Half of geriatric trauma patients have significant ocular disease: Findings of a novel trauma provider eye examination for vision screening

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BACKGROUND: Geriatric ground level fall is a common admission diagnosis for trauma centers in the United States. Visual health has been linked to fall risk reduction in older adult but is rarely fully evaluated during a trauma admission. Using a commercial application and a questionnaire, we developed and tested a trauma provider eye examination (TPEE) to screen visual health. This study used the TPEE to (1) evaluate the prevalence of undiagnosed or undertreated visual disease in geriatric trauma patients and (2) determine the feasibility and reliability of the TPEE to screen for vision disease.

METHODS: This prospective study included patients older than 60 years evaluated by the trauma service from June 2019 to May 2020. Patients with ocular or globe trauma were excluded. The primary outcome was significant abnormal vision (SAV) found using the TPEE. Ophthalmology performed a dilated examination as the criterion standard for comparison. We assessed the feasibility and reliability of the TPEE. Fisher's exact test and logistic model were used in the data analysis.

RESULTS: Enrollment concluded with 96 patients. Mean age was 75 years, and fall (79%) was the most common mechanism of injury. Significant abnormal vision was common: undiagnosed disease was found in 39% and undertreated in 14%. Trauma provider examination was 94% sensitive and 92% specific for SAV cases. Congruence between TPEE and ophthalmology examination was highest in pupil examination (86%), visual fields (58%), and Amsler grid (52%). Multivariate analysis found that a combination of an abnormal Amsler test and abnormal visual field defect was significantly associated with SAV (odds ratio, 4.1; $p = 0.03$).

CONCLUSION: Trauma provider eye examination screening can identify patients with visual deficits. Given the association between visual deficits and fall risk, older adults may benefit from such a screening or a formal ophthalmology referral. (*J Trauma Acute Care Surg.* 2021;91: 148–153. Copyright © 2021 Wolters Kluwer Health, Inc. All rights reserved.)

LEVEL OF EVIDENCE: Therapeutic/Care Management, level II.

KEY WORDS: Geriatric trauma; injury prevention; visual health; screening.

Geriatric ground level fall is becoming one of the leading admission diagnoses for trauma centers in the United States.[1,2] The Centers for Disease Control and Prevention estimates that 28% of older adults will fall yearly, and 37% of those will need medical treatment.[3] To help with recidivism, one common approach has been a geriatrician consultation for comorbid review and polypharmacy adjustment.[4] Geriatrician evaluation at admission has demonstrated positive outcomes and is supported by current guidelines.[2,5,6] There are, however, many factors that can contribute to an older patient's fall, including vision and ocular health. Despite this association, a comprehensive vision examination is unlikely to occur by any provider during a trauma admission, unless an orbital injury is present. A visual health screening tool for use by trauma teams might be feasible and useful.[7]

The ophthalmology literature demonstrates a strong correlation between age and poor vision, and between poor vision and falls.[8–10] There is evidence that annualized fall risk can be reduced 8% to 73% with appropriate intervention and treatment.[11,12] Recognizing that many of these older adults continue to drive has led to significant research on the effect of visual impairment with motor vehicle collision. Again, the ophthalmology literature demonstrates an injury prevention opportunity and that visual impairment elevates the at-fault collision risks among geriatric drivers.[13–16] However, there remain large knowledge gaps, and there are no data on the prevalence of vision problems in geriatric trauma patients.[17] We hypothesized that there are a large number of geriatric trauma patients with preexisting ocular disease, which is either undiagnosed or undertreated. Identifying patients who present to the trauma service with visual deficits could create an opportunity to reduce the risk of future falls or readmission.

Several digital applications have been developed and validated to assist with vision screening for the non–eye-care provider. These applications have shown positive results for health care providers in remote rural locations that do not have the support and infrastructure of a hospital and eye-care providers.[18–20] Using these commercial applications and a questionnaire, we developed and tested a trauma provider eye examination (TPEE). The TPEE was used to (1) evaluate the prevalence of undiagnosed or undertreated visual disease in geriatric trauma patients and (2) determine the feasibility and reliability of the TPEE to screen for ocular disease.

PATIENTS AND METHODS

This pilot study prospectively enrolled patients from June 2019 to May 2020. Subjects were eligible for the study if they were age 60 years or older, injured in a fall or motor vehicle collision, and evaluated by the trauma service. Subjects were excluded if intubated, had a Glasgow Coma Scale score of <12 or were unable to participate in the examination because of mental status, had ocular and globe trauma, or were prisoners or members of a vulnerable population. Institutional review board approval was obtained before subject enrollment. Patients who met the criteria were approached for participation by research staff. Consenting patients underwent both ophthalmology examination and TPEE. Examinations were completed before discharge. After discharge data were abstracted from the trauma database at our facility to include Injury Severity Score and Abbreviated Injury Scale (AIS). Trauma providers also completed the Trauma Specific Frailty Index during the TPEE.[21]

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Trauma Provider Eye Examination

The TPEE was designed by the investigators to serve as a simple, reproducible, and rapid bedside evaluation for non–eye-care providers. It is intended as a screening test for abnormal vision and not designed to provide a specific diagnosis. The test screens both subjectively and objectively (Fig. 1). Subjects were asked six screening questions regarding recent vision difficulty or changes. Any affirmative answer was considered abnormal. Multiple free digital applications are available for use on handheld smart devices; in this case, eyeTests Easy (c) (George Kong Software) was used for visual acuity at distance, and Smart Optometry (c) (Smart Optometry D.O.O, Slovenia) was used for near visual acuity and Amsler grid testing. Patients used their corrective lenses during testing. Visual acuity was considered abnormal if distance vision was 20/40 or worse, or if near vision was 20/70 or worse. The Amsler grid was recorded as abnormal if the subject identified any areas of "wavy or missing" lines. Confrontational visual fields were obtained by having the patient cover one eye with the palm of their hand while the provider checked for vision in each of the four visual field quadrants. Visual fields were considered abnormal if there were inconsistencies in any field or missing vision in one quadrant. This was then repeated for the contralateral eye. A glaucoma screening application was used as well, in which the trauma provider followed the on-screen instructions to have the subject tap the screen when a red dot was visualized. An external examination was then performed to identify any pupil or orbital abnormalities. Any abnormal test result was considered a positive screen. A series of 10 TPEEs were evaluated for time to complete to estimate the time burden of the TPEE; these were evenly distributed between multiple care providers. Trauma provider eye examinations were performed in this study by all level of care providers on the trauma team. The TPEE is demonstrated in Supplemental Digital Content (Video 1: TPEE, http://links.lww.com/TA/B943).

Ophthalmology Examination

After completion of the TPEE, an ophthalmologist performed a comprehensive dilated eye examination as the criterion standard. The primary outcome of undiagnosed or undertreated visual disease was based on this examination, and either finding was classified as a combined outcome of significant abnormal vision (SAV). Undiagnosed pathology was defined as vision less than 20/40 without history of ocular disease or pathology on examination without history of disease. Undertreatment was defined as the presence of any of the following: (1) visual acuity reduced to less than 20/40 in the presence of known nuclear sclerotic cataracts, (2) increased intraocular pressure with known glaucoma history, (3) untreated double vision, and (4) difficulty in low light situations with presence of ocular pathology.

The same initial TPEE evaluation was performed by the ophthalmologist; they then performed a standard dilated eye examination. Intraocular pressures were checked using a Reichert tonopen; abnormal intraocular pressure was >21 mmHg. Pupils were checked for symmetry, and the presence/absence of a relative afferent pupillary defect was checked using a swinging light test. Anterior segment ocular examination was performed using a portable slit lamp. Pupils were dilated using tropicamide 1% and phenylephrine 2.5%, and a dilated eye examination was performed with an indirect ophthalmoscope and 20 D lens. An abnormal dilated eye examination included any pathology

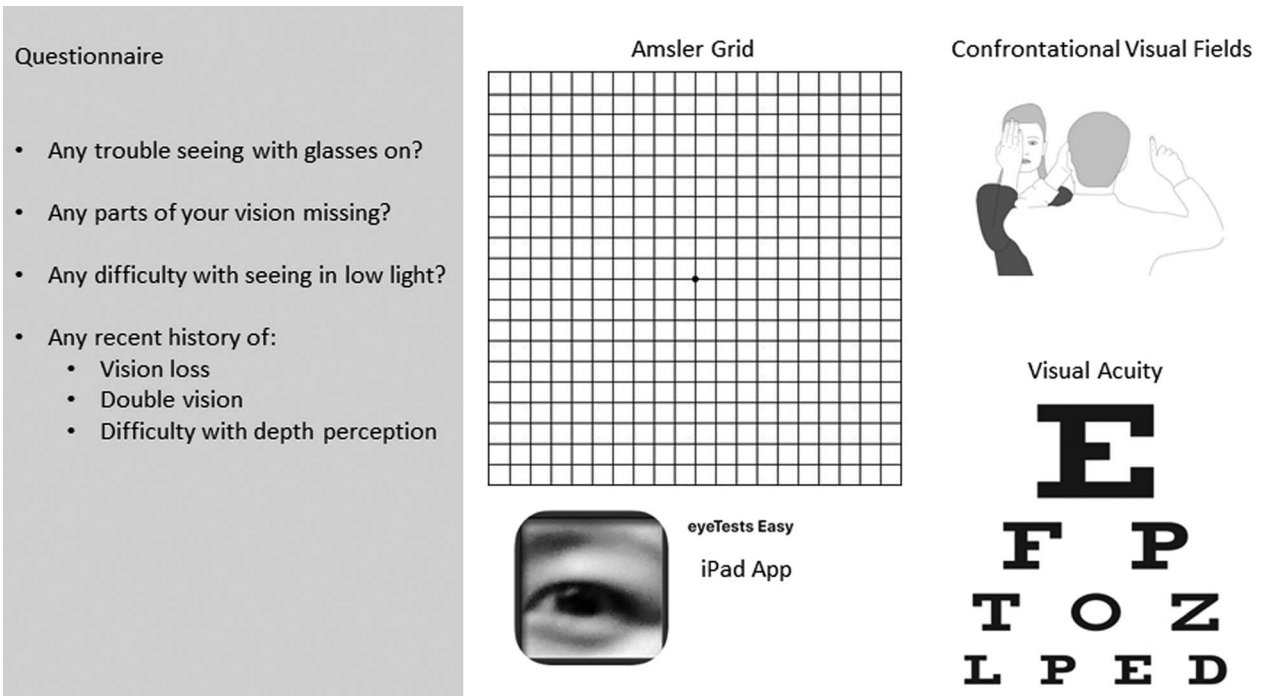

Figure 1. Trauma provider eye examination (TPEE). Questionnaire items (gray background) and the components used on the digital app (white background) are shown. Any abnormality on TPEE was considered a positive screen for SAV.

identified from corneal or lens opacity, evidence of enlarged cup/disc ratio suggestive of glaucoma, or macular pathology.

TPEE Accuracy

Congruence was determined for each individual examination element, comparing findings between TPEE and ophthalmologist examination (criterion standard). Visual acuity was deemed congruent if within one line of acuity. Confrontation visual fields were congruent if defects or lack of defects were identified in the same quadrant. The pupillary examination was congruent if the presence of symmetry or asymmetry was the same. The Amsler grid was congruent if the trauma provider stated that the Amsler was abnormal and the ophthalmologist found an abnormality as well. The external examinations were considered congruent if the findings were the same, excluding the diagnoses of dermatochalasis and blepharitis.

Statistical Consideration and Power Analysis

This was a prospective hypothesis-generating study, and the primary outcome was the incidence of SAV. The sample size justification was based on the statistical software PASS (version 15.0.5, NCSS, LLC, Kaysville, Utah). In the univariate data analysis, Fisher's exact test was performed for the categorical variables, and Wilcoxon's sum rank test was performed for continuous variables. In the multivariate data analysis, a logistic regression model was used to assess the association between risk factors and incidence rate, adjusting for potential confounding variables. A p value of <0.05 implies the statistical significance in this study. Statistical calculations were performed using SAS (Version 9.4, Cary, NC) and R software (version R 3.6.3, Vienna, Austria).

RESULTS

A total of 104 patients were prospectively enrolled, 96 (92%) of them completed both vision examinations and were included for analysis. Mean age was 75 years (range, 61–94 years), and 55% were male. The most common mechanism of injury was fall (79%), and the remainder was motor vehicle collisions. Median Injury Severity Score was 9 (IQR, 6), and median AIS head and AIS face were 0 (range, 0–3). Comorbid conditions were present in 86% of subjects, including hypertension (84%) and diabetes mellitus (36%). Median Trauma Specific Frailty Index was 0.13 (IQR, 0.13). Most patients (69%) were discharged home or to rehab. Care providers at all levels completed the TPEE: attending, 10%; advanced practice provider, 10%; resident, 9%; and students, 71%.

A high rate of prior ocular disease was present; 66% of patients reported at least one preexisting vision diagnosis other than refractive error. Cataracts were the most commonly reported preexisting condition in 39 (41%). New SAV based on the ophthalmology examination was common, identifying undiagnosed disease in 39% and undertreated disease in 14%. Accounting for subjects with both undiagnosed and undertreated disease, 47 (49%) were identified with the combined SAV outcome. Significant new pathology was identified, including 19 subjects with cataracts and 24 with concern for macular pathology. Two patients exhibited serious pathology, one white cataract and one retinal detachment (Table 1).

TABLE 1. Pathology Identified in Subjects' Past Medical History Compared With New SAV Identified During Ophthalmology Examination

	Patient-Reported Ocular History	Ophthalmology-Identified SAV
Astigmatism	1 (1%)	0 (0%)
Cataract	39 (41%)	19 (20%)
Diabetic retinopathy	1 (1%)	6 (6%)
Dry eye	1 (1%)	0 (0%)
Eye trauma	2 (2%)	0 (0%)
Glaucoma	5 (5%)	3 (3%)
Macular pathology	3 (3%)	24 (25%)
Nerve palsy	0 (0%)	1 (1%)
Refractive error	88 (92%)	19 (20%)
Retinal detachment	3 (3%)	1 (1%)

Prior corrective lens use was prevalent (92%). Despite this, significant new refractive error was found in 20% of subjects on examination. Subjective vision difficulty was common, 66 subjects (69%) responded affirmatively to at least one screening question on the TPEE, including difficulty seeing in low light (44%) or difficulty seeing with their current glasses prescription (25%). An abnormal response to any one of the six TPEE screening questions identified 74% of patients with SAV identified on ophthalmology examination.

The TPEE was evaluated for congruence, accuracy, and testing characteristics. Congruence between TPEE and ophthalmology examination was highest in pupil examination (90%), external examination (78%), visual fields (60%), and Amsler grid (54%). Congruence was poor in distance acuity (42%) and near acuity (31%). Trauma provider eye examination glaucoma screening was discontinued after subject 10 because of poor accuracy on TPEE (10% congruence). Mean time to complete the TPEE was 7 minutes. Timed examinations were distributed between attendings (2), residents (2), advanced practice providers (2), and students (4). There was no significant difference between provider level and congruence or time to perform the examination.

The TPEE was reviewed for testing characteristics: 94% sensitive and 92% specific for SAV cases, positive predictive value of 92%, and negative predictive value of 94%. On univariate analysis of the TPEE, an abnormal Amsler grid ($p = 0.004$), abnormal visual field ($p = 0.15$), and report of difficulty in low light ($p = 0.16$) were commonly identified in patients with SAV. Multivariate analysis (Table 2) found that a combination of abnormal Amsler grid and visual field defect was significantly associated with SAV (odds ratio, 4.1; $p = 0.03$).

DISCUSSION

Geriatric falls and trauma are extremely common and lead to a significant number of trauma service encounters. With the increasing number of older adults in the United States, novel strategies are needed to mitigate this public health problem. Vision is known to play an important role in fall risk, and improved visual health has been linked to significant fall risk reduction. In

TABLE 2. Multivariate Logistic Model of the Components of the TPEE

	Odds Ratio	Lower 95%	Upper 95%	*p*
Abnormal Amsler and visual field	4.105	1.143	14.748	0.031
Age	1.063	1.002	1.127	0.044
Sex	1.440	0.529	3.920	0.475
Vision loss	1.171	0.306	4.485	0.818
Double vision	0.626	0.169	2.323	0.484
Difficulty with depth perception	1.583	0.447	5.614	0.477
Missing portions of vision	0.361	0.098	1.332	0.126
Difficulty in low-light setting	0.546	0.203	1.473	0.232
Vision trouble with glasses	1.108	0.352	3.488	0.861
Trauma specific frailty index	1.029	0.750	1.411	0.860
TPEE distance acuity	1.461	0.514	4.148	0.477
TPEE near acuity	0.896	0.306	2.620	0.841

collaboration with ophthalmology, we developed and tested a TPEE to assess visual deficits in geriatric trauma patients. We found that half of geriatric trauma patients had undiagnosed or undertreated ocular disease. This suggests an opportunity for injury prevention. By using a screening tool such as TPEE, trauma services have an opportunity to refer at risk subjects for formal ophthalmology evaluation, potentially preventing future falls and readmission.

This study sought to investigate the level of preexisting ocular disease in geriatric trauma patients and investigate whether a screening tool could be feasible and reliable when used by trauma care providers who were not eye care providers. Nearly all patients reported prior glasses use or ocular diagnosis, but 14% were found to be undertreated for their disease and 20% required significant refractive correction. Despite previous visual evaluation, the majority of study participants reported subjective visual disturbances, and more than one third (39%) had newly diagnosed disease based on participation in this study. Before their hospitalization, these patients had been active members of their community, many of them driving, with limited visual acuity. This poses a significant health risk, both to the patient and the public at large.[22–24]

Based on the high level of SAV, any traumatic injury requiring admission should be considered an opportunity for vision screening in the geriatric population. For a screening test to be widely adopted, it needs to be quick and easy to use, and demonstrate reproducible results. The TPEE was designed to meet each of these criteria. It was conducted by multiple providers (student, advanced practice provider, resident, attending surgeon) to demonstrate ease of use and reproducibility. The examination is done through bedside interview and used a free application that any provider can download. The TPEE was designed so that no additional or special equipment would be needed by these non–eye-care providers. Screening tests were completed in a mean of 7 minutes, and future iterations could be shorter if lower impact portions are removed from the examination.

The TPEE congruence with a criterion standard examination varied across individual portions of the examination. However, as a whole, the TPEE served as an excellent screening examination with 94% sensitivity and 92% specificity for SAV. The vision screening questions alone accounted for nearly three quarters of the SAV identified and may provide the simplest approach. As the population continues to age, trauma services could adopt new injury prevention strategies to meet the needs of an aging population. Given the potential for fall risk reduction and the low burden of performing the TPEE screening examination, this could have an effect on trauma volume and readmission.

This study does have some limitations. The study was conducted in a rural state with a population of low socioeconomic status, which likely provides its own barriers to vision care and may account for the high rate of SAV. In addition, the authors do not have data on the long-term effect of identifying SAV and the subsequent ophthalmology interventions. This pilot study was not designed to demonstrate fall risk reduction based on the TPEE. A multicenter longitudinal study would be needed to demonstrate fall risk reduction after TPEE, as well as evaluate the incidence of SAV in other populations.

CONCLUSION

Unrecognized visual health deficits are present in half of geriatric trauma patients. Trauma admission presents an opportunity for vision screening and the potential for injury prevention. To adequately screen for visual health, trauma services can adopt new practices for visual examinations, an area in which most trauma providers are inexperienced. The addition of a TPEE screening examination can identify vision abnormalities in 94% of cases. This identifies high–fall-risk older adults who may benefit from formal ophthalmology referral.

AUTHORSHIP

J.M.B., A.B., and J.D. contributed in the literature search. J.M.B., A.B., D.J.G., J.N., A.W., and S.W. contributed in the study design. J.M.B., A.B., J.D., A.A., and K.C.C. contributed in the data collection. S.W., J.M.B., A.B., and D.J.G. contributed in the data analysis and interpretation. J.M.B., A.B., and D.J.G. contributed in the writing of the article. All authors participated in critical revisions.

DISCLOSURE

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