Aims
This study aimed to describe preoperative waiting times for surgery in hip fracture patients in Norway, and analyze factors affecting waiting time and potential negative consequences of prolonged waiting time.

Methods
Overall, 37,708 hip fractures in the Norwegian Hip Fracture Register from January 2014 to December 2018 were linked with data in the Norwegian Patient Registry. Hospitals treating hip fractures were characterized according to their hip fracture care. Waiting time (hours from admission to start of surgery), surgery within regular working hours, and surgery on the day of or on the day after admission, i.e. ‘expedited surgery’ were estimated.

Results
Mean waiting time was 22.6 hours (SD 20.7h); 97.2% (n=36,652) waited less than three days (<72 hours), and 73% (n=27,527) of the patients were operated within regular working hours (08:00 to 16:00). Expedited surgery was given to 84% (n=31,675) of patients, and of these 53% (n=19,985) were treated during regular working hours. American Society of Anesthesiologists (ASA) 4/5 patients were more likely to have surgery within regular working hours (odds ratio (OR) 1.59; p < 0.001) and less likely to receive expedited surgery than ASA 1 patients (OR 0.29; p < 0.001). Low-volume hospitals treated a larger proportion of patients during regular working hours than high volume hospitals (OR 1.26; p < 0.001). High-volume hospitals had less expedited surgery and significantly longer waiting times than low and intermediate-low volume hospitals. Higher ASA classes and Charlson Comorbidity Index increased waiting time. Patients not receiving expedited surgery had higher 30-day and one-year mortality rates (OR 1.19; p < 0.001) and OR 1.13; p < 0.001), respectively.

Conclusion
There is inequality in waiting time for hip fracture treatment in Norway. Variations in waiting time from admission to hip fracture surgery depended on both patient and hospital factors. Not receiving expedited surgery was associated with increased 30-day and one-year mortality rates.

Cite this article: Bone Jt Open 2021;2-9:xxx–xxx.

Keywords: Orthogeriatrics, Hip fracture, Trauma, Health services

Introduction
A hip fracture in elderly people is associated with a substantially increased risk of death compared to the general population, and with subsequent 30-day mortality of around 8%.1 Prolonged waiting time from fracture to surgery increases mortality.2,3 On the other hand, accelerated surgery within six hours of diagnosis did not reduce postoperative mortality.4 Pincus et al5 identified a potential
Evidence-based guidelines from the National Institute of Health and Care Excellence (NICE) and the American Academy of Orthopaedic Surgeons recommend the shortest possible waiting time, and advocate performing surgery within 36 and 48 hours of admission, respectively. The Norwegian multidisciplinary guidelines (2018) concur with this view and recommend surgery preferably within 24 hours, or at least within 48 hours after admission. The National Hip Fracture Database (NHFD) in the UK reports “prompt surgery”, defined as surgery on the day of or after admission, as a key performance indicator (KPI) in order to standardize and improve patient care.

This study aimed to describe the temporal distribution of preoperative waiting time for surgery in patients with a hip fracture in Norway, particularly the proportion of patients receiving treatment within and outside regular working hours (08:00 to 16:00), receiving treatment within recommended waiting time, and having prompt (expedited) surgery. Further, we analyzed patient- and system-related factors affecting waiting time, and assessed potential effects on mortality of extended waiting time for surgery.

Methods
This is a national (5.3 million inhabitants in 2018) retrospective analysis of prospective data, based on linked data from the Norwegian Hip Fracture Register (NHFR) and the Norwegian Patient Registry (NPR). Patients’ unique national identification number enables precise coupling of data from these two registries.

National Hip Fracture Register. The NHFR has collected data on all hip fracture patients operated in Norwegian hospitals since 2005. Total hip arthroplasty (THA) as primary treatment is recorded in the Norwegian Arthroplasty Register and subsequently imported to the NHFR. Data from the NHFR were used to identify patients, and for retrieval of basic information on sex, age, American Society of Anesthesiologists (ASA) class, hospital identification, fracture type, type of operation, and grouping on surgeon experience (i.e. more than three years’ experience of fracture surgery). Completeness of reporting to the NHFR is evaluated regularly, and was 88.2% for osteosynthesis, 94.5% for hemiarthroplasties, and 87.8% for THAs from 2015 to 2016. Date of death was retrieved from the National Population Register.

Characterization of hospitals. All 43 hospitals treating hip fractures in Norway were included. Hospital characteristics and organization of hip fracture care (separate ward, dedicated hip fracture unit, hip fracture programme or orthogeriatric service) were obtained from a national survey of hospitals as part of this research programme.

Flow chart patient selection Hip fractures recorded in the National Hip Fracture Register from 2014 to 2018.
hospitals were grouped in quartiles by hip fracture surgery volume in the inclusion period.

**Administrative data.** Administrative data from all hospitals and other specialist healthcare providers are reported to the NPR monthly including dates and exact times for admission, discharge and surgical interventions. Furthermore, data on all in- and outpatient contacts, including ICD-10 diagnoses, from 1 January 2013 to 31 December 2019 were obtained.

Comorbidity using the Charlson Comorbidity Index (CCI) was calculated from NPR data. The CCI has been validated for use in Norway. The baseline patient characteristics are given in Table I and Table II.

| Table I. Baseline patient characteristics. |
|------------------------------------------|
| **Variable** | **Data** |
| Study population, n | 37,708 |
| **Sex, n (%)** | |
| Females | 25,586 (67.9) |
| Males | 12,122 (32.1) |
| **Median age, yrs (IQR)** | |
| Females | 83 (76 to 90) |
| Males | 84 (78 to 91) |
| **ASA class, n (%)** | |
| 1 | 1,304 (3.5) |
| 2 | 12,483 (33.1) |
| 3 | 21,074 (55.9) |
| 4 and 5 | 2,847 (7.5) |
| **Charlson Comorbidity Index, n (%)** | |
| 0 | 26,027 (69.0) |
| 1 to 2 | 8,309 (22.0) |
| 3 to 4 | 2,160 (5.7) |
| 5 | 1,212 (3.2) |
| **Fracture type, n (%)** | |
| Undisplaced femoral neck fracture - garden 1 to 2 | 4,877 (12.9) |
| Displaced femoral neck fracture - garden 3 to 4 | 17,293 (45.9) |
| Basocervical | 1,070 (2.8) |
| Trochanteric AO/OTA A1 | 5,664 (15.0) |
| Trochanteric AO/OTA A2 | 5,919 (15.7) |
| Intertrochanteric AO/OTA A3 | 905 (2.4) |
| Subtrochanteric | 1,980 (5.4) |
| **Treatment type, n (%)** | |
| Two or three parallel screws | 5,367 (14.2) |
| Arthroplasty | 16,725 (44.4) |
| Sliding hip screw | 8,471 (22.5) |
| Intramedullary nailing | 6,656 (17.7) |
| Other | 489 (1.3) |

AO, Arbeitsgemeinschaft für osteosynthesefragen; ASA, American Society of Anaesthesiologists; IQR, interquartile range; OTA, Orthopaedic Trauma Association.

| Table II. Hospital and structural characteristics for 37,708 hip fracture patients. |
|------------------------------------------|
| **Variable** | **n = 37,708, n (%)** |
| **Surgeons’ experience in fracture surgery** | |
| < 3 years | 5,145 (13.6) |
| > 3 years | 29,584 (78.5) |
| Missing | 2,979 (7.9) |
| **Hospital volume groups** | |
| Quartile 4 (range 1,128 to 2,639)* | 18,006 (47.8) |
| Quartile 3 (range 746 to 1,124)* | 10,074 (26.7) |
| Quartile 2 (range 524 to 740)* | 6,913 (18.3) |
| Quartile 1 (range 83 to 367)* | 2,715 (7.2) |
| **Hospital characteristics** | |
| Orthogeriatric service | |
| Yes | 16,632 (44.1) |
| No | 21,077 (55.9) |
| **Hill fracture programme** | |
| Yes | 34,978 (92.8) |
| No | 2,730 (7.2) |
| **Dedicated hip fracture unit** | |
| Yes | 15,296 (40.6) |
| No | 22,412 (59.4) |
| **Separate orthopaedic ward** | |
| Yes | 33,048 (87.6) |
| No | 4,660 (12.4) |

*Range in hospital volume groups is total volume 2014 to 2018 for hospitals in quartile.

AO, Arbeitsgemeinschaft für osteosynthesefragen; OTA, Orthopaedic Trauma Association.

To explore the effect of delaying surgery from the afternoon and night the day after admission (day 1) to daytime on the following day (day 2), we defined two patient groups: one group operated between 16:00 (day 1) and to 08:00 (day 2). The second group was operated on the following day (day 2) in daytime (08:00 to 16:00). By 31 December 2019, the NHFR had compiled data on 41,699 fractures, admitted from 1 January 2014 to 31 December 2018 (Figure 1). Patients with missing information at time of admission or operation (n = 2,790, 6.7%), and patients with pathological fracture (n = 405, 1.0%), missing information on ASA class (n = 435, 1.0%), and combined fracture types or missing information on fracture type (n = 361, 0.9%) were excluded, leaving 37,708 (90.4%) fractures for analyses (Figure 1), made up of 25,586 females (67.9%) and 12,122 males (32.1%), with a median age of 83 years (interquartile range (IQR) 76 to 90). In analysis of mortality, patients suffering from a contralateral hip fracture within the observation time (minimum one year) were excluded (n = 938/37,708). Baseline patient characteristics are given in Table I and
hospital and system characteristics are presented in Table II.

**Statistical analysis.** The analyses were performed using SAS/STAT for Windows v. 8.2 (SAS Institute, USA). Continuous variables are presented as medians and IQRs. Categorical variables are presented as absolute numbers and percentages. Differences between categorical variables were analyzed using multiple logistic regression, adjusted for sex, age, and ASA class, unless stated otherwise. Age-dependent risk of death at 30 days and 365 days after surgery was estimated by logistic regression analysis. Comparison between groups and differences in
means of waiting time before surgery was evaluated by analysis of variance (ANOVA) with Bonferroni corrections, and the corrections were justified due to the non-normal distribution of the observations. Association between volume and proportion treated expedited was evaluated by a linear regression model. Significance was set at 5% in all analyses.

**Ethics, funding, and conflict of interest.** The project was approved by the Northern Norway Regional Committee for Medical and Health Research Ethics and was exempted from the duty of confidentiality (REK 2018/1955). A data protection integrity assessment was compiled according to the EU General Data Protection Regulation (GDPR). The project was funded by the Northern Norway Regional Health Authority (HNF1482-19). The NHFR is financed by the Western Norway Regional Health Authority. No competing interests were declared.

**Results**

**Time of admission and time of surgery.** Admission time to hospital is illustrated in Figure 2a. Overall, 17,326 patients (46.0%) were admitted during daytime, 15,123 (40.1%) in the afternoon or evening, and 5,259 (14.0%) at night. Time for start of surgery on the day of operation, irrespective of waiting time, is shown in Figure 2b. In all, 19,810 patients (52.5%) were operated during daytime, while 16,972 (45.0%) were operated on in the afternoon or evening. Night-time surgery was rarely performed (n = 926; 2.5%).

**Distribution of time of surgery related to waiting time.** The temporal distribution of time of surgery after admission is illustrated in Figure 3. A total of 12,103 of patients (32.1%) were operated on the day of admission (day 0), 19,640 (52.1%) the day after admission (day 1), 4,901 (13.0%) on day 2, and 1,064 (2.8%) on day 3 or later (day 3+). An increasing proportion were operated during daytime and regular working hours for every day that passed; 25% on day 0, 63% on day 1, and 73% on day 2 and day 3+. Overall, 27% of patients operated on day 3+ had afternoon/evening or night surgery and 4% of surgeries took place at night-time from day 2 and onwards.

**Patient-related factors and timing of surgery.** High-risk patients (i.e. higher ASA class) were more often treated during daytime (Table III). Displaced femoral neck fractures (FNFs) were more likely to be treated during daytime and within regular working hours than all other fracture types. Arthroplasties were also more frequently performed in daytime than other procedures (Table III). Both higher ASA class and CCI score reduced the likelihood of receiving expedited treatment (Table III). Subtrochanteric fractures were more likely to receive expedited surgery. Arthroplasties were less likely to receive expedited surgery than all other surgical procedures.

| Table III. Patient-related factors influencing daytime and expedited surgery. |
|---------------------------|-----------------|-----------------|-----------------|-----------------|-----------------|
| Variable                  | n   | Daytime/working hours, n (% | Logistic regression, OR (95% CI) | p-value | Expedited surgery, n (%) | Logistic regression, OR (95% CI) | p-value |
| ASA class                 |     |                              |                               |        |                              |                               |        |
| 1                         | 1,304 | 614 (47.1) | Ref                          | Ref    | 1,169 (89.7) | Ref                          | Ref    |
| 2                         | 12,485 | 6,447 (51.6) | 1.27 (1.13 to 1.43) | p < 0.001 | 10,946 (87.7) | 0.71 (0.59 to 0.86) | p < 0.001 |
| 3                         | 21,034 | 11,142 (52.9) | 1.37 (1.21 to 1.54) | p < 0.001 | 17,485 (83.0) | 0.47 (0.39 to 0.57) | p < 0.001 |
| 4 and 5                   | 2,847 | 1,607 (56.4) | 1.59 (1.38 to 1.83) | p < 0.001 | 2,143 (75.3) | 0.29 (0.24 to 0.36) | p < 0.001 |
| Charlson Comorbidity Index |     |                              |                               |        |                              |                               |        |
| 0                         | 26,027 | 13,554 (52.1) | Ref                          | Ref    | 22,152 (85.1%) | Ref                          | Ref    |
| 1 to 2                    | 8,309 | 4,456 (53.6) | 1.07 (1.01 to 1.12) | p = 0.013 | 6,883 (82.9) | 0.85 (0.80 to 0.91) | p < 0.001 |
| 3 to 4                    | 2,160 | 1,352 (63.3) | 1.05 (0.96 to 1.15) | p = 0.246 | 1,731 (80.2) | 0.73 (0.65 to 0.81) | p < 0.001 |
| 5                         | 1,212 | 648 (53.5) | 1.06 (0.94 to 1.19) | p = 0.357 | 973 (80.3) | 0.73 (0.63 to 0.84) | p < 0.001 |
| Fracture type             |     |                              |                               |        |                              |                               |        |
| Displaced FNF - garden 3 to 4 | 17,293 | 10,036 (58.0) | Ref                          | Ref    | 14,175 (82.0) | Ref                          | Ref    |
| Undisplaced FNF - garden 1 to 2 | 8,477 | 2,176 (44.6) | 0.58 (0.55 to 0.62) | p < 0.001 | 4,148 (85.0) | 1.21 (1.11 to 1.32) | p < 0.001 |
| Basoacervical             | 1,070 | 527 (49.3) | 0.70 (0.62 to 0.79) | p < 0.001 | 929 (86.8) | 1.49 (1.24 to 1.78) | p < 0.001 |
| Trochanteric AO/OTA A1    | 5,664 | 2,686 (47.4) | 0.65 (0.62 to 0.69) | p < 0.001 | 4,851 (83.7) | 1.32 (1.21 to 1.43) | p < 0.001 |
| Intertrochanteric AO/OTA A2 | 5,919 | 2,909 (49.2) | 0.70 (0.66 to 0.74) | p < 0.001 | 5,098 (86.1) | 1.37 (1.26 to 1.49) | p < 0.001 |
| Subtrochanteric           | 1,980 | 1,039 (52.5) | 0.80 (0.72 to 0.88) | p < 0.001 | 1,762 (90.0) | 1.78 (1.54 to 2.07) | p < 0.001 |
| Treatment type            |     |                              |                               |        |                              |                               |        |
| Arthroplasty              | 16,725 | 9,757 (58.3) | Ref                          | Ref    | 13,629 (81.5) | Ref                          | Ref    |
| 2 or 3 parallel screws    | 5,367 | 2,418 (45.1) | 0.58 (0.54 to 0.61) | p < 0.001 | 4,631 (86.3) | 1.41 (1.29 to 1.55) | p < 0.001 |
| Sliding hip screw         | 8,471 | 3,970 (46.9) | 0.63 (0.60 to 0.66) | p < 0.001 | 7,247 (85.6) | 1.35 (1.26 to 1.46) | p < 0.001 |
| Intramedullary nailing    | 6,656 | 3,427 (51.5) | 0.76 (0.72 to 0.80) | p < 0.001 | 5,809 (87.3) | 1.57 (1.44 to 1.70) | p < 0.001 |
| Other                     | 489   | 238 (48.7) | 0.67 (0.56 to 0.80) | p < 0.001 | 427 (87.3) | 1.60 (1.22 to 2.10) | p < 0.001 |

Logistic regression analyses adjusted for sex, age and ASA class, except analyses on ASA and Charlson Comorbidity Index where ASA class is excluded.

AO, Arbeitsgemeinschaft für osteosynthesefragen; ASA, American Society of Anesthesiologists; CI, confidence interval; FNF, femoral neck fracture; OR, odds ratio; OTA, Orthopaedic Trauma Association.
Hospital/system factors and timing of surgery. Less experienced surgeons operated fewer patients in daytime and within regular working hours, but a higher proportion within the period defined as expedited surgery (Table IV). There was a significant trend that high volume hospitals had a lower proportion of patients treated with expedite surgery than low volume hospitals ($r^2 = 0.1528$; $df = 41$; mean square error 0.0048) (Figure 4).

An orthogeriatric service unit did not increase the proportion of patients having surgery within regular working hours or as expedited surgery. A dedicated hip fracture unit increased the proportion of patients having a daytime operation, but reduced the proportion having expedited surgery. A separate orthopaedic ward reduced the proportion of patients having expedited surgery (Table IV).

Differences in mean waiting time. Waiting time increased significantly with higher ASA classes and increasing CCI (Table V). Displaced FNFs treated with arthroplasty had statistically significantly longer waiting times than all other fractures and treatment types, except basocervical fractures (Table V). High volume (Q4) hospitals had significantly longer waiting times than low volume (Q1) and intermediate low volume (Q2) hospitals. Low volume (Q1) hospitals had almost five hours shorter waiting time (Table V).

Consequences of the timing of surgery. In unadjusted logistic regression analyses, non-expedited surgery resulted in higher 30-day and one-year mortality rates compared to expedited surgery (OR 1.19; 95% confidence interval (CI) 1.08 to 1.31; $p < 0.001$, and OR 1.13; 95% CI 1.06 to 1.20; $p < 0.001$, respectively). Working hours surgery on day 2 increased 30-day and one-year mortality compared to afternoon/evening/night surgery on day 1 in unadjusted analyses (Table VI). Adjusting for age, sex, and CCI demonstrated that not receiving expedited surgery resulted in higher mortality rates. Figure 5 illustrates the effect on 30-day mortality for each ASA class and CCI group related to age. There was a statistically significant higher 30-day mortality rate for non-expedited surgery than for expedited surgery in all CCI groups (OR 1.16; 95% CI 1.05 to 1.29; $p = 0.004$). All analyses logistic regression, adjustment stated in each analyses.

Discussion

The waiting time issue has been addressed using three indicators; waiting time in hours, surgery within regular working hours, and the UK KPI indicator expedited surgery (prompt surgery). Patient comorbidity, expressed as both higher ASA class and CCI score, increased waiting time. Similarly, fracture type and surgical procedure affected waiting time. Displaced FNF and treatment with arthroplasty prolonged waiting time, but at the same time increased the probability of surgery within regular working hours. We hypothesize that specialized surgeons

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**Table IV. Hospital- and system-related factors influencing daytime and expedited surgery.**

| Variable                                | n     | Daytime/working hours, n (%) | Logistic regression, OR (95% CI) p-value | Expedited surgery | Logistic regression, OR (95% CI) p-value |
|-----------------------------------------|-------|-----------------------------|----------------------------------------|-------------------|----------------------------------------|
| Surgeon’s experience in fracture surgery|       |                             |                                        |                   |                                        |
| > 3 years                               | 29,584| 15,565 (52.6)               | Ref                                    | 24,967 (84.4)     | Ref                                    |
| < 3 years                               | 5,145 | 2,240 (43.5)                | 0.70 (0.66 to 0.74) p < 0.001           | 4,447 (86.4)      | 1.11 (1.04 to 1.19) p = 0.003           |
| Missing                                 | 2,979 | N/A                         | N/A                                    | N/A               | N/A                                    |
| Hospital volume groups                   |       |                             |                                        |                   |                                        |
| High volume (quartile 4)                | 18,006| 9,712 (53.9)                | Ref                                    | 14,570 (80.9%)    | Ref                                    |
| Intermediate-high volume (quartile 3)   | 10,074| 4,925 (48.9%)               | 0.81 (0.78 to 0.86) p < 0.001           | 8,591 (85.3%)     | 1.39 (1.30 to 1.49) p < 0.001           |
| Intermediate-low volume (quartile 2)    | 6,913 | 3,555 (51.4)                | 0.90 (0.85 to 0.95) p < 0.001           | 6,180 (89.4)      | 2.05 (1.88 to 2.23) p < 0.001           |
| Low volume (quartile 1)                 | 2,715 | 1,618 (59.6)                | 1.26 (1.16 to 1.37) p < 0.001           | 2,402 (88.5)      | 1.83 (1.62 to 2.07) p < 0.001           |
| Orthogeriatric service                  |       |                             |                                        |                   |                                        |
| Yes                                     | 16,631| 8,820 (53.0)                | Ref                                    | 13,940 (83.3)     | Ref                                    |
| No                                      | 21,077| 10,990 (52.1)               | 0.97 (0.93 to 1.01) p = 0.110           | 17,803 (84.5)     | 1.04 (0.96 to 1.10) p = 0.157           |
| Hip fracture programme                   |       |                             |                                        |                   |                                        |
| Yes                                     | 34,978| 18,320 (52.4)               | Ref                                    | 29,273 (83.7)     | Ref                                    |
| No                                      | 2,730 | 1,490 (54.6)                | 1.10 (1.02 to 1.19) p = 0.020           | 2,470 (90.5)      | 1.84 (1.62 to 2.10) p < 0.001           |
| Dedicated hip fracture unit              |       |                             |                                        |                   |                                        |
| Yes                                     | 15,296| 8,441 (55.2)                | Ref                                    | 12,562 (82.1)     | Ref                                    |
| No                                      | 22,412| 11,369 (50.7)               | 0.84 (0.80 to 0.87) p < 0.001           | 19,181 (85.6)     | 1.30 (1.23 to 1.38) p < 0.001           |
| Separate orthopaedic ward               |       |                             |                                        |                   |                                        |
| Yes                                     | 33,048| 17,355 (52.5)               | Ref                                    | 27,549 (83.4%)    | Ref                                    |
| No                                      | 4,660 | 2,455 (52.7)                | 1.01 (0.95 to 1.08) p = 0.721           | 4,194 (90.0)      | 1.78 (1.61 to 1.96) p < 0.001           |

Logistic regression analyses were adjusted for sex, age, and ASA class.
ASA, American Society of Anesthesiologists; CI, confidence interval; OR, odds ratio
performed the arthroplasties, especially THAs, in working hours. Other treatment alternatives may be considered less technically demanding, and require less surgical experience.

Compared to arthroplasties, other fracture treatments more frequently were performed outside regular working hours, and were more often performed by less experienced surgeons.

The high-volume (Q4) hospital group had significantly longer waiting times and a lower proportion of patients treated during regular working hours than Q1 to Q3 volume groups. The larger hospitals should have resources and staff to perform surgery for a longer period of the day. Recently Nilsen et al. demonstrated that strained hospital resources, increased waiting time to surgery by 20% and led to a 20% higher 60-day mortality. This supports our contention that hip fracture patients are not prioritized in hospital management.

Waiting time is a modifiable risk factor. Reimbursement schemes introduced to encourage expedited surgery have been followed by reduced preoperative waiting time. Introduction of the Best Practice Tariff (BPT) in the UK reduced preoperative waiting time and one-year mortality rate. Some hospitals have restructured fracture care for elderly people but with inconclusive effects. The paradoxical effect on waiting time by system factors changes as demonstrated here, is a finding we cannot explain. Currently, there is no professional consensus nor high-level scientific evidence for the effectiveness of system changes. Despite the inconclusive scientific literature, optimization of patient pathways with a focus on reducing unnecessary waiting should have high priority in day-to-day management.

Comorbidity was a factor in delayed surgery, but was also an independent predictor of postoperative mortality. Our interpretation is that the increased mortality we observed when waiting time was prolonged was explained by a delay in surgery for patients with greater comorbidity. Consequently, there is a balance between preoperative optimization of the patient and increasing waiting time. Waiting an extra night was associated with increased mortality in the postoperative period. An extra night may improve the fitness of patients with significant comorbidities but at the potential expense of a higher mortality, and increases patient’s discomfort by waiting immobilized.
In a narrative literature review, Lewis et al documented that ASA class was a consistent predictor of 30-day mortality, while CCI expresses more underlying chronic diseases and pre-fracture function which also affects mortality. However, others have shown a low predictive power of comorbidity indices for mortality after hip fractures treated with arthroplasty. Recently, Narula et al has shown, in a retrospective study, that the Clinical Frailty Scale (CFS) was a good predictor of mortality for hip fracture patients. CFS cannot be estimated based on routine administrative data but CFS data should be recorded in future prospective studies.

The increased postoperative death rate associated to treatment delay both in medically fit and unfit patients are not substantial but in line with findings in other studies. A support for the notion that delay is associated with increased mortality is the subgroup analysis comparing day 1/afternoon and evening surgery and surgery day two/working hours operations. Although the negative effect of treatment delay on mortality is relatively small, a more focused professional attention on delay as a health issue problem, could rectify this problem.

Both from a patient and health policy perspective, variations in waiting time for surgery is unwarranted healthcare inequality. Any contrast in hospital waiting time must be considered unwarranted. We conclude that expedited surgery, as used in the UK, is a better indicator than hours of waiting, embracing both the aspects of time and patient discomfort.

**Strengths and limitations.** The main strengths of the study are the large study population and the inclusion of all hospitals in Norway routinely treating hip fractures. We were not able to prove causality, although an association between mortality (or survival) and treatment delay has been documented. We acknowledge that pre-hospital waiting time was not included in our analysis. A
previous study from the NHFR has shown that the median time from fracture to admission is six hours.\(^2\) Given a mean in-hospital waiting time of 23 hours in this study, we find it unlikely that the addition of pre-hospital waiting time would have led to different results and changed our conclusions.

The findings in this study clearly indicate inequity in waiting time for hip fracture treatment in Norway. Variations in waiting time from admission to hip fracture surgery depended on both patient and hospital factors. Not receiving expedited treatment was associated with increased 30-day and one-year mortality rates. Further studies should address why such differences occur and whether specific patient groups should be prioritized differently.

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**References**
1. Leer-Salvesen S, Dylvik E, Engesaeter LB, Dahl OE, Gjertsen JE. Low-molecular-weight heparin for hip fracture patients treated with osteosynthesis: should thromboprophylaxis start before or after surgery? An observational study of 45,913 hip fractures reported to the Norwegian Hip Fracture Register. Acta Orthop. 2018;89(6):615–621.
2. Pincus D, Ravi B, Wasserstein D, et al. Association between wait time and 30-day mortality in adults undergoing hip fracture surgery. JAMA. 2017;318(20):1994–2003.
3. Leer-Salvesen S, Engesaeter LB, Dylvik E, Furnes O, Kristensen TB, Gjertsen JE. Does time from fracture to surgery affect mortality and intraoperative medical complications for hip fracture patients? An observational study of 73,557 patients reported to the Norwegian Hip Fracture Register. Bone Joint J. 2019;101-B(9):1129–1137.
4. Investigators THA. Accelerated surgery versus standard care in hip fracture (HIP ATTACK): an international, randomised, controlled trial. Lancet. 2020;395(10225):698–708.
5. National Institute of Health and Care Excellence. Hip fracture: management (Clinical guideline (CG124)). 2011. www.nice.org.uk/guidance/cg124 (date last accessed 10 August 2021).
6. American Academy of Orthopaedic Surgeons. Management of hip fractures in the elderly. AAOS. 2014. https://www.aaos.org/cc_files/aaosresearch/research/ guidelines/hipfractureguideline.pdf (date last accessed 10 August 2021).
7. Saltvedt I, Frihagen F, Sletvold O. Norwegian guidelines for interdisciplinary care of hip fractures. Norwegian Orthopaedic Association, Norwegian Geriatric Society, Norwegian Anaesthesiological Society. 2018. https://www.legeforeningen.no/contentassets/7f4bec178c34464489b83240606f9ee/norske-retningslinjer-for-tverrfaglig-behandling-av-hoftebrudd.pdf (date last accessed 10 August 2021).
8. National Hip Fracture Database UK. Key Performance Indicators Hip Fracture Care. https://www.nhfd.co.uk/20/NHFDCharts/nsf/vwCharts/KPIsOverview: National Hip Fracture Database. 2021. https://www.nhfd.co.uk/20/NHFDCharts/nsf/vwCharts/KPIsOverview (date last accessed 10 August 2021).
Mortality at 30-days postoperatively related to age of patients

Gjertsen JE, Engesaeter LB, Furnes O, Hallen G, et al. Annual report 2019: Norwegian Advisory Unit on Arthroplasty and Hip Fractures. 2019. http://hrweb.ihelse.net/eng/Rapporter/Report2019_eng.pdf Access date 230919 (date last accessed 10 August 2021).

11. Kjærvik C, Stensland E, Byhring HS, Gjertsen JE, Dybvik E, Søreide O. Hip fracture treatment in Norway: deviation from evidence-based treatment guidelines: data from the Norwegian Hip Fracture Register, 2014 to 2018. Bone Joint J Open. 2020;11(10):644–653.

12. World Health Organization. ICD-10: International Statistical Classification of Diseases and Related Health Problems: Tenth Revision, 2nd ed. 2004. https://apps.who.int/iris/handle/10665/423880

13. Quan H, Li B, Couris CM, Fushimi K, Graham P, Hider P, et al. Updating and validating the Charlson comorbidity index and score for risk adjustment in hospital discharge abstracts using data from 6 countries. Am J Epidemiol. 2011;173(6):676–682.

14. Nilsen Y, Strand TE, Wiik R, Bakken UJ, XQ Y, O’Connell DL, et al. Utilizing national patient-register data to control for comorbidity in prognostic studies. Clin Epidemiol. 2014;6:395–404.

15. Nilsen SM, Asheim A, Carlsten F, et al. High volumes of recent surgical admissions, time to surgery, and 90-day mortality. Bone Joint J. 2021;103-B(2):264–270.

16. Uri O, Folman Y, Lauder G, Behrbalk E. A reimbursement system based on a 48-hour target time for surgery shortens the waiting time for hip fracture fixation in elderly patients. J Orthop Trauma. 2020;34(5):248–251.

17. Oakley B, Nightingale J, Moran CG, Moggett IK. Does achieving the best practice tariff improve outcomes in hip fracture patients? An observational cohort study. BMJ Open. 2017;7(2):e014190.

18. Pollmann CT, Rutterud JH, Gjertsen J-E, Dahl FA, Lenvik O, Åreén A. Fast track hip fracture care and mortality - an observational study of 2230 patients. BMC Musculoskelet Disord. 2019;20(1):248.

19. Haugan K, Johnson LG, Basso T, Foss OA. Mortality and readmission following hip fracture surgery: a retrospective study comparing conventional and fast-track care. BMJ Open. 2017;7(8):e015574.

20. Larsson G, Stromberg RU, Røtterud JH, Nilsdotter A. Prehospital fast track care for patients with hip fracture: Impact on time to surgery, hospital stay, post-operative complications and mortality in a randomised, controlled trial. Injury. 2018;49(4):881–888.

21. Lewis PM, Waddell JP. When is the ideal time to operate on a patient with a fracture of the hip? The Bone & Joint Journal. 2016;98-B(12):1573–1581.

22. Balow E, Cnudde P, Røtterud JH, Nemes S. Low predictive power of comorbidity indices identified for mortality after acute arthroplasty surgery undertaken for femoral neck fracture. Bone Joint J. 2019;101-B(1):104–112.

23. Narula S, Lawless A, D’Alessandro P, Jones CW, Yates P, Seymour H. Clinical Frailty Scale is a good predictor of mortality after proximal femur fracture: A cohort study of 30-day and one-year mortality. Bone Joint J. 2020;103-B:443–449.

24. Kelly-Pettersson P, Samuelsson B, Muren O, Unbeck M, Gordon M, Stark A, et al. Waiting time to surgery is correlated with an increased risk of serious adverse events during hospital stay in patients with hip-fracture: A cohort study. Int J Nurs Stud. 2017;69:91–97.

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Funding statement:

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