Isolated Traumatic Brain Injury in the Very Old

Daniel Solomon MD[1,2], Oleg Kaminski MD[1,2], Ilan Schrier MD[1,2], Hanoch Kashtan MD[1,2] and Michael Stein MD[1,2]

[1]Department of Surgery, Rabin Medical Center (Beilinson Campus), Petah Tikva, Israel
[2]Sackler Faculty of Medicine, Tel Aviv University, Tel Aviv, Israel

ABSTRACT: **Background:** Older age is an independent predictor of worse outcome from traumatic brain injury (TBI). No clear guidelines exist for the management of TBI in elderly patients.

Objectives: To describe the outcomes of elderly patients presenting with TBI and intracranial bleeding (ICB), comparing a very elderly population (≥ 80 years of age) to a younger one (70–79).

Methods: Retrospective analysis of the outcomes of elderly patients presenting with TBI with ICB admitted to a level I trauma center.

Results: The authors analyzed 100 consecutive patients aged 70–79 and 100 patients aged 80 and older. In-hospital mortality rates were 9% and 21% for groups 70–79 and ≥ 80 years old, respectively ($P = 0.017$). Patients 70–79 years old showed a 12-month survival rate of 73% and a median survival of 47 months. In patients ≥ 80 years old, 12-month survival was 63% and median survival was 27 months (P = NS). In patients presenting with a Glasgow Coma Scale score of ≥ 8, the in-hospital mortality rates were 41% (n=5/12) and 100% (n=8/8). Among patients ≥ 80 years old undergoing emergent surgical decompression, in-hospital mortality was 66% (n=12/18). Survivors presented with a severe drop in their functional score. Survival was dismal in patients ≥ 80 years old who were treated conservatively despite recommended operative guidelines.

Conclusions: There is a lack of reliable means to evaluate the outcome in patients with poor functional status at baseline. The negative prognostic impact of severe TBI is profound, regardless of treatment choices.

IMAJ 2019; 21: 779–784

KEY WORDS: decompressive craniectomy, epidural hematoma, octogenarians, subdural hematoma, traumatic brain injury

BACKGROUND

Traumatic brain injury (TBI) is one of the most prominent health and socioeconomic problems worldwide [1-3]. TBI may be considered a silent epidemic, because it is of the major causes of death in young adults, and leads to high rates of TBI-related disability. In the United States, 5.3 million people are living with a TBI-related disability [1] in addition to 7.7 million people in European Union [2].

Rates of TBI are highest in the very young (0–4 years), in adolescents and young adults (15–24 years), and in the elderly (age > 65 years) [3]. While the mechanism of TBI in younger patients is mainly related to motor vehicle accidents (MVA), in the elderly it is almost entirely attributable to fall accidents.

Over the course of the last decades, increasing preventive measures regarding traffic safety, together with an increasing life expectancy, have led to a shift in the population affected by TBI toward the older age group [4]. According to the US Centers for Disease Control and Prevention database, rates of TBI-related hospitalizations in patients 65 years of age and older increased more than 50% during the last decade. Mortality rates for people 65 years and older were at least twice as high compared to any younger age group [5]. Falls cause the majority of TBI-related hospitalizations, followed by transportation-related incidents. Mortality in the ≥ 65 years age group has been reported as high as 13% [6].

In addition, older age has long been recognized as an independent predictor of worse outcome from TBI [7,8]. Nonetheless, in the latest TBI treatment guidelines, established between 2006 (surgical management) [9] and 2007 (medical management) [10], age or functional status are not addressed.

With an aging population, defining the elderly patient is subject to the personal judgment of the treating physician. In an arbitrary manner, elderly age in literature is most often considered as patients 60 or 65 years old or older. With improved health status for patients 65–80 years old, conducting research in this population including patients above 80 years old might confound the results and ignore the latter's unique physiology, functional status, co-morbidity, pathogenetic mechanisms, and outcome. We therefore decided to review two groups of 100 consecutive cases of isolated head injury leading to intracranial bleeding (ICB) in the elderly (70–79 years old) and very elderly (80 and older) populations to compare treatment and outcomes.

OBJECTIVES

Our objectives for this study were to:

- Describe the outcome of patients presenting to the emergency department (ED) of a level I trauma center due to isolated traumatic brain injury with intracranial bleeding
- Establish whether there is a worse outcome in a very

elderly population (80 years old and older) compared to the younger group (70–79 years old)
- Verify whether current surgical treatment guidelines are acceptable and appropriate to those populations

PATIENTS AND METHODS

This retrospective cohort study was conducted at Rabin Medical Center, an urban level I trauma center located in Petah Tikva, Israel. Approval from our institutional review board was obtained prior to study initiation.

PARTICIPANTS

Adult patients aged 70 and older who were admitted for a TBI in our level I trauma center were identified from the Rabin Medical Center Trauma Registry, a part of the Israeli National Trauma Registry (INTR). The INTR adopted the 1998 Abbreviated Injury Scale (AIS), and all TBI patients who presented with ICB were selected using AIS ≥ 3. Only isolated head injuries were included in our study.

We retrospectively analyzed two groups of patients. The first group included 100 consecutive cases of patients aged 70–79 admitted to our medical facility between January 2006 and August 2009, while a second group included 100 consecutive cases of patients aged 80 and older admitted between January 2006 and December 2007. A follow-up of 10 years was obtained for both groups.

VARIABLES

The Charlson Comorbidity Index (CCI) [11] was used to evaluate co-existing disease in the study population.

To evaluate a patient's functional status, we used the Katz Index of Activity of Daily Living (Katz ADL) [12]. Functional statuses prior to and after TBI were considered. The index ranks performance in six functions: bathing, dressing, toileting, transferring, continence, and feeding; 6 indicates full function, 4 moderate impairment, and 2 or less severe functional impairment.

Glasgow Coma Scale (GCS) was evaluated on admission to the ED or before sedation and intubation and at time of surgery. For data analysis purposes, GCS scores were divided into three subgroups depending on severity: mild (13–15), moderate (9–12), and severe (≤ 8). Relevant clinical findings during neurologic examination were also included in the study.

In our institution, brain computed tomography (CT) is the test of choice for patients in these age groups presenting to the ED with a TBI. Clinical and radiological findings were evaluated to establish the need for surgery according to 2006 TBI Author Group Guidelines [9]. An epidural hematoma (EDH) with an estimated volume of more than 30 cc (regardless of GCS score) or an acute EDH with GCS equal to or lower than 8 and anisocoria was considered an indication for emergency evacuation through decompressive craniectomy. Surgical indications for acute subdural hematoma (SDH) were: a SDH thicker than 10 mm, which caused a midline shift of more than 5 mm that was associated with a GCS of 8 or less or was followed by a GCS drop equal to or higher than 2 points. The SDH induced pupillary changes or a persistent intracranial pressure higher than 20 mmHg. Glasgow Outcome Scale (GOS) is a functional score for TBI patients used as an objective assessment of their recovery. According to the GOS, outcomes are grouped into five categories: dead, vegetative state, severe disability, moderate disability, or good recovery. GOS was calculated at discharge and during follow-up for every patient included in the study.

SUBSETS

To compare type of treatment and outcomes, we identified and analyzed three subsets of patients: all patients with GCS score of 8 of less at presentation, all patients surgically treated (either evacuation craniotomy or craniectomy), and all patients amenable for urgent surgical treatment according to the 2006 TBI Author Group Guidelines who were treated non-operatively, generally due to poor overall medical condition, low performance status, severe TBI considered beyond treatment, and family request not to undergo invasive life-saving procedures.

STATISTICS

Statistical analyses were performed using IBM Statistical Package for the Social Sciences statistics software, version 22 (SPSS, IBM Corp, Armonk, NY, USA). Categorical data were expressed as percentages and continuous data were expressed as means. The Student *t*-test and Mann-Whitney test were used to compare continuous variables. Categorical variables were compared by the chi-square test or Fisher's exact test. Overall survival analyses were calculated from the date of TBI using the Kaplan–Meier method. Subgroups were compared with the log-rank test. When more than one GCS score was found on the ED admission chart, only the worse score was included in the analysis.

RESULTS

PATIENT DESCRIPTIVE DATA

Each cohort included 100 consecutive patients [Table 1]. Only patients presenting with an isolated head injury were included. Gender distribution was comparable in both groups (P = NS). Median age in the two groups was 75 and 84.5 years (ranges 70–79 and 80–99), respectively.

In the younger subset of patients the median Katz ADL score on admission was significantly higher (6 vs. 5, $P = 0.001$) while the median CCI score was significantly lower (5 vs. 6, $P < 0.001$). In both groups, use of antiplatelet (50% in the 70–79 age group vs. 49% in ≥ 80 group), or anticoagulant medication (16% in the 70–79 age group vs. 17% in ≥ 80 group) were comparable (P = NS).

Table 1. Patient demographics, TBI characteristics

	Age Group			
Variable	**Overall**	**70–79 years old**	**80+ years old**	***P* value**
Total	N=200	N=100	N=100	
Gender				NS
Male	93 (46%)	50	43	
Female	107 (53%)	50	57	
Age, median (range)	79.5 (70–99)	75 (70–79)	84.5 (80–99)	
Drug treatment				NS
Antiplatelet	99 (49)	50	49	
Anticoagulant	33 (16)	16	17	
CCI, median (range)	5 (3–13)	5 (3–12)	6 (4–13)	< 0.001
Katz score at admission, median (range)	6 (0–6)	6 (0–6)	5 (0–6)	0.001
Cause of injury				NS
Fall	188 (94)	92	96	
MVA	12 (6)	8	4	
AIS, median (range)	4 (3–5)	4 (3–5)	4 (3–5)	NS
GCS				NS
Mild (13–15)	168 (84)	84 (42)	84 (42)	
Moderate (9–12)	13 (6)	5	8	
Severe (3–8)	19 (9)	11	8	
Treatment				NS
DC	29 (14)	11	18	
Conservative	171 (85)	89	82	
Length of stay, median, days, (range)	4 (0–74)	4 (0–50)	4 (1–74)	NS
Katz score at discharge, median (range)	4 (0–6)	5 (0–6)	2.5 (0–6)	0.002
In-hospital mortality	30 (15)	9	21	0.017

All values reported as n (% of variable) unless otherwise specified $P < 0.05$

AIS = abbreviated injury scale, CCI = Charlson comorbidity index, DC = decompressive craniectomy, GCS = Glasgow coma scale, MVA = motor vehicle traffic accident, TBI = traumatic brain injury

TBI DESCRIPTIVE DATA

A majority of the included patients reported brain injury as a result of falling (94% and 96%, for patients 70–79 years old and ≥ 80 respectively, P = NS), while only a small number of patients were involved in a motor vehicle traffic accident. Best GCS at admission was similar in both age groups (median 15 in both, P = NS). Distribution of GCS severity was also comparable in both groups (P = NS). Only 8% of patients arrived at the ED with a GCS ≤ 8. Median AIS was significantly higher in the very elderly group when compared to the younger group (4 for both groups, $P \leq 0.001$).

OUTCOME DATA

Median length of hospital stay (LOS) was similar in the two groups (4 days for both, P = NS). Overall, patients who survived and were discharged alive from the hospital presented with lower functional scores (5 vs. 2.5, median Katz at discharge in ≥ 80 and 70–79 age groups, $P = 0.002$). The functional impairment evaluated as the difference between the calculated Katz score at admission and at discharge was higher in the ≥ 80 years old group (1.0 vs. 2.5, median values).

In-hospital mortality was significantly higher for the ≥ 80 years of age group (21% vs. 9%, $P = 0.017$). On Kaplan–Meier analysis, patients 70–79 years old had a 1-year survival rate of 73% and a median survival of 47 months (SD ± 11.3), while in patients ≥ 80 years old, 1-year survival was 63% and median survival was 27 months (SD ± 4.5) [Figure 1A]. This difference did not reach significance (P = NS). At 10-year follow-up, survival was significantly lower for patients ≥ 80 years old ($P = 0.001$) [Figure 1B].

SUBSET ANALYSIS

Overall, 19 patients presented to the emergency department with a GCS ≤ 8 [Table 2]. In these patients presenting with severe TBI the in-hospital mortality rates were 54% (n=6/11) in the younger group and 100% (n=8/8) in the older one ($P = 0.012$). All 6 patients who survived presented with a dramatic drop in functional status (from a median Katz score of 6 at admission to 0 at discharge, ranges 0–6 and 0–2). Treatment modalities (surgical vs. conservatives) were similar between the two groups (P = NS). Kaplan–Meier curves from this subset of patients are shown in Figure 1C.

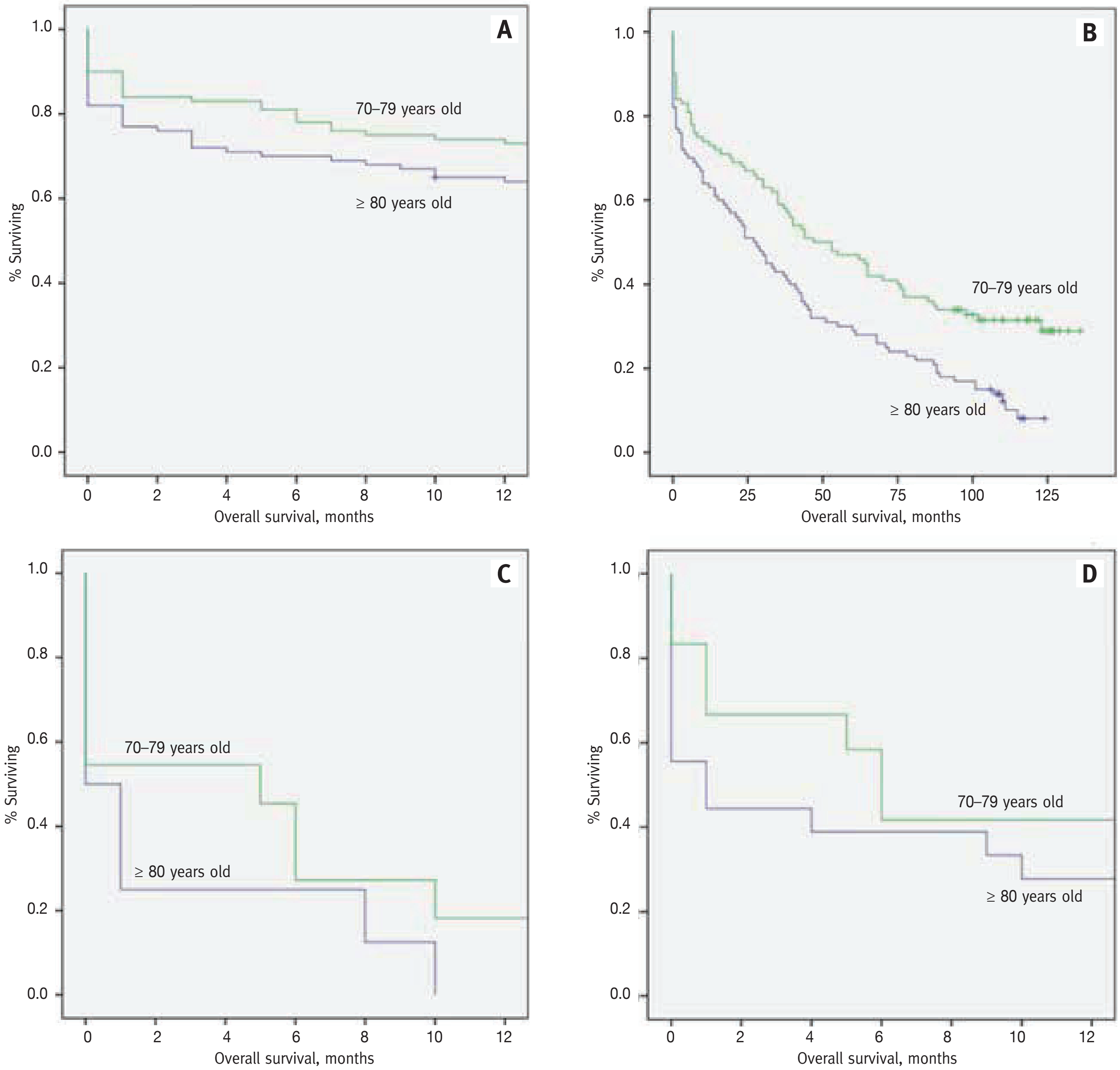
Among all patients who underwent surgical decompression [Table 3], most of them belonged to the ≥ 80 years old group (n=18/30, 60%), probably reflecting a trend toward lower median GCS at presentation in this group (15 vs. 10, P = NS). In-hospital mortality in the latter group was 66% (n=12/18); those patients who survived were discharged from the hospital after an average in-hospital stay of 19.4 days, showing a major drop in their functional outcome score (from a median Katz score of 6 at admission to 1 at discharge, ranges 0–6 to 0–4). Younger patients experienced in-hospital mortality rates of 27% (n=3/11). The survivors from this age group showed a severe drop in their functional score (from a median Katz score of 6 at admission to 0 at discharge, ranges 0–6 to 0–5). No significant difference was found in the abovementioned variables between the two age groups.

The last subset analyzed included patients that theoretically were amenable for surgical procedure but did not undergo surgery. This subset included six patients from the younger group and nine patients from the group of ≥ 80 years old. Median GCS was significantly lower in the younger group (median 6 vs. 15, $P = 0.044$). Some patients (n=3/15, 20%) presented with GCS 15 and deteriorated only after the admission. Interestingly, their AIS score was the highest (AIS = 5 for all three cases). Younger patients presented with in-hospital mortality rates of 66% (n=4/6); in-hospital mortality for ≥ 80 years old patients were 77.8% (n=7/9). Kaplan–Meier curves from this subset of patients are shown in Figure 1D.

DISCUSSION

Mortality rates for elderly patients improved significantly. A few decades ago mortality was extremely high in patients above

Figure 1. Kaplan–Meier survival analysis
[A] Kaplan–Meier curves of overall survival at 12 months follow-up (*P* = NS)
[B] Kaplan–Meier curves of overall survival at long-term follow-up (*P* < 0.001)
[C] Kaplan–Meier curves for patients presenting with severe TBI (GCS ≤ 8), 12 months follow-up (*P* = NS)
[D] Kaplan–Meier curves for patients after decompressive craniectomy, 12 months follow-up (*P* = NS)



65 years old undergoing decompressive craniectomy, ranging from 74% to 88% [13-15]. Recently, mortality rates of 38% were reported in patients over 60 years old presenting with TBI, both surgically and conservatively treated [16]. A recent prospective study found a dramatic increase in the odds of death and poor neurological outcome after 70 years of age with 1-year mortality dramatically increased after that cut-off [17]. Similarly, our analysis shows that when considering patients ≥ 80 years of age admitted with severe GCS, patients who underwent surgery and patients who were treated non-operatively despite being amenable for surgical treatment, both in-hospital and 6-month mortality rates were extremely high. Therefore, an appropriate assessment of these patients at admission is of foremost importance to decide which treatment strategy is most appropriate.

Recent literature [18] established non-operative treatment as a reasonable and often preferable strategy in managing elderly

Table 2. Choice of treatment and outcomes in patients with severe GCS score (3–8)

Variable	70–79 years old	80+ years old	*P* value
Total	N=11	N=8	
AIS, median (range)	5 (4–5)	5 (3–5)	NS
GCS, median (range)	6 (3–8)	5.5 (3–8)	NS
Treatment			NS
Surgical	6 (55)	4 (50)	
Conservative	5 (45)	4 (50)	
In-hospital mortality	6 (54)	8 (100)	0.012
Katz score at discharge, median (range)	0 (0–2)	N/A	N/A

All values reported as n (%) unless otherwise specified

AIS = abbreviated injury scale, GCS = Glasgow coma scale

Table 3. Choice of treatment and outcomes in patients amenable for urgent decompressive craniectomy

Type of treatment	70–79 years old	80+ years old	*P* value
Operative			
Total	N=12	N=18	
AIS, median, (range)	5 (4–5)	5 (4–5)	NS
GCS, median, (range)	10 (3–15)	15 (3–15)	NS
In-hospital mortality	3 (25)	12 (66.6)	NS
Katz score at discharge, median, (range)	0 (0–5)	1 (0–4)	NS
Conservative			
Total	N=6	N=9	
AIS, median, (range)	4 (4–5)	5 (4–5)	NS
GCS, median, (range)	6 (3–13)	15 (8–15)	0.044
In-hospital mortality	3 (50)	7 (77.8)	NS
Katz score at discharge, median, (range)	3 (0–6)	0 (0–6)	NS

All values reported as n (%) unless otherwise specified

AIS = abbreviated injury scale, GCS = Glasgow coma scale

patients experiencing a severe TBI. It has been demonstrated that while decompressive craniectomy can reduce the mortality associated to an elevated ICP, irreversible primary brain injury, intra-operative morbidity, postoperative infections, co-morbidities, and reduced capacity for recovery negatively affect the outcome. Nonetheless, other authors are now arguing for this conservative approach and reconsidering a more aggressive treatment as a viable option in the older patient [19-21]. Notably, in our series all patients above 80 years old presenting with severe GCS died, independently of the treatment received. Further confirming the urgent need for investigation in this population, implementation of new head injury treatment guidelines by the English National Institute for Health and Care Excellence improved in-hospital mortality in patients aged 16–64 years, while admission and mortality rates in those above age 65 increased [22].

On a positive note, the large majority of the elderly patients coming to the ED presented with mild TBI with a high GCS score and therefore they were non-operatively treated. Those patients were discharged home in a relatively short time and did not experience any major drop in their functional status. Yet, the overall average Katz score on admission indicated a marked dependence for most of the patients in basic activities of daily living. Understanding the consequences and functional status impairment that TBI may cause in this population is challenging. In our opinion, the GOS is not an appropriate tool in assessing this population of patients since a large majority of octogenarian patients express functional, cognitive, or neurological impairment (e.g., severe dementia, cerebrovascular accident status) prior to injury.

Last, treatment and co-morbidities are known to play important roles in determining the outcome of TBI in the elderly. It has been demonstrated that, for each 1-year increase in age beyond age 65, odds of dying after any geriatric trauma event increased by 6.8%. As one might expect, other than advanced age, co-morbidities strongly influenced the outcome with hepatic disease, kidney disease, and cancer bearing the strongest association with unfavorable prognosis [23]. Interestingly, in our study population rates of anticoagulant or antiaggregant treatment were similar and both groups showed a comparable GCS distribution. Nonetheless, AIS score, in-hospital stay, and 6-month mortality were significantly higher in the very elderly group.

Our study is a small retrospective series, but with a relatively long follow-up. Larger series of patients focusing only on the severe TBI subset in the octogenarians are needed to improve understanding of this relatively common condition. Moreover, our study was limited by using a previous version of the AIS classification system adopted by the nationwide INTR program.

CONCLUSIONS

Treating the growing rates of geriatric trauma patients is an increasing challenge for the health system. There is a lack of reliable means to evaluate the outcome in patients with poor functional status at baseline. We reported on the dramatic repercussions of severe TBI, regardless of treatment choices. On a positive note, even in this very elderly population, most patients will come with minor injuries, therefore surviving with a relatively good outcome and fair chances of recovery.

Correspondence
Dr. D. Solomon
Dept. of Surgery, Rabin Medical Center (Beilinson Campus), Petah Tikva 49100, Israel
Phone: (972-3) 937-7043
Fax: (972-3) 937-7042
email: daniel.s985@gmail.com

References

1. Langlois JA, Sattin RW. Traumatic brain injury in the United States: research and programs of the Centers for Disease Control and Prevention (CDC). *J Head Trauma Rehabil* 2005; 20: 187-8.
2. Tagliaferri F, Compagnone C, Korsic M, Servadei F, Kraus J. A systematic review of brain injury epidemiology in Europe. *Acta Neurochir (Wien)* 2006; 148: 255-68.
3. Rutland-Brown W, Langlois JA, Thomas KE, Xi YL. Incidence of traumatic brain injury in the United States, 2003. *J Head Trauma Rehabil* 2006; 21: 544-8.
4. Roozenbeek B, Maas AIR, Menon DK. Changing patterns in the epidemiology of traumatic brain injury. *Nat Rev Neurol* 2013; 9: 231-6.

5. CDC Injury Center. TBI Data and Statistics - Concussion. 2016. [Available from https://www.cdc.gov/traumaticbraininjury/data/index.html]. [Accessed 19 November 2017].
6. Harvey LA, Close JCT. Traumatic brain injury in older adults: characteristics, causes and consequences. *Injury* 2012; 43 (11): 1821-6.
7. Hukkelhoven CWPM, Steyerberg EW, Rampen AJJ, et al. Patient age and outcome following severe traumatic brain injury: an analysis of 5600 patients. *J Neurosurg* 2003; 99: 666-73.
8. Czosnyka M, Balestreri M, Steiner L, et al. Age, intracranial pressure, autoregulation, and outcome after brain trauma. *J Neurosurg* 2005; 102: 450-4.
9. Bullock MR, Chesnut R, Ghajar J, et al. Guidelines for the surgical management of traumatic brain injury author group. *Neurosurgery* 2006; 58: S2-vi-S2-vi.
10. Brain Trauma Foundation, American Association of Neurological Surgeons, Congress of Neurological Surgeons. Guidelines for the Management of Severe Traumatic Brain Injury. *J Neurotrauma* 2007; 24 (Suppl 1): S1-106.
11. Charlson ME, Pompei P, Ales KL, MacKenzie CR. A new method of classifying prognostic comorbidity in longitudinal studies: development and validation. *J Chronic Dis* 1987; 40: 373-83.
12. Katz S, Ford AB, Moskowitz RW, Jackson BA, Jaffe MW. Studies of illness in the aged. The index of ADL: a standardized measure of biological and psychosocial function. *JAMA* 1963; 185: 914-9.
13. Cagetti B, Cossu M, Pau A, Rivano C, Viale G. The outcome from acute subdural and epidural intracranial haematomas in very elderly patients. *Br J Neurosurg* 1992; 6: 227-31.
14. Hatashita S, Koga N, Hosaka Y, Takagi S. Acute subdural hematoma: severity of injury, surgical intervention, and mortality. *Neurol Med Chir (Tokyo)* 1993; 33: 13-8.
15. Howard MA, Gross AS, Dacey RG, Winn HR. Acute subdural hematomas: an age-dependent clinical entity. *J Neurosurg* 1989; 71: 858-63.
16. McIntyre A, Mehta S, Aubut J, Dijkers M, Teasell RW. Mortality among older adults after a traumatic brain injury: a meta-analysis. *Brain Inj* 2013; 27: 31-40.
17. Bouzat P, Ageron FX, Thomas M, et al. Modeling the influence of age on neurological outcome and quality of life one year after traumatic brain injury: a prospective multi-center cohort study. *J Neurotrauma* 2019; 36 (17): 2506-12.
18. De Bonis P, Pompucci A, Mangiola A, et al. Decompressive craniectomy for elderly patients with traumatic brain injury: it's probably not worth the while. *J Neurotrauma* 2011; 28: 2043-8.
19. Wan X, Liu S, Wang S, et al. Elderly patients with severe traumatic brain injury could benefit from surgical treatment. *World Neurosurg* 2016; 89: 147-52.
20. Valadka AB, Sprunt JM. Craniotomy for acute subdural hematoma in the elderly: not as bad as you thought. *World Neurosurg* 2012; 78: 231-2.
21. Herou E, Romner B, Tomasevic G. Acute traumatic brain injury: mortality in the elderly. *World Neurosurg* 2015; 83: 996-1001.
22. Marincowitz C, Lecky F, Allgar V, Sheldon T. Evaluation of the impact of the NICE head injury guidelines on inpatient mortality caused by traumatic brain injury: an interrupted time series analysis. *BMJ Open* 2019; 9: e028912.
23. Grossman MD, Miller D, Scaff DW, Arcona S. When is an elder old? Effect of preexisting conditions on mortality in geriatric trauma. *J Trauma* 2002; 52: 242-6.

Capsule

Prising open the human brain

Meningococcus (*Neisseria meningitidis*) causes meningitis and rapidly progressing fatal shock, but only in humans. To invade the brain, meningococcus uses its filamentous pili to hijack the β2-adrenergic receptor (β2AR), inducing an allosteric β-arrestin-biased signaling cascade in endothelial cells lining the capillaries of the brain. This cascade allows bacterial colonies to tether to endothelial cells, despite the shear stress of blood flow, and also promotes opening of endothelial junctions, which allows bacteria to penetrate the brain. **Virion** and colleagues sought to understand how a G protein-coupled receptor is activated by bacterial type IV pili proteins to transduce a signaling cascade that normally needs a cognate ligand. They found that β2AR activation requires two asparagine-branched glycan chains with terminally exposed sialic acid residues. Meningococcus triggers receptor signaling by exerting mechanical forces on β2AR glycans with its retractable pili. Because human glycans are unusual in exposing sialic acid residues on their glycans, this mechanism may help explain the specificity of meningococcus to its human host.

Nat. Commun. 2019; 10: 4752

Eitan Israeli

Capsule

Exercise finds its niche

Regular physical activity is associated with a lower rate of death from heart disease, but the underlying mechanisms are not fully understood. **Frodermann** and colleagues examined the effect of exercise on cardiovascular inflammation, a known risk factor for atherosclerosis, by studying mice that voluntarily ran for long distances on exercise wheels. They found that these physically active mice had fewer inflammatory cells (leukocytes) than sedentary mice, an effect they traced to diminished activity of hematopoietic stem and progenitor cells (HSPCs). The lower activity of HSPCs was due at least in part to exercise-induced reduction in the levels of leptin, a hormone produced by fat tissue that regulates cells within the hematopoietic bone marrow niche.

Nat Med 25, 1761 (2019)

Eitan Israeli

> **"Spoon feeding, in the long run teaches us nothing but the shape of the spoon"**
>
> E.M. Forster (1879–1970), English novelist, short story writer, essayist, and librettist