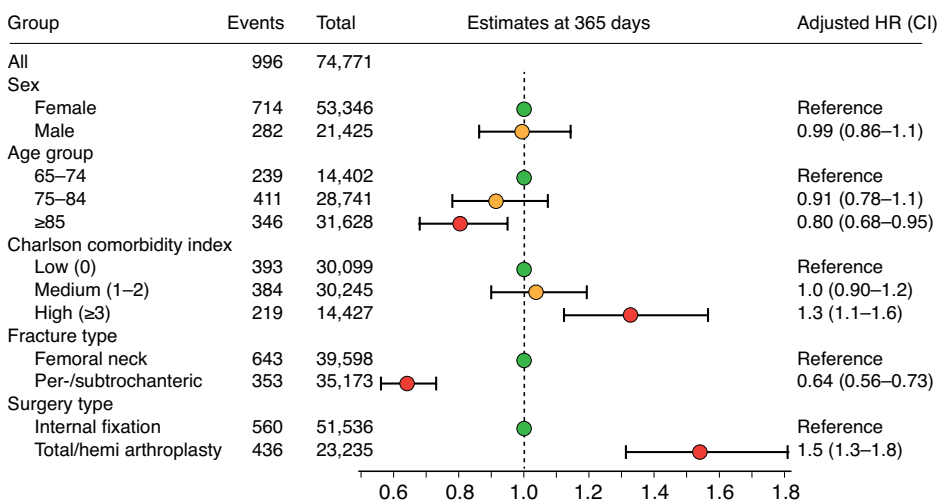
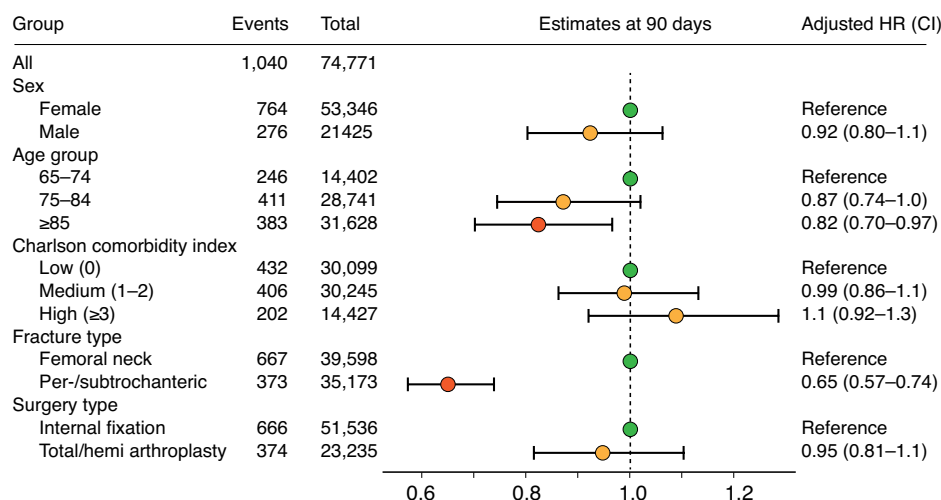


Figure 1. Risk factors for reoperation due to SSI within 1 year of hip fracture surgery.

Original Figure 2



Corrected Figure 2

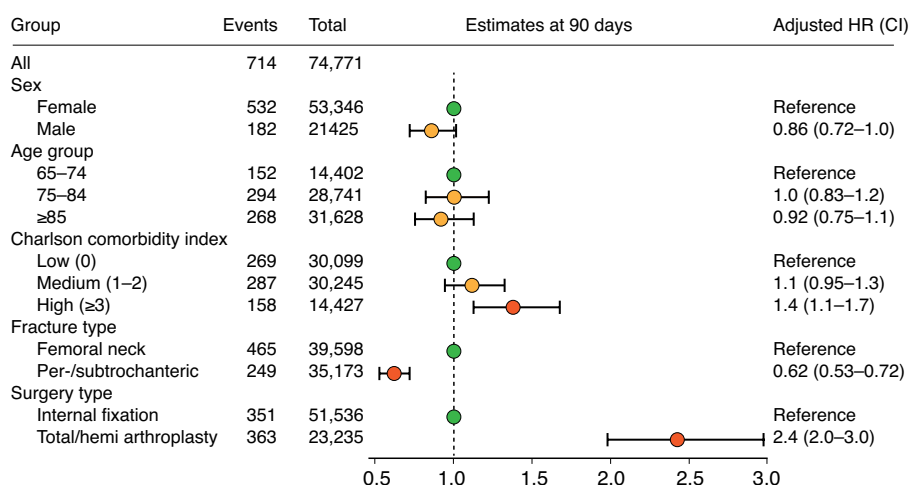


Figure 2. Risk factors for reoperation due to SSI within 90 days of hip fracture surgery.

In the References, the following is changed

Original references

19. Ferguson R, Prieto-Alhambra D, Peat G, Delmestri A, Jordan KP, Strauss V Y, et al. Influence of pre-existing multimorbidity on receiving a hip arthroplasty: Cohort study of 28 025 elderly subjects from UK primary care. *BMJ Open* 2021; 11(9): 1-7. **Deleted reference.**

20. Rogmark C, Kristensen M T, Viberg B, Rönnquist S S, Overgaard S, Palm H. Hip fractures in the non-elderly—Who, why and whither? *Injury* 2018; 49(8): 1445-50. doi: 10.1016/j.injury.2018.06.028

Corrected references

19. Rogmark C, Kristensen M T, Viberg B, Rönnquist S S, Overgaard S, Palm H. Hip fractures in the non-elderly—Who, why and whither? *Injury* 2018; 49(8): 1445-50. doi: 10.1016/j.injury.2018.06.028. **New number.**

20. Kjørholt K E, Kristensen N R, Prieto-Alhambra D, Johnsen S P, Pedersen A B. Increased risk of mortality after postoperative infection in hip fracture patients. *Bone* 2019; 127: 563-70. doi: 10.1016/j.bone.2019.07.023. **Added reference.**