



Outcomes

Cognitive impairment is associated with mortality in older adults in the emergency surgical setting: Findings from the Older Persons Surgical Outcomes Collaboration (OPSOC): A prospective cohort study[☆]



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ABSTRACT

Background: Cognitive impairment is prevalent in older surgical patients; however, the condition is greatly under-recognized, and outcomes associated with it are poorly understood.

Methods: This is a prospective multicenter cohort study of unselected consecutive older adults admitted to 5 emergency general surgical units across the United Kingdom participating in the Older Persons Surgical Outcomes Collaboration from 2013–2014. The effect of moderate cognitive impairment defined as ≤ 17 , bottom quartile of Montreal Cognitive Assessment was examined using multivariate logistic regression models. Primary outcome measure was the relationship between a low Montreal Cognitive Assessment score (≤ 17) and mortality at 30 and 90 days. Secondary outcome measures included the association between having a low Montreal Cognitive Assessment and hospital length of stay.

Results: A total of 539 older patients admitted consecutively to 5 surgical units during the 2013 and 2014 study periods were included. The median age (interquartile range) was 76 years (70–82 years), the emergency operation rate was 13% ($n = 72$). The prevalence of cognitive impairment, using the traditional Montreal Cognitive Assessment cutoff score of ≤ 26 , was 84.4% and, using the recently suggested cutoff score of ≤ 23 , the prevalence was 61.0%. Multivariable analyses showed patients with a low Montreal Cognitive Assessment score (≤ 17) had a three-fold increase in 30-day mortality (adjusted odds ratio = 3.10; 95% confidence interval: 1.19–8.11; $P = .021$) and an increased length of hospital stay (10 or more days; 1.80 [1.10–2.94; $P = .02$] and 14 or more days; 2.06 [1.17–3.61; $P = .012$]).

Conclusion: We recommend a routine cognitive assessment in an emergency surgical setting whenever feasible to help identify patients at risk of poor outcomes.

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Introduction

Cognitive impairment is reported in more than 65% of older adults (65 years and older) presenting with emergency general surgical conditions.^{1,2} Earlier evidence from elective surgery suggests that cognitive impairment is associated with an increased risk of postoperative complications and poorer outcomes when compared with patients with normal cognition.³ With the older adult population continuing to increase in significant numbers and

subsequently placing increasing demands on the emergency surgeon, establishing the relationship of cognitive impairment with patient outcomes could lead to improved recognition, understanding, and early intervention in this vulnerable older adult surgical population.⁴

Cognitive impairment can be longstanding (dementia) or acute (delirium) and both frequently coexist in acutely unwell older people. Dementia is defined as chronic cognitive impairment involving at least two domains of intellectual capacity: memory, language, visuospatial, executive functioning, and calculation, which all negatively impact functioning.^{4–7} Meanwhile, delirium is characterized by fluctuating disturbances of consciousness, disorientation, and perceptual abnormalities, with impaired thinking and speech, which usually resolves after several days.⁴ There are a multitude of predisposing factors for delirium, including polypharmacy, sepsis, surgical intervention, and dementia.⁴

The screening tool of choice for detecting mild cognitive impairment is the Montreal Cognitive Assessment (MoCA).^{1,8,9} This is a validated and easy-to-use questionnaire consisting of visual, memory/recall questions, scored out of 30.¹⁰ The creators of the cognitive assessment provide guidance on the interpretation of MoCA scores, with scores of 18–25 indicating mild, 10–17 indicating moderate, and scores of less than 10 indicating severe cognitive impairment.¹⁰ When compared with the Mini Mental State Examination (MMSE), the sensitivity of the MoCA was 90% versus 18% in the detection of mild cognitive impairment.^{8,10–13}

An earlier work using MoCA in a single center vascular surgical setting reported the prevalence of cognitive impairment to be as high as almost 70%.¹³ However, this has yet to be confirmed in a multicenter study of acute general surgical patients. Moreover, it was also observed that a low MoCA was associated with poor outcomes, such as an increased length of hospital stay.¹³ Nevertheless, there remains a gap in the literature examining the association between a low MoCA and outcomes, such as mortality and hospital readmission, in a multicenter cohort of older adults admitted to the emergency general surgical setting.

Methods

Study design

As part of the Older Persons Surgical Collaboration (OPSOC), a prospective study was conducted across five hospitals in the United Kingdom between 2013 and 2014. Data were collected within the acute general surgical admissions setting for patients ≥ 65 years of age consecutively admitted to the participating units throughout May–June (2 months) of both years, as described in an earlier OPSOC study by Hewitt et al.¹ Patients were excluded if they presented with vascular, orthopedic, urologic, gynecologic, or neurologic conditions, because these patients are admitted to specialist surgical departments within the National Health Service (NHS). In the United Kingdom, most emergency general surgical admissions relate to gastrointestinal disturbances (ie, appendicitis, diverticulitis, bowel obstruction/perforation, or pancreatobiliary disease), but may also include surgical conditions, such as abscesses.¹

Outcomes

Primary outcome measure was the relationship between the MoCA score and mortality at 30 and 90 days. Secondary outcome measures included the association between having impaired cognition (a low MoCA score) and 30-day readmission and hospital length of stay.

Data collection

Data were recorded and stored in conjunction with local data management and safety standard operating procedures. Anonymized data were collated centrally at the chief investigator's institution. All patients were service users of the state-funded point-of-access care provided by the NHS in the United Kingdom, and only routinely available audited data were collected. As such, the collection of the data used in this study was deemed a service evaluation audit that did not require ethical approval. Only approval from individual organizations participating in the service evaluation was required and granted. All patients were identified prospectively, and baseline demographic data were collected at admission. As a surrogate marker of comorbidity and disease severity, we recorded the presence of anemia ($<129\text{g/L}$), hypoalbuminemia (albumin $<35\text{g/L}$), and polypharmacy (≥ 5 medications on admission) as categorical data.

All data collectors were appropriately trained in the cognitive assessments used. In both the 2013 and 2014 data collection periods ($N=539$), all older adults admitted to the emergency general surgical setting had a MoCA test before any surgical intervention or within 24 hours of their admission. MoCA is a 30-point score (range 0–30) that is used as a screening tool to detect cognitive impairment.¹⁰ Scores were dichotomized into being in the bottom 25% versus the other 75% to reflect the actual MoCA scores of the bottom quartile of older emergency surgical patients across the United Kingdom. When using data collected from 2013 and 2014, the bottom 25% MoCA was ≤ 17 . Developers of MoCA have recommended the interpretation of MoCA scores between 10–17 to indicate moderate cognitive impairment.¹⁰ We used the MoCA test in English, original v 7.1.

During the 2014 data collection period ($N=354$), both MoCA and Confusion Assessment Method (CAM) data were collected from all older patients admitted to the emergency general surgical setting before any surgical intervention or within 24 hours of their admission. CAM is a validated method of allowing nonpsychiatric clinicians to detect delirium by identifying 3 out of 4 described features, demonstrating an overall sensitivity of 94% and specificity of 89%.^{14,15} CAM data were only collected during the 2014 collection period because of delirium becoming a new service evaluation focus of OPSOC. In the 2014 sample, the bottom 25% MoCA was ≤ 18 . With the 1-point difference, it is unlikely to have any major clinically significant differences in outcomes between the 2 cutoff points; however, using specific cutoff points for subgroup analysis provides statistical robustness and confirms the association between bottom quartile of MoCA and outcome in the subcohort.

Follow-up data were obtained from electronic patient records. A continuous value was recorded for length of hospital stay (LOS), with days rounded up to the nearest whole-day integer. The LOS was arbitrarily recategorized, for ease of interpretation for clinicians, into 3 dichotomized variables <7 and ≥ 7 days, <10 days, and ≥ 10 days and <14 days and ≥ 14 days, which corresponded approximately with the 60th, 75th, and 85th centile values of the continuous values. Furthermore, data regarding patient readmission at 30 days and mortality at 30 and 90 days were collected as dichotomized variables.

Statistical analysis

All analyses were performed using SPSS, v 24.0 (IBM, Armonk, NY, USA). Descriptive statistics were compared between patients in the bottom 25% MoCA score (≤ 17) versus patients in the other 75% MoCA score (≥ 18), using the ANOVA and χ^2 test for continuous and categorical data.

In our primary analysis, we examined the association between having moderate cognitive impairment (bottom 25% MoCA score of

≤ 17) with study outcomes using unadjusted models (model A) and adjusted models (model B) for receiving an emergency operation and characteristics (age, sex, low hemoglobin, hypoalbuminemia, and polypharmacy [≥ 5 medications on admission]).¹ In our secondary analysis, which only included patients with both CAM and MoCA data ($N=354$), we recalculated the bottom quartile MoCA cutoff score for sensitivity analysis purposes (bottom 25% MoCA score of ≤ 18). Models used in our secondary analysis included adjusted for delirium assessed using CAM (model A) and adjusted for receiving an emergency operation and characteristics (age, sex, low hemoglobin, hypoalbuminemia, and polypharmacy [≥ 5 medications on admission]); model B).

To assess the sensitivity of our approach of using the bottom quartile MoCA cutoff score in predicting our primary outcome of 30-day mortality, using our full cohort, we also calculated cutoff points for the middle 50% and upper 25% of MoCA scores, which were $\leq 22/30$ and $\leq 25/30$, respectively. We then examined the association between the middle 50% and upper 25% of MoCA scores, adjusted for receiving an emergency operation and characteristics (age, sex, low hemoglobin, hypoalbuminemia, and polypharmacy [≥ 5 medications on admission]) with 30-day mortality.

To identify the relationship between delirium and mild-to-moderate cognitive impairment, we compared the rates of patients with delirium assessed using CAM and a MoCA score of $\leq 18/30$, using only patients with both CAM and MoCA data (ie, 2014 cohort). Descriptive statistics were compared between patients excluded because of the MoCA test not being completed versus patients included in our study with completed MoCA data, using ANOVA and χ^2 test for continuous and categorical data.

Results

A total of 660 patients were enrolled into 2013 and 2014 data collection cycles. Of those patients, 121 patients were excluded because of incomplete data (Fig 1). Thus 539 patients were included in the current study. The median age (interquartile range [IQR]) was 76 years (70–82 years). There were 283 (52.5%) women in our sample. The median (IQR) MoCA score was 22.0 (17–25). When using the traditional cutoff score, 455 (84.4%) had a MoCA score ≤ 26 , and using the recently proposed cutoff score of ≤ 23 , the prevalence was 329 (61.0%). When using the bottom quartile MoCA cutoff score of ≤ 17 , a total of 379 (73.7%) patients scored ≥ 18 , with 142 (26.3%) patients scoring ≤ 17 , indicating that about a quarter of the older unselected emergency general surgical patients had cognitive impairment comparable with people living with Alzheimer's disease.⁸

The characteristics of the sample by MoCA categories (≤ 17 and ≥ 18) are presented in Table 1. Of the 142 patients with a score of ≤ 17 , a total of 80 (56.3%) were female and 62 (43.7%) male, with a similar likelihood of being in the lowest quartile of the study population between two sexes ($P=.29$). Polypharmacy was prevalent (65.1%). Nearly half of all patients had low serum albumin levels (35g/L; 44.0%) and anemia (46.0%) in the low MoCA group. Characteristic comparisons between groups showed increasing age, polypharmacy, low hemoglobin levels, and delirium were all significantly associated with having a low MoCA score. Figure 2 presents the relationship between delirium assessed using CAM and moderate cognitive impairment (bottom 25% MoCA score of ≤ 18) using only those with both CAM and MoCA data (ie, 2014 cohort). A low MoCA score was not associated with low serum albumin levels or receiving surgical intervention.

We have also presented the characteristics of the 95 patients excluded from our study attributable to MoCA testing not being conducted for reasons such as severe disability, being too unwell, or known advanced dementia¹ (Supplementary Table 1). Patients without a completed MoCA test were predominantly male (56.8%),

had low serum albumin levels (35g/L; 77.9%), and were anemic (80.0%). We observed no statistical association between not having a completed MoCA and 30-day mortality; whereas we did observe an association between the excluded patients and higher 90-day mortality when compared with patients included in our study.

For our primary analysis, the bottom 25% MoCA group (≤ 17) in univariate analyses was associated with 30-day mortality (3.27 [1.30–8.21]; $P=.012$) and increased hospital length of stay: ≥ 7 days (1.57 [1.04–2.36]; $P=.032$), ≥ 10 days (1.69 [1.10–2.61]; $P=.018$), and ≥ 14 days (1.78 [1.08–2.95]; $P=.024$). In fully adjusted logistic regression models, being in the bottom 25% MoCA group was associated with 30-day mortality (3.10 [1.19–8.11]; $P=.021$) and increased hospital length of stay: ≥ 10 days (1.80 [1.10–2.94]; $P=.020$) and ≥ 14 days (2.06 [1.17–3.61]; $P=.012$). We found no association between being in the bottom 25% MoCA group and 90-day mortality, 30-day readmission, and a hospital length of stay of ≥ 7 days (Table 2).

Patients with missing delirium data (185 patients) assessed using CAM were further excluded from our secondary analysis. Therefore, subgroup analysis was undertaken in 354 patients (Fig 1) and additional adjustment was made for presence of delirium in model A (Table 3). In our subgroup analysis, being in the bottom 25% of MoCA (≤ 18) was associated with 30-day mortality (3.61 [1.31–9.95]; $P=.013$) and increased odds of hospital length-of-stay outcomes: ≥ 7 days (1.94 [1.15–3.26]; $P=.012$) and ≥ 10 days (1.87 [1.08–3.25]; $P=.025$) in univariate analysis. In fully adjusted logistic regression models, being in the bottom 25% of MoCA score was associated with 30-day mortality (3.42 [1.19–9.81]; $P=.022$) and increased hospital length of stay: ≥ 7 days (1.91 [1.07–3.41]; $P=.029$) and ≥ 10 days (1.96 [1.02–3.77]; $P=.044$). A total of 24.8% of patients with dementia also had delirium, with 11.1% of this group dying at 30 days. No association was observed for other outcomes in subgroup analyses.

Using the full cohort in our sensitivity analysis, MoCA scores of the middle 50% ($\leq 22/30$) and upper 25% ($\leq 25/30$) were not found to be associated with our primary outcome of 30-day mortality (2.81 [0.90–8.81], $P=.08$; 4.84 [0.67–37.44], $P=.13$; Table 4).

Discussion

This is the first study to report the association between cognitive impairment, assessed using MoCA score in older adults aged ≥ 65 years and patient related outcomes on admission to the emergency general surgical setting. Mild-to-moderate cognitive impairment assessed on admission, using MoCA, was associated with increased odds of 30-day mortality and increased hospital length of stay. When adjusting additionally for delirium in a subgroup of patients with available CAM data, we observed that having a low MoCA score remained associated with a three-fold increase in the odds of 30-day mortality and increased odds of prolonged length of hospital stay.

In a 2014 single-center study of elective and emergency aortic and lower limb vascular surgical patients ≥ 60 years of age, in which the MoCA was assessed preoperatively, it was reported that nearly 70% of the patients had cognitive impairment when using the cutoff score of 24/30.¹³ Within our UK multicenter cohort of older patients (aged ≥ 65 years), we were able to confirm the high prevalence of cognitive impairment in the emergency general surgery setting. This may reflect the World Health Organization's estimation that there are approximately 9.9 million new cases of dementia each year and this may be increasing.¹⁶ It has been reported that dementia is often undiagnosed, with 1 study finding that 88% of the patients detected to have dementia were previously unaware of their condition.^{2,13,17} To the best of our knowledge, it is not a routine practice to complete a cognitive assessment on admission to the general surgical wards.¹

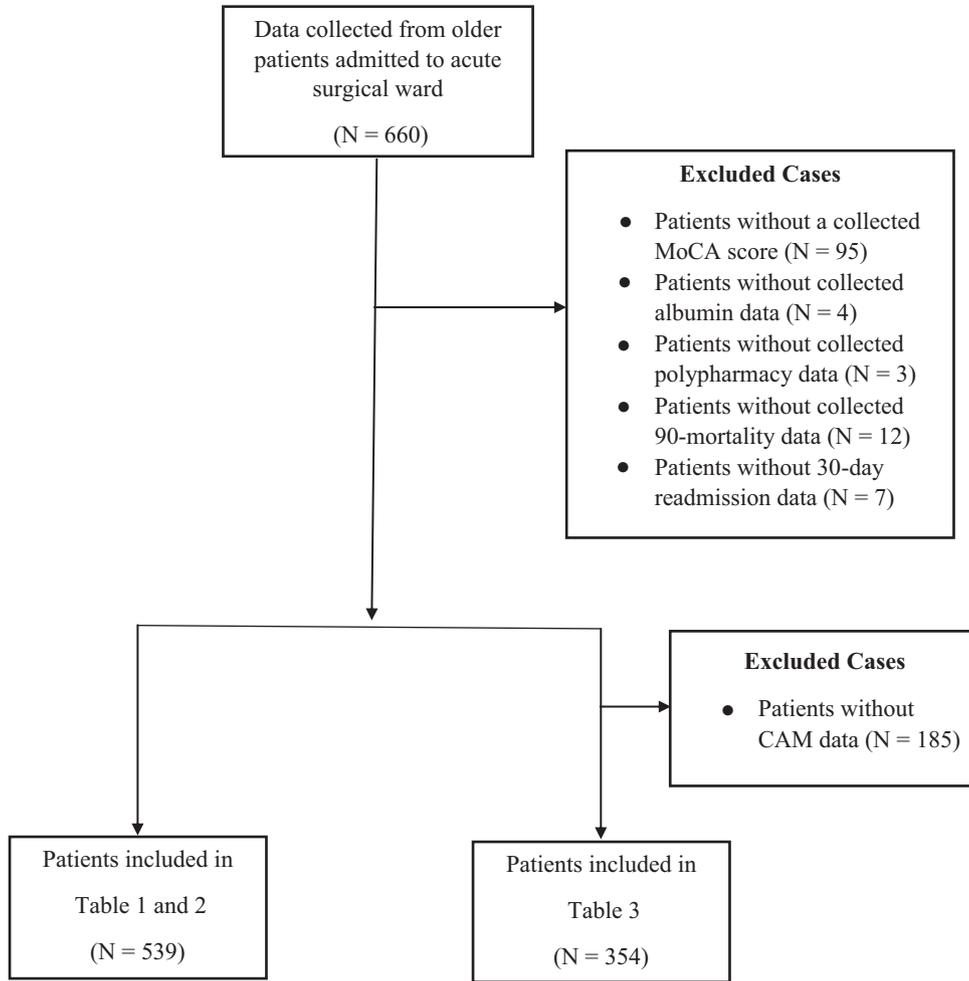


Fig. 1. Flowchart describing reasons for exclusion.

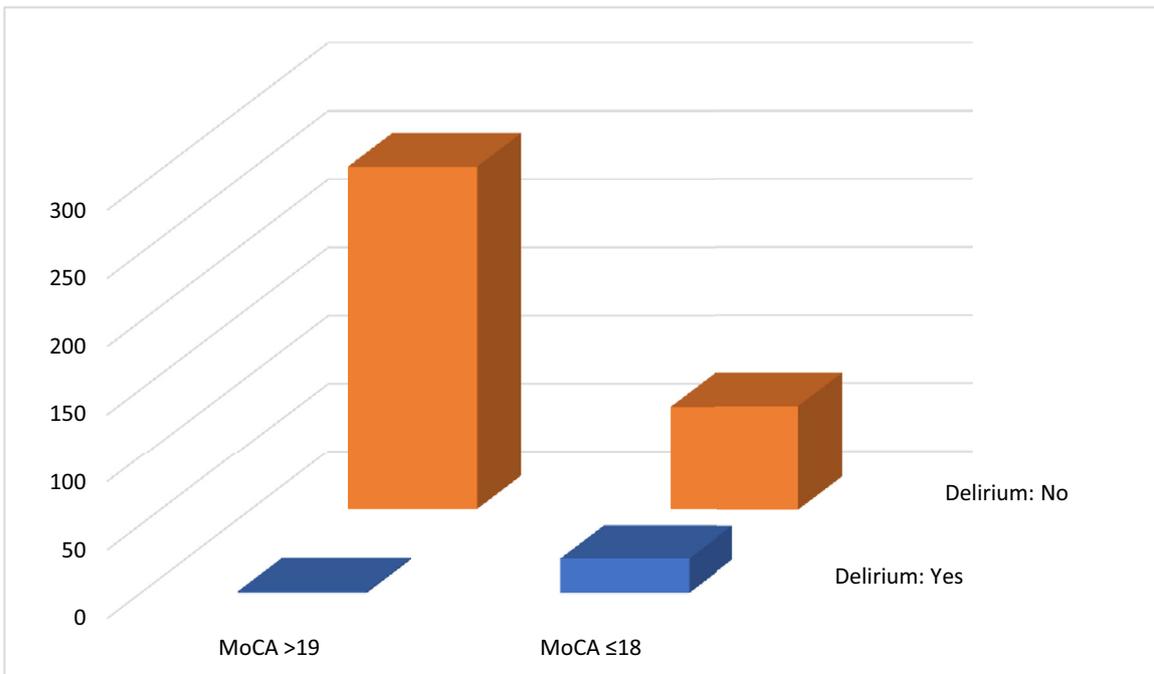


Fig. 2. Relationship between delirium assessed using CAM and moderate cognitive impairment (bottom 25% MoCA score ≤ 18), using only the 2014 cohort.

Table 1
Patient characteristics by patients with bottom 25% MoCA score (≤ 17) versus other 75% MoCA score (≥ 18) in 539 patients*.

| Variable | MoCA score (≤ 17) (n = 142) | MoCA score (≥ 18) (n = 397) | P value |
|----------------------------------|------------------------------------|------------------------------------|---------|
| Age (years) | 79.44 (7.34) | 75.61 (7.63) | < .001 |
| Sex | | | .29 |
| Male | 43.7% (62) | 48.9% (194) | |
| Female | 56.3% (80) | 51.1% (203) | |
| Polypharmacy (≥ 5) | | | .010 |
| Yes | 73.9% (105) | 62.0% (246) | |
| No | 26.1% (37) | 38.0% (151) | |
| Hemoglobin < 129 (g/L) | | | .002 |
| Yes | 57.0% (81) | 42.1% (167) | |
| No | 43.0% (61) | 57.9% (230) | |
| Albumin < 35 (g/L) | | | .63 |
| Yes | 42.3% (60) | 44.6% (177) | |
| No | 57.7% (82) | 55.4% (220) | |
| Receiving an emergency operation | | | .99 |
| Yes | 13.4% (19) | 13.4% (53) | |
| No | 86.6% (123) | 86.6% (344) | |
| Death 30 days after admission | | | .008 |
| Dead | 7.0% (10) | 2.3% (9) | |
| Alive | 93.0% (132) | 97.7% (388) | |
| Death 90 days after admission | | | .16 |
| Dead | 9.9% (14) | 6.3% (25) | |
| Alive | 90.1% (128) | 93.7% (372) | |
| Length of hospital stay | | | |
| 7 or more days | 45.1% (64) | 36.3% (144) | .031 |
| 10 or more days | 32.4% (46) | 23.2% (92) | .017 |
| 14 or more days | 21.1% (30) | 13.6% (54) | .023 |
| Readmitted within 30 days | | | .78 |
| Yes | 19.7% (28) | 18.6% (74) | |
| No | 80.3% (114) | 81.4% (323) | |
| Delirium | | | < .001 |
| Yes | 17.6% (25) | 0.3% (1) | |
| No | 45.8% (65) | 66.2% (263) | |

* Values presented are mean (SD) for continuous data and percentage (actual number) for categorical data. P values were generated using a one-way ANOVA test for continuous variables and a χ^2 test for categorical variables.

Table 2

Results of logistic regression analysis (N = 539), examining the association between having moderate cognitive impairment* and mortality, readmission, and LOS[†].

| Outcomes | Model A [‡] | | Model B [§] | |
|--------------------|----------------------|------|----------------------|------|
| | OR (95% CI) | P | OR (95% CI) | P |
| 30-day mortality | 3.27 (1.30–8.21) | .012 | 3.10 (1.19–8.11) | .021 |
| 90-day mortality | 1.63 (0.82–3.23) | .16 | 1.60 (0.78–3.28) | .20 |
| 30-day readmission | 1.07 (0.66–1.74) | .78 | 1.00 (0.61–1.66) | .99 |
| LOS | | | | |
| 7 days or more | 1.57 (1.04–2.36) | .032 | 1.52 (0.97–2.38) | .07 |
| 10 days or more | 1.69 (1.10–2.61) | .018 | 1.80 (1.10–2.94) | .020 |
| 14 days or more | 1.78 (1.08–2.95) | .024 | 2.06 (1.17–3.61) | .012 |

* Bottom 25% MoCA score of ≤ 17 (reference category = other 75% MoCA score).

[†] Including patients from 2013 and 2014 cohort. Delirium assessed using CAM was not included in this analysis.

[‡] Unadjusted.

[§] Adjusted for receiving an emergency operation, age, sex, polypharmacy, low hemoglobin, and low albumin.

Table 3

Results of logistic regression subanalysis (N = 354), including only patients who had both CAM and MoCA assessment, examining the association between having mild-moderate cognitive impairment* and mortality, readmission, and LOS[†].

| Outcomes | Model A [‡] | | Model B [§] | |
|--------------------|----------------------|------|----------------------|-------|
| | OR (95% CI) | P | OR (95%CI) | P |
| 30-day mortality | 3.61 (1.31–9.95) | .013 | 3.42 (1.19–9.81) | .022 |
| 90-day mortality | 1.89 (0.81–4.39) | .14 | 1.80 (0.74–4.34) | .19 |
| 30-day readmission | 1.02 (0.55–1.90) | .95 | 0.85 (0.44–1.63) | .62 |
| LOS | | | | |
| 7 days or more | 1.94 (1.15–3.26) | .012 | 1.91 (1.07–3.41) | 0.029 |
| 10 days or more | 1.87 (1.08–3.25) | .025 | 1.96 (1.02–3.77) | .044 |
| 14 days or more | 1.82 (0.95–3.49) | .07 | 2.01 (0.95–4.26) | .07 |

* Bottom 25% MoCA score of ≤ 18 (reference category = other 75% MoCA score).

[†] Including only patients from the 2014 cohort.

[‡] Adjusted for delirium (CAM)

[§] Adjusted for delirium (CAM), receiving an emergency operation, age, sex, polypharmacy, low hemoglobin, low albumin.

Indeed, the consistent finding of a high prevalence of cognitive impairment among older acute surgical patient population has several important implications for acute care surgeons. First, pre-operative assessment of cognitive function will allow acute care surgeons to more accurately assess perioperative risk because dementia is an independent risk factor associated with increased postoperative complications, such as sepsis, delirium, and reoperation.³ Second, within UK courts, the Montgomery ruling of 2015 elucidated the importance of explaining treatment options to patients, which requires patients to have the capacity to evaluate the risks and benefits of options proposed by their surgeon.¹⁸

Similarly in the United States, approximately half of the states adopt reasonable-patient standards based upon the *Harnish v Children's Hospital Medical Center* case, which views the informed consent process from the patient's perspective.¹⁹

Capacity is a requirement for informed consent, and high rates of patients with mild-to-moderate cognitive impairments and more severe dementias may lack capacity.^{20–22} In the wake of the Montgomery ruling, the Royal College of Surgeons in 2016 warned NHS trusts that they are at great risk of a substantial increase of litigation payouts if appropriate changes to gaining informed consent before an operation are not made.²² Meanwhile, in the United States, the recognition of the inadequacy of current

Table 4

Results of logistic regression analysis ($N=539$), examining the association between having different MoCA cutoff scores* with 30-day mortality[†].

| MoCA score cutoff | 30-day mortality | |
|-------------------------|-------------------|------|
| | OR (95% CI) | P |
| Bottom 25% $\leq 17/30$ | 3.10 (1.19–8.11) | .021 |
| Middle 50% $\leq 22/30$ | 2.81 (0.90–8.81) | .08 |
| Upper 25% $\leq 25/30$ | 4.84 (0.67–37.44) | .13 |

* Bottom 25%, middle 50%, upper 25%.

[†] Each MoCA score cutoff adjusted for receiving an emergency operation, age, sex, polypharmacy, low hemoglobin, and low albumin. Including patients from 2013 and 2014 cohort. Delirium assessed using CAM was not included in this analysis.

informed consent practice has led to states such as Washington promoting the use of decision aids and supporting concomitant training for health professionals to engage more effectively in shared decision-making.²³ With that in mind, the high prevalence in conjunction with the high proportion of undiagnosed dementia may suggest that using the MoCA on admission in older patients (aged ≥ 65) is useful in identifying patients who are unable to give informed consent in the emergency surgical setting. It is worth noting that although cognitive assessment on admission may identify older adults who may lack capacity, cognitive assessment alone is not sufficient to establish capacity because other factors, such as medical illiteracy, also have an important role.

Furthermore, unlike elective care, the 2016 National Emergency Laparotomy Audit (NELA) report highlighted that there is often limited time to investigate and prepare patients before emergency surgery and therefore the use of the MoCA score on admission will allow surgeons to promptly identify patients in need of additional support from other healthcare professionals, including input from care-of-the-elderly services.²⁴ The NELA has already identified that the highest mortality rates after emergency laparoscopy occur in older adults aged >65 years, and therefore cognitive assessment on admission may allow identification of older adults at a greater risk of poor outcomes.²⁴ Current guidance recommends that a cutoff score of ≤ 18 is usually considered the borderline between mild cognitive impairment and Alzheimer's disease, but there is overlap in the scores because Alzheimer's disease is defined by the presence of cognitive impairment in conjunction with the loss of autonomy.¹⁰ In a study conducted by the creators of the cognitive assessment, Nasreddine et al.⁸ reported that the mean MoCA score of patients with mild Alzheimer's disease was 16.2.¹⁰ Furthermore, Hoops et al.²⁵ report that a MoCA of 17–18, out of a maximum of 30, was the optimal diagnostic cutoff point for the detection of dementia in a cohort of patients with no cognitive impairment, mild cognitive impairment, and Parkinson's disease dementia. Within our study, we observed that a MoCA of both $\leq 17/30$ and $\leq 18/30$, representing the bottom quartile of MoCA in the whole cohort and the subcohort, respectively, were independent predictors of mortality at 30 days. This suggests that our study may be describing 30-day mortality in patients with cognitive impairment that is comparable to those with the early stages of dementia. Future research is required to identify the optimal MoCA cutoff score to predict 30-day mortality in older adults admitted to the emergency general surgical setting and whether this finding can be extended to other emergency surgical departments.

Dementia is recognized as a main risk factor for the development of delirium, with delirium and dementia often coexisting in acutely unwell older patients.^{7,26} In Fig 2, we have presented the relationship between delirium and low MoCA (≤ 18) in this cohort, which shows all patients with delirium, apart from 1, also had a low MoCA score (≤ 18). Earlier studies^{3,27} have shown that

delirium superimposed on dementia is associated with mortality and therefore it may be the case that 30-day mortality is codriven by delirium rather than dementia alone. This is further supported by the failure to detect an association with mortality at 90 days because the acute effects of delirium will have diminished by that time point. Subsequently, in a subcohort with available data on both MoCA and delirium ($N=354$), we adjusted additionally for delirium using CAM, with the intention of establishing whether our previous findings presented in Table 2 were in actuality being driven by delirium. We recalculated the MoCA cutoff score to reflect the bottom quartile (≤ 18) of the sample population and adjusted additionally for presence or absence of delirium. In the multivariate analysis, despite adjusting for delirium, we observed that having a low MoCA was an independent predictor associated with a three-fold increased risk of 30-day mortality. Although the 2 patients with delirium that died at 30 days also had a MoCA score ≤ 18 , there were 16 additional patients with a MoCA score of ≤ 18 that died at 30 days who did not have delirium. This may suggest that, although delirium assessed using CAM has been shown to predict mortality in older surgical patients, MoCA assessed on admission may in fact be a more sensitive predictive tool. Nevertheless, it is important to note that MoCA is unable to distinguish acute from chronic cognitive impairments—rather it serves to detect the presence of a cognitive deficit.

Our findings are in agreement with earlier studies that reported the association between dementia/delirium and an increased length of hospital stay in both medical and surgical units.^{13,27–31} Prolonged hospital stay is not only costly but also results in a reduced availability of surgical ward beds.^{29,30} This is problematic because dementia is on the rise globally, and a lack of available beds because of prolonged hospital stay and under resourcing of social care has an impact on elective bed utilization and acute surgical admissions.^{28–31} Furthermore, patients with dementia/delirium have additional care needs that require a greater number of staff with specific training.³² A low MoCA score is associated with an increased hospital length of stay and offers a potential predictive tool in identifying patients at risk of a prolonged hospital stay at the point of health care.

The high prevalence of cognitive impairment detected in the emergency general surgical setting in conjunction with the associated poor outcomes identified in our study raise additional important issues. First, undiagnosed cognitive impairment may lead to a delay in patients seeking medical care and a prolongation of length of stay in operative patients receiving surgery attributable to missing the opportunity to address early clinical symptoms of complications. This may be a contributing factor that leads to the increased odds of mortality at 30 days in this study. Routine MoCA testing of older adults admitted to the emergency general surgical setting offers surgeons the opportunity to identify this vulnerable group at the point-of-contact, thereby allowing emergency surgeons to more accurately tailor patient-centered care. Cognitive assessment on admission will also allow surgeons to make pre-emptive adjustments, including early comprehensive geriatric assessment and multidisciplinary discharge planning. In addition, a low MoCA score may be considered along with other predictors of poor surgical outcome to help decide whether the benefits of operative management outweigh the risks, and in cases where the risks are judged to be inappropriately high, patient/family counselling can be considered.

This was a pragmatic exploratory analysis using nonrandomized patients from a multi-site service evaluation, so the results need to be interpreted with caution. Data were not collected on comorbidities and therefore we cannot be certain that the association between having a low MoCA score and 30-day mortality and increased length of hospital stay are not being driven by comorbidities. However, we were able to adjust for polypharmacy and

low hemoglobin and albumin, which are all highly related to comorbid burden. These serve as surrogate markers of severity of existing chronic and acute comorbid burden, thus perhaps a better measure of comorbidities compared with simple yes/no, which merely states the presence of a diagnosis rather than the severity of the condition. In addition, we did not have any records of which patients were previously diagnosed with dementia and therefore we are unable to assess the extent to which dementia was under diagnosed. We did not collect data on admission or discharge diagnosis, nor the type of emergency procedure carried out. The strengths of our study include large sample size, consecutive unselected data collection during study periods, and multicenter nature of the study, which covered various regions of the United Kingdom.

In conclusion, moderate cognitive impairment in older adults admitted to the emergency general surgical setting and assessed using MoCA on admission is prevalent and is associated with increased odds of 30-day mortality and an increased length of hospital stay. These observations are relevant to emergency surgeons because they provide the potential of identifying older patients at risk of poor outcomes so that appropriate adjustments can be preemptively made. Preemptive adjustments include early geriatric involvement and patient/family counselling. We recommend that emergency surgeons routinely complete MoCA tests on admission because they will allow surgeons to more accurately tailor patient-centered care postoperatively and assess competence and the ability to consent to invasive procedures.

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Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:[10.1016/j.surg.2018.10.013](https://doi.org/10.1016/j.surg.2018.10.013).

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