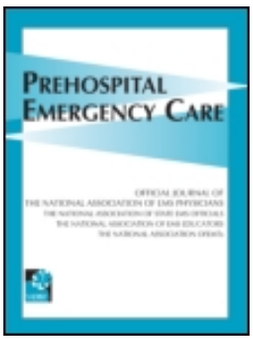

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Retrospective Validation of a Protocol to Limit Unnecessary Transport of Assisted-living Residents Who Fall

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Abstract

Objective. Emergency medical services (EMS) often transports patients who suffer simple falls in assisted-living facilities (ALFs). An EMS "falls protocol" could avoid unnecessary transport for many of these patients, while ensuring that patients with time-sensitive conditions are transported. Our objective was to retrospectively validate an EMS protocol to assist decision making regarding the transport of ALF patients with simple falls. **Methods.** We conducted a retrospective cohort study of patients transported to the emergency department from July 2010 to June 2011 for a chief complaint of "fall" within a subset of ALFs served by a specific primary care group in our urban EMS system (population 900,000). The primary outcome, "time-sensitive intervention" (TSI), was met by patients who had wound repair or fracture, admission to the ICU, OR, or cardiac cath lab, death during hospitalization, or readmission within 48 hours. EMS and primary care physicians developed an EMS protocol, a priori and by consensus, to require transport for patients needing TSI. The protocol utilizes screening criteria, including history and exam findings, to recommend transport versus nontransport with close primary care follow-up. The EMS protocol was retrospectively applied to determine which patients required transport. Protocol performance was estimated using sensitivity, specificity, and negative predictive value (NPV). **Results.** Of 653 patients transported across 30 facilities, 644 had sufficient data. Of these, 197 (31%) met the primary outcome. Most patients who required TSI had fracture (73) or wound repair (92). The EMS protocol identified 190 patients requiring TSI, for a sensitivity of 96% (95% CI: 93–98%), specificity of 54% (95% CI: 50–59%), and NPV of 97% (95% CI: 94–99%). Of 7 patients with false negatives, 3 were readmitted (and redischarged) after another fall, 3 sustained hip fractures that were surgically repaired, and 1 had a lumbar compression fracture and was discharged. **Conclusions.** In this cohort, two-thirds of patients with falls in ALFs did not require TSI. An EMS protocol may have sufficient sensitivity to safely allow for nontransport of these patients with falls in ALFs. Prospective validation of the protocol is necessary to test this hypothesis. **Key words:** accidental falls; emergency medical services; assisted-living facilities; geriatrics; decision support techniques; protocols

PREHOSPITAL EMERGENCY CARE 2015;19:68–78

Introduction

In 2011, unintentional falls were the leading cause of nonfatal injury for adults age 65 and older treated in emergency departments (EDs) in the United States, with over 2.4 million occurrences.[1] As the population of the United States ages, a larger proportion of the nation's elderly populace is residing in assisted-living facilities (ALF) designed to accommodate the specific needs of the aging adult. Repeated falls are a common reason for the admission of previously independent elderly persons to long-term care facilities.[2] Given the high rates of falls within this elderly demographic, the incidence rate of injury secondary to these falls, and the potential for medico-legal consequences related to an undetected injury, many assisted-living facilities have enacted policies requiring EMS activation (and presumed subsequent ED evaluation) for falls that occur in a facility, regardless of severity or circumstance.

Received November 27, 2013 from Wake County, NC Emergency Medical Services, Raleigh, North Carolina (JGW, MWB, BC, ML, JZ), Department of Emergency Medicine, University of North Carolina at Chapel Hill, Chapel Hill, North Carolina (JGW, JBM, DLM, VJD), Clinical Research Unit, Emergency Services Institute, WakeMed Health and Hospitals, Raleigh, North Carolina (JGW, JRM, HTV, VJD), Department of Public Health, Brody School of Medicine at East Carolina University, Greenville, North Carolina (AWJ), and Doctors Making Housecalls, Durham, North Carolina (AKK). Revision received May 15, 2014; accepted for publication May 21, 2014.

This project with these results was presented in abstract form in a poster presentation at the National Association of EMS Physicians' Annual Meeting in Bonita Springs, FL, on January 12, 2013.

The authors report no conflicts of interest. The authors alone are responsible for the content and writing of the paper.

Author contributions: JBM and AKK conceived the study. MWB, JGW, and AWJ created the study databases, performed and supervised data entry, and performed and supervised data analysis. DLM, BC, ML, JZ, and HTV assisted with study planning and administration, database management, and data entry. JRM and VJD assisted with statistical design, methods, and data analysis. MWB and JGW were primary authors of the abstract. AWJ and JGW were the primary authors of the manuscript, with input and editing from all authors. JBM and JGW take responsibility for the study as a whole.

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There is considerable risk, burden, and expense to both older patients and the health-care system associated with ED evaluation, as older patients receive a greater number of diagnostic tests, remain in the ED longer, and have higher ED charges than younger patients.[3] As these patients are often unknown to the receiving emergency physician, they are often the subject of a battery of potentially unnecessary tests to exclude an acute illness or injury. In addition, the prevalence of cognitive impairment among ALF-dwelling residents has been assessed at greater than 50%,[4] a co-morbidity that may further exacerbate issues surrounding patient–provider interaction in the ED. Acquisition of nosocomial infections and the introduction of iatrogenic complications are known consequences of ED evaluation, particularly among elderly persons with multiple co-morbidities.[5]

Despite the high risks of falling and evaluation in the ED, from 2001 to 2011, 72.8% of elderly patients within the United States presenting to an ED following a fall were treated and released without admission or transfer.[6] While a portion of these nonadmitted, nontransferred patients may have received time-sensitive intervention (TSI) in the ED (such as wound repair), the "per protocol" approach to requiring EMS transport for any fall may represent an unnecessary burden and increased risk to certain patients, EMS systems, and receiving EDs.

Previous studies have described characteristics of EMS fall patients[7] and EMS responses to falls,[8] including a qualitative analysis of the use of a decision tool involving nontransport.[9] No research reported to date, however, has described the development and performance of an EMS protocol designed to identify patients who may not need to be transported to the ED after a simple fall. As a first step leading to possible prospective evaluation, we conducted a retrospective cohort study to evaluate the test characteristics of an EMS protocol for minimizing unnecessary transport of ALF patients with ground-level falls. We hypothesized that this EMS protocol would demonstrate a high degree of sensitivity for ruling out emergency medical conditions in patients who fall from standing height or lower ("ground-level") in this retrospective analysis. The specific objective of this study was to retrospectively evaluate a novel EMS protocol that could safely discriminate between patients who require transport to the ED after a simple fall, and those patients who can be safely evaluated in a timely manner as an outpatient by a primary care provider.

Methods

Study Setting and Population

Wake County is an urban/suburban county located in central North Carolina, with an area of 854 square miles and a 2010 U.S. census population of 900,993 residents. The Wake County EMS System is composed of the Wake County Department of EMS and three contracted provider agencies: Apex EMS, Cary Area EMS, and Eastern Wake EMS. The system is an advanced life support (ALS) system, sending at least one ambulance staffed by at least one paramedic to every 9-1-1 call for service. In addition, Wake County EMS created and utilizes an "advanced practice paramedic" (APP) program, which sends an experienced paramedic single responder as an additional resource to high-acuity calls and for certain specialty patients, including selected falls in assisted-living facilities. APPs do not have an expanded scope of practice, but do have additional training regarding medical decision making, patient navigation, and available community resources. As one of North Carolina's largest EMS systems, both in personnel and call volume, Wake County EMS places 39 paramedic-level ambulances, 6 district chiefs, and 5 advanced practice paramedics in service every day. In 2012, WCEMS received 84,867 calls for service and transported 62,428 patients to area hospitals.

Doctors Making Housecalls (DMH) is a medical practice group of 32 experienced, board-certified primary care providers who make more than 45,000 home visits per year throughout the Wake/Durham/Orange County region of North Carolina. DMH clinicians provide in-home preventative and urgent care 7 days a week, with same-day or next-day appointments. They specialize in caring for older patients and those with complex medical problems. This expertise, combined with their ability to deliver care within a patient's home and with minimal disruption to the patient's daily routine, has led to an estimated 60% of elderly assisted-living facility residents within Wake County choosing DMH as their primary care group.

Due to the nature of the relationship between DMH and the study population, a partnership between Wake County EMS and DMH was critical to study development; DMH administration and clinicians collaborated with Wake County EMS leadership in the development of the novel EMS falls protocol. Should the protocol be implemented prospectively in our system, APPs would assist with the application of the protocol, and DMH clinicians will provide the designed urgent outpatient follow-up of their patients. Therefore, the study population was defined as patients residing in one of 30 assisted-living facilities in Wake County where DMH provides primary care. The study sample was a consecutive cohort of these patients who suffered a fall and subsequent EMS transport to any of a network of 6 EDs from a single hospital system. WakeMed Health & Hospitals was chosen because it is Wake County's largest hospital system and includes the only trauma center, and therefore receives a large proportion of falls occurring within the county.

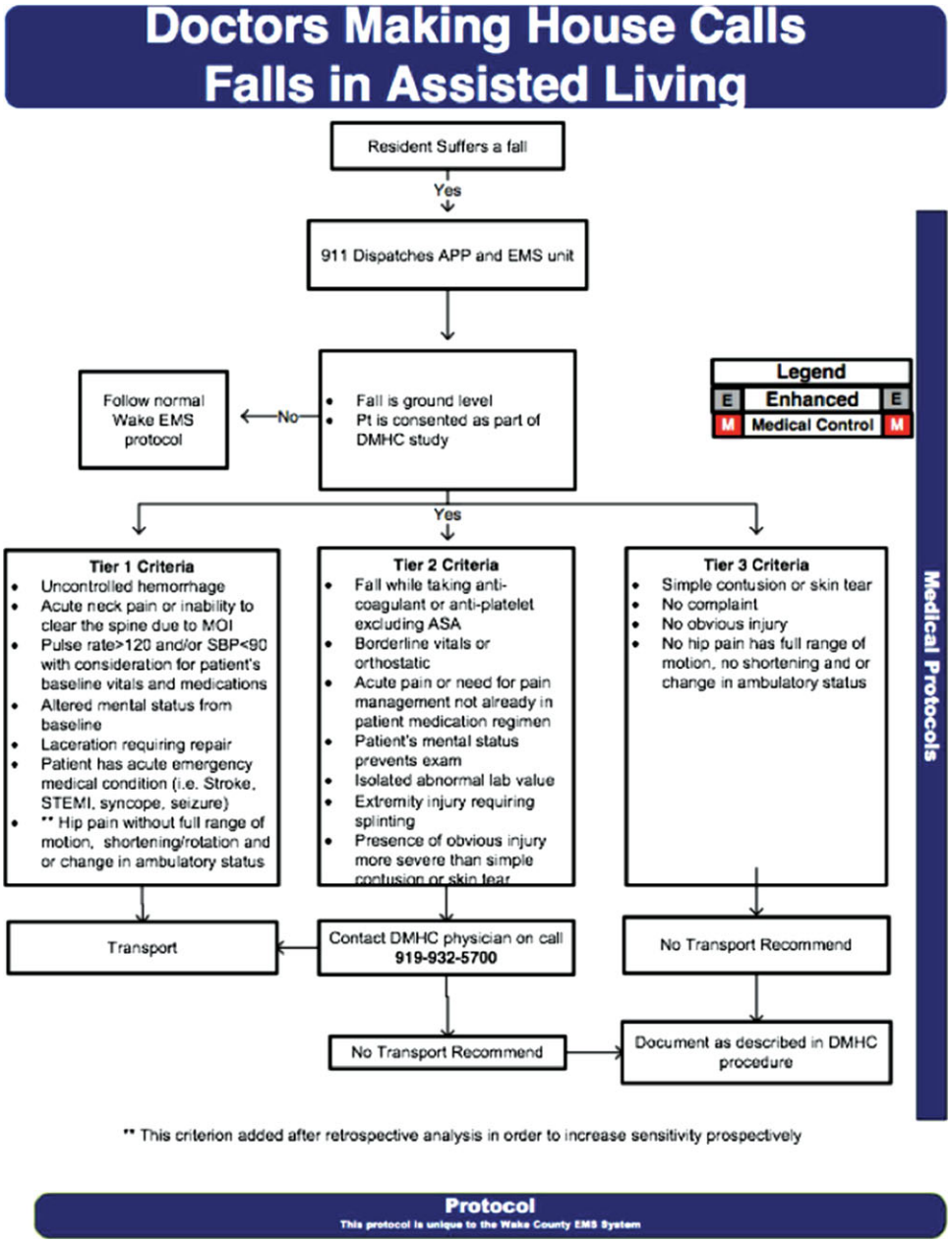

FIGURE 1. Study protocol.

Human Subjects Committee Review

This retrospective study was performed solely via review of patient data abstracted from existing EMS patient care reports and hospital medical records. It was submitted to the WakeMed institutional review board, which deemed it approved and exempt from full review.

Study Design and Protocol

A novel EMS protocol (Figure 1) designed to help EMS personnel evaluate ALF residents after a fall was developed by consensus between Wake EMS leadership and physicians from Doctors Making Housecalls. The protocol utilizes patient history and physical exam findings to recommend patient transport versus non-transport with close primary care follow-up. Led by two study authors (JBM, AKK), the protocol development group's primary goal was to develop a sensitive protocol that would ensure transport for any patient who may be suffering an acute medical or traumatic condition that requires TSI. Secondarily, the group wanted the protocol to encourage communication between EMS personnel and DMH clinicians at the time of the EMS evaluation, to assist EMS personnel in determining which patients required transport and which could safely remain at the ALF, to receive

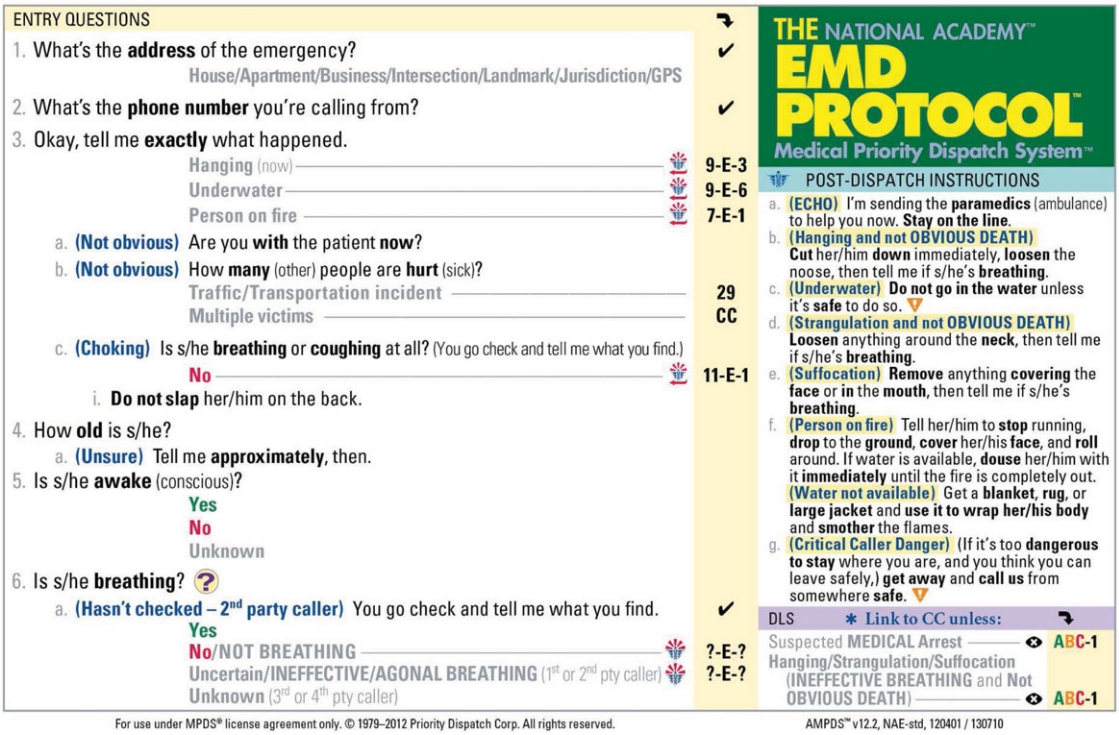

Figure 2. MPDS case entry questions asked of 9-1-1 callers to elucidate key information necessary to utilize the most appropriate "card." © 2014 IAED. All Rights Reserved. Used by permission of IAED.

urgent follow-up (within 18 hours) by DMH clinicians. The protocol, completed via multiple roundtable discussions, utilizes 3 "tiers" of classification. Tier 1 lists criteria that possibly represent an emergent condition and therefore warrant EMS transport to the ED, tier 2 lists criteria that may or may not require transport to the ED if the condition could be managed by the primary care provider with timely follow-up, and tier 3 (essentially the absence of tiers 1 and 2) lists criteria that likely do not require urgent evaluation. By design, the protocol lists several broad criteria in tiers 1 and 2, in an attempt to prioritize sensitivity. Any degree of specificity was deemed beneficial compared with the existing situation whereby virtually all patients with simple falls in ALFs are transported to the ED by facility policy.

To identify cases for the study sample, we retrieved EMS electronic patient care reports (PCRs) with a dispatch code of 17 (medical priority dispatch system (MPDS) code for "fall") from July 1, 2010 to June 30, 2011 (please see Figures 2 and 3 for the MPDS dispatch code "17" process). We did not determine a sample size a priori, rather, we attempted to evaluate the protocol by gathering all cases that met inclusion criteria that were available via our new charting software (ESO Solutions, Austin, TX) as of July 2010. Fall cases were eligible for inclusion if the patient suffered a ground-level fall and was transported by EMS from one of the 30 ALFs served by DMH to one of six WakeMed EDs. Cases were excluded if the patient suffered a fall from greater than standing height, if the patient was not transported, or if the patient was transported to a non-WakeMed ED.

Data were abstracted for included cases from the EMS PCR by two experienced paramedic supervisors (BC, ML) who were blinded to the patient's ED course and hospital outcome, and abstracted from the hospital medical record by two emergency physicians (DLM, JGW) who were blinded to the patient's EMS record. Variables collected into a Microsoft Excel (2010, version 14.0, Redmond, WA) database included patient demographics, past medical history, medications, vital signs, diagnostic studies, interventions, treatments, provider impressions and diagnoses, and ED and hospital admission/discharge data, including length of stay.

Measurements and Data Analysis

The primary outcome was "time-sensitive intervention" (TSI), and was met if the patient in an included case required urgent medical evaluation and treatment that would have precluded close outpatient follow-up by the primary care provider. Patients were classified in the database as requiring TSI if their hospital record contained any one or more of the following: admission from the ED to the intensive care unit, the operating room, or the cardiac catheterization lab; death from any cause within 72 hours of fall; diagnosis of fracture;

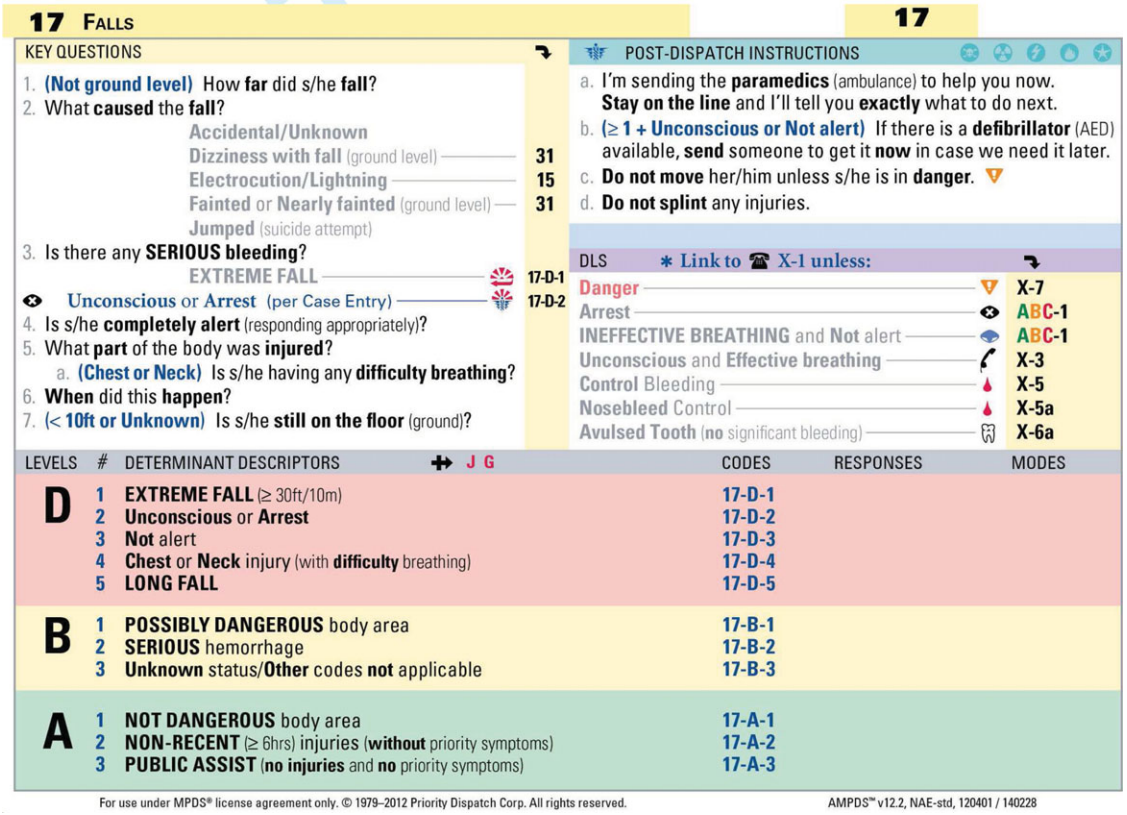

FIGURE 3. MPDS card 17, utilized to dispatch appropriate resources to "falls" patients. © 2014 IAED. All Rights Reserved. Used by permission of IAED.

documentation of wound repair, and/or re-admission to the ED within 48 hours of discharge from the initial fall transport. Admission to the hospital floor or observation status was not considered evidence of "time-sensitive intervention" because the authors believe that many patients in this population are admitted to floor status and/or observation status for reasons that could be managed on an outpatient basis with prompt primary care follow-up. Also, the inclusion as "TSI" of cases in which the patient was re-admitted to the ED for any reason within 48 hours was intended as evidence of a "failed discharge," i.e., a patient who may have required more care (or sooner care) than outpatient services could provide.

To test whether the protocol could discriminate between patients judged to require TSI and those who could safely remain at home, two experienced paramedics (MWB, AWJ), blinded to patient outcome, reviewed the database entry for all included patients. The EMS PCR narrative was also reviewed concurrently as necessary when additional information was required regarding protocol criteria for a given case. Using a printed copy of the EMS protocol, they determined whether the protocol tested positive or negative for a case possibly requiring TSI (and therefore recommending EMS transport to the ED or immediate consultation with a DMH provider) for each case. The protocol was determined to test "positive" if a case met any tier 1 or tier 2 criteria, and was determined to test "negative" if a case did not meet any tier 1 or tier 2 criteria and met all tier 3 criteria. Two disagreements (due to poor PCR documentation) were adjudicated by consensus discussion including another study author (JGW or JBM), with blinding of patient demographics and outcomes, with all reviewers finally agreeing on the disposition of these cases.

Data were analyzed using standard descriptive statistics. Test performance measures, including sensitivity, specificity, positive predictive value, negative predictive value, and positive and negative likelihood

TABLE 1. Patients with an EMS provider documented mechanism of injury of "Fall" who were not coded MPDS 17 during the study period ($n = 2,276$)

MPDS code	*n*
30–Traumatic injury (specific)	518
31–Unconscious	447
26–Sick person (specific)	208
12–Convulsion/seizure	176
21–Hemorrhage	105
33–Transfer/palliative care	101
Other	721

Codes representing more than 100 dispatches are shown.

ratios, were computed to estimate the ability of the EMS protocol to accurately identify patients in need of TSI. We captured data on all available included cases over a 1-year period. A post hoc analysis indicates that the sample size was adequate for sensitivity with a precision of ±2% and for specificity with a precision of ±5% at the 95% confidence level.[10]

Results

A total of 11,117 patients who fell were identified in the Wake County EMS System during the study period. An MPDS code other than "17" was assigned for 2,276 of these cases (see Table 1), which were excluded from the analysis. Of the remaining 8,841 MPDS "17" events, 2,373 (26.8%) occurred at one of 93 addresses that could be classified as "adult care homes" in which assisted-living services can be provided. After excluding non-transports ($n = 449$), transports to non WakeMed EDs ($n = 851$), transports from facilities not served by DMH ($n = 420$), and cases with insufficient data ($n = 9$), 644 events, incurred by 415 unique patients, remained for inclusion in this analysis. One hundred twenty-four patients were transported to the ED more than once (range 2–11 falls) during the 12-month period. Patient demographics representing both the 644 falls cases and the 415 unique patients are presented in Table 2. Table 3 compares the included MPDS "17" cases to the excluded MPDS "17" cases.

Of the 644 included fall cases, 197 (31%) met the primary outcome; i.e., the patient met criteria for TSI. The novel EMS protocol identified 190 of these cases, for a sensitivity of 96% (95% CI 93–98%), specificity of 54% (50–59%), and NPV of 97% (93–99%). Regarding the 7 cases that the protocol missed (false negatives), 3 were classified as meeting criteria for TSI because the patient was readmitted to the ED within 48 hours of ED discharge. All 3 of these cases were due to another simple fall, and all 3 patients were discharged again from the ED. Three false-negative patients had hip fractures that required surgical repair, and 1 false-negative patient was diagnosed with a lumbar compression fracture of indeterminate age and was discharged from the ED. The 2 × 2 table used to calculate test characteristics for the novel EMS protocol is shown as Table 4.

Table 3. Comparison of MPDS "17" dispatches during the study period

Determinant	All 17 cards n	% of total with 95% CI	Study sample n	% of total with 95% CI
17 nos[a]	71	0.8 (0.6–1.0)	5	0.7 (0.3–2)
17A	2,240	25 (24–26)	86	13 (11–16)
17B	5,763	65 (64–66)	538	82 (79–85)
17D	767	9 (8–9)	24	4 (2–5)
Total	8,841		653	7 (7–8)

[a]nos, not otherwise specified.

Most patients who met criteria for TSI received wound repair ($n = 92$) or had a diagnosis of fracture ($n = 73$). Table 5 presents the individual components of the composite primary outcome. Seven patients who received wound closure and both patients admitted to the OR also met TSI criteria due to a diagnosis of fracture. Seven of the 35 patients who were re-admitted within 48 hours met additional TSI criteria: 5 received wound repair and 2 had concomitant fractures.

Separate from the primary outcome, and the novel EMS protocol's ability to predict TSI, it is important to describe the health-care course and utilization of these 644 assisted-living patients who suffered a simple fall. Available data indicate that this cohort spent over 2,867 hours in the ED (mean 5 hours per fall), and admitted patients spent 569 days in the hospital (mean 6 days per admission). Overall, 129 patients (20%) were admitted to the hospital from the ED: only 4 went to the operating room or the intensive care unit. The most common diagnoses for admitted patients were "fracture" ($n = 68$) and "fall" ($n = 17$) and the most common diagnoses for discharged patients were "contusion" ($n = 157$), "fall" ($n = 121$), and "laceration" ($n = 98$). Two hundred twenty-five patients were spinally immobilized by EMS, yet only 5 patients had a diagnosis of spinal fracture (3 lumbar, 1 thoracic, and 1 cervical) and all spinal fractures were of unknown

Table 2. Demographics for included falls cases ($n = 644$) compared to total unique patients ($n = 415$)

	Met criteria for TSI ($n = 197$)	Did not meet criteria for TSI ($n = 447$)	Total falls ($n = 644$)	Total patients ($n = 415$)
Mean age (SD)	85.3 (7.2)	83.9 (8.6)	84.3 (8.3)	84.1 (8.8)
Female	74.1 (67.6, 79.7)	76.7 (72.6, 80.4)	75.9 (72.5, 79.1)	74.9 (70.6, 78.9)
Caucasian	89.9 (84.8, 93.4)	88.4 (85.0, 91.0)	88.9 (86.1, 91.0)	87.7 (84.2, 90.6)
EMS documented as having DNR	12.2 (8.3, 17.5)	12.3 (9.6, 15.7)	12.2 (9.9, 15.0)	10.6 (8.0, 14.0)
EMS documented history of past falls	14.2 (10.0, 19.8)	16.1 (13.0, 19.8)	15.5 (12.9, 18.5)	10.1 (7.6, 13.4)
Ambulatory without assist at baseline	72.1 (65.4, 77.9)	62.6 (58.1, 67.0)	65.5 (61.8, 69.1)	66.3 (61.6, 70.7)
History of dementia in the medical record	64.0 (57.0, 70.3)	63.1 (58.5, 67.4)	63.3 (59.6, 67.0)	56.6 (51.8, 61.3)
Previously prescribed an anticoagulant	6.6 (3.8, 11.1)	9.4 (7.0, 12.5)	8.5 (6.6, 11.0)	9.2 (6.7, 12.3)
Previously prescribed a narcotic	16.8 (12.2, 22.6)	21.5 (17.9, 25.5)	20.0 (17.1, 23.3)	20.0 (16.4, 24.1)
Previously prescribed an anxiolytic	29.4 (23.5, 36.2)	28.6 (24.6, 33.0)	28.9 (25.5, 32.5)	25.3 (21.4, 29.7)
Previously prescribed a sedative	9.1 (5.8, 14.1)	14.3 (11.4, 17.9)	12.7 (10.4, 15.5)	11.6 (8.8, 15.0)

Values presented are percentages with 95% confidence limits for the proportions, unless otherwise noted.

TABLE 4. Cross-tabulation to calculate test characteristics for the novel EMS falls protocol

	Met criteria for TSI	Did not meet criteria for TSI	Total
Protocol = positive	190	204	394
Protocol = negative	7	243	250
Total	197	447	644

chronicity. The cervical fracture patient was discharged back to the assisted-living facility from the ED with no further intervention, as were 2 patients with lumbar compression fractures, while the other 2 patients were admitted for unrelated reasons.

These 644 patients had 793 CT scans and over 1,100 laboratory panels drawn while in the ED. One patient had 11 falls (and 11 transports to the ED) during the study period. She had 15 CT scans and 13 laboratory panels drawn, and spent 39 hours in the ED. She was discharged back to her facility 10 times, and once was diagnosed with a new subdural hemorrhage (this was her only abnormal acute finding on CT). On this occasion, she was admitted for 4 days of observation without intervention, suffered significant "sun-downing," which required restraints, and was subsequently discharged back to her home at her original assisted-living facility. Please see Table 6 for further information regarding the health-care utilization of this cohort.

DISCUSSION

This cohort study used a population of assisted-living patients who suffered a simple fall and were transported to the ED to test the predictive value of a novel EMS protocol intended to identify patients at low risk for requiring time-sensitive medical intervention. In this sample of patients where the prevalence was 31% for requiring time-sensitive intervention, only 3% of cases meeting the protocol for nontransport met our criteria for TSI. Based on our findings, use of the protocol could have safely prevented 243 EMS transports, or about 54% of all transports to the ED for patients not requiring TSI.

TABLE 4A. Characteristics for the novel EMS protocol tested in this population

Characteristic	Value	95% CI
Sensitivity (%)	96.5	92.7–98.4
Specificity (%)	54.4	49.7–58.9
Positive predictive value (%)	48.2	43.3–53.2
Negative predictive value (%)	97.2	94.2–98.8
Prevalence of TSI (%)	30.6	27.1–34.3
Likelihood ratio for EMS protocol positive	2.1	1.9 –2.3
Likelihood ratio for EMS protocol negative	0.07	0.03–0.14

TABLE 5. "Time-sensitive intervention" components

Composite outcome component	Number of patients who met criteria for this component	Percentage of all TSI
Received wound repair	92	46.7
Fracture diagnosis	73	37.1
ED Readmission in <48 h	35	17.8
Death within 72 h	6	3.0
ICU admission	2	1.0
OR admission	2	1.0
Cardiac catheterization lab admission	0	0.0

Number of patients and percentages add up to more than 100% of patients who met primary outcome ($n = 197$) because patients could have met criteria for more than one component.

Although the literature is rich with studies that indicate that simple falls in the elderly can result in serious injury and have significant impact on the health-care system, external validity and selection bias must be carefully considered as most of these studies evaluated admitted patients or patients who met criteria to be evaluated at a trauma center.[11–14] Considering differences in study populations, admitted patients in our cohort had similar patient characteristics, incidence of notable injuries, including hip fractures (23%) and intracranial hemorrhage (6%), and mortality (5%), compared to prior literature.[12–15] Our study adds to this literature by considering a sample of patients with simple falls in a subset of assisted-living facilities who did not necessarily meet "trauma center criteria" and for the most part (80%) were not admitted, which is also consistent with reported outcomes in this population.[7]

With regard to prehospital literature, Simpson and colleagues have recently described the EMS response characteristics and patient presentation of elderly patients who fall,[16] and then analyzed which of these variables were associated with nontransport.[17] While these associations may be helpful in identifying possible components of a predictive model, neither of these studies evaluated patient-based outcomes or follow-up diagnoses. These authors agree that the decision-making process regarding nontransport of elderly fallers is complex,[9,17] and further study is warranted to determine what goals define an appropriate nontransport for both patients and providers.

A few prior studies have examined the decision-making process regarding transport of elderly patients to the ED. A Swedish study[18] described the retrospective development and pilot prospective implementation of a decision support tool intended to steer geriatric patients to "alternative" level of health care (such as primary care) instead of the ED. The tool was developed for 11 conditions, including falls, and utilized by prehospital nurses in the EMS system. They were able to redirect 34% of patients in their pilot, with no patient subsequently transferred from primary care to the ED.

TABLE 6. Therapeutic measures, diagnostic testing, and other health-care utilization measures accrued for falls cases ($n = 644$)

	Met criteria for TSI ($n = 197$)	Did not meet criteria for TSI ($n = 447$)	Total included ($n = 644$)
Patients with hemorrhage control by EMS[a]	22 [11.2 (7.4, 16.4)]	13 [2.9 (1.7, 5.0)]	35 [5.4 (3.9, 7.5)]
Patients with extremity splint placed by EMS	8 [4.1 (1.9, 7.9)]	5 [1.1 (0.0, 2.7)]	13 [2.9 (1.7, 5.0)]
Patients who were spinally immobilized by EMS	69 [35.0 (28.7, 41.9)]	156 [34.9 (30.6, 39.4)]	225 [34.9 (31.4, 38.7)]
Patients who had an IV placed by EMS[a]	29 [14.7 (10.4, 20.4)]	33 [7.4 (5.3, 10.2)]	62 [9.6 (7.6, 12.2)]
Number of CBCs[a]	104 [52.8 (45.8, 59.6)]	172 [38.5 (34.1, 43.1)]	276 [42.9 (39.1, 46.7)
Blood chemistry panels[a]	103 [52.3 (45.3, 59.2)]	177 [39.6 (35.2, 44.2)]	280 [43.5 (39.7, 47.3)]
Coagulation panels	64 [32.5 (26.3, 39.3)]	86 [19.2 (15.8, 23.2)]	150 [23.3 (20.2, 26.7)]
Urinalyses	58 [29.4 (23.5, 36.2)]	140 [31.3 (27.2, 35.8)]	198 [30.8 (27.3, 34.4)]
Head CTs	147 [74.6 (68.1, 80.2)]	305 [68.2 (63.8, 72.4)]	452 [70.2 (66.5, 73.6)]
Cervical spine CTs	97 [49.2 (42.3, 56.2)]	183 [40.9 (36.5, 45.6)]	280 [43.5 (39.7, 47.3)]
Torso CTs	8 [4.1 (1.9, 7.9)]	14 [3.1 (1.8, 5.2)]	22 [3.4 (2.2, 5.1)]
Hip or pelvis CTs	15 [7.6 (4.6, 12.3)]	24 [5.4 (3.6, 7.9)]	39 [6.1 (4.4, 8.2)]
Chest XRs	58 [29.4 (23.5, 36.2)]	104 [23.2 (19.6, 27.4)]	162 [25.1 (22.0, 28.7)]
Hip or pelvis XRs	61 [31.0 (24.9, 37.7]	107 [23.9 (20.2, 28.1)	168 [26.1 (22.8, 29.6)]
Mean emergency department LOS in hours (SD)	4.9 (2.5)	4.4 (2.4)	4.6 (2.5)
Patients admitted to hospital from the ED[a]	61 [31.0 (24.9, 37.7)]	68 [15.2 (12.2, 18.9)	129 [20.0 (17.1, 23.3)]
Mean hospital LOS in days (SD) for admitted patients	6.3 (4.2)	6.3 (4.1)	6.3 (4.1)

Values are numbers of patients who received the noted test or therapy while in the care of EMS or in the ED. Values expressed are raw numbers with percentages and 95% confidence limits in brackets, unless otherwise noted. LOS, length of stay; CBC, complete blood count; CT, computed tomography; XR, "plain film" x-ray.
[a]Measures that have nonoverlapping confidence limits between the group that required TSI and the group that did not require TSI.

Halter et al. (London, UK) reported their EMS system's experience with use of a clinical tool intended to guide falls-specific assessment, including the decision to transport to the ED or not.[9,19] Using the judgment of clinical reviewers, they concluded that the tool led to the correct transport decision in about 90% of cases. However, they also report low utilization rates of the tool by EMS staff members in a qualitative analysis, with some data suggesting that the tool was used in only about 10% of indicated cases.

In general, the EMS literature has called into question paramedics' ability to safely determine which patients do not require transport to the ED.[20,21] The strength of evidence examining this question is weak, however, as few studies evaluate both an objective protocol for use by paramedics in combination with patient-centered outcomes (instead using physician opinion or another subjective "gold standard"). We are not aware of any studies that also include immediate communication between EMS and primary care, including paramedic access to the patient's primary care medical record, as an integral part of an otherwise objective protocol. It may be most accurate to say that there is a lack of rigorous evidence regarding the decision of EMS personnel to not transport patients to the ED.[20,21]

The modern movement toward patient-centered, cost-effective medicine mandates that EMS care occur in a network that can provide care alternatives centered on the needs of patients, rather than in traditional isolation that results in rote transport for all patients to the ED. A key goal of modern health care is getting "the right resource to the right patient at the right place at the right time,"[22,23] which is akin to the EMS provider's goal of making the right disposition decision. Presumably achieving this goal will result in better care at lower cost – higher value care and greater satisfaction on the part of patients and their caregivers. To contribute to that goal, EMS, the ED, the hospital, and the community-based primary care clinicians must operate as an integrated system, rather than separate silos, to achieve patient-centered care. For an elderly patient with a simple fall, patient-centered care is defined by rapidly evaluating the patient and safely determining whether his or her needs are best served by transport to the ED or by EMS communication with the patient's primary care provider to arrange close outpatient follow-up for management of a nonemergent condition. Mobile integrated health-care practices[24] such as our Wake County EMS program are key entities in terms of realizing these goals and also studying them with a high degree of scientific rigor.

The National Association of EMS Physicians position statement regarding EMS Provider Determinations of Necessity for Transport[25,26] states that EMS providers may be able to avoid unnecessary ED visits by determining which patients can be safely managed without transport. In addition, peer-reviewed evidence should demonstrate that nontransport in a specific situation is a safe practice. Provider education, a quality improvement process, and active physician oversight are necessary elements of such nontransport programs. We believe that our study reports the evaluation of a protocol and program that contains those necessary elements, and also supports the goal of integrated, patient-centered care for patients in assisted-living facilities.

Limitations and Future Research

The results of this study are limited by the retrospective, chart review methodology. Given that all patients in the study were transported to the ED, it is

inherently difficult to determine what "would have happened" if the protocol were in place. The potential for measurement bias of the outcome was limited by the discrete, clear, easy to obtain elements of the composite outcome "met criteria for time-sensitive intervention." Measurement bias of the exposure (the EMS protocol) could systematically occur if reviewers subconsciously want the protocol to succeed, thereby overestimating sensitivity. We limited the potential for measurement bias by blinding reviewers to patient outcomes, and also by having clear criteria in the protocol that should be standard elements of an EMS provider's assessment and documentation. Evaluation of protocol criteria, however, was based primarily on consideration of distilled and decluttered data that were abstracted from patient care reports (PCRs) into a spreadsheet, with the original PCR immediately available as needed. Clearly, this retrospective approach does not represent application of the protocol to a "live" set of cases with on-scene distractors by paramedics with various experience levels. In addition, conclusions regarding the protocol criteria for each patient were determined solely upon information documented by EMS providers in the PCR. A poorly documented PCR therefore limited the reviewers' ability to determine whether the protocol would have recommended transport. For the sake of protocol safety and a conservative estimate of sensitivity, these cases of poor documentation were classified as "transport not recommended." For example, in 2 of the cases, the PCR documentation contained no discussion of the nature, apparent severity, or physical exam findings associated with the resident's fall and as such did not provide any useful information for determining a tier classification for the patient. Both of these met criteria for TSI and were therefore classified as false negatives in order to conservatively estimate sensitivity.

In addition, regarding increasing the sensitivity of the protocol, 3 of the 7 false negatives sustained hip fractures. We therefore recommend modifying the evaluation protocol prior to prospective evaluation to include specific verbiage aimed at more positively identifying patients who may have sustained hip fractures. Tier 1 language was added that mandates transport for patients with hip pain without full range of motion, clinical findings of shortening/rotation, and/or change in the patient's ambulatory status. The inclusion of change in ambulatory status was made after a review of medical records of the 3 patients who sustained hip fractures indicated they were without complaint of pain and had no obvious deformity/foreshortening/rotation of the injured leg, but were found to be unable to ambulate after falling.

Perhaps most notably, the study was conducted in a subset of fall patients with immediately available primary care follow-up in a subset of assisted-living facilities who were transported to a single hospital system, and may not be generalizable to other populations or EMS systems. We further recognize that our results are confounded by our definition of TSI. While DMH providers may have the resources and capacity to aggressively monitor and treat patients in the outpatient setting, this capability may not be present in many communities. While the external validity of these results is a concern, our definitions and methodology are based on our health-care community's resources. Hopefully, as the health-care system changes to meet the needs of patients in the out-of-hospital setting, EMS protocols that support care outside of ED transport will be more applicable to more systems.

Furthermore, there is potential for selection bias in this subset of patients. While the included cases represent only about 6% of all falls in our system, they represent nearly 28% of falls at facilities in which assisted-living services can be provided. Also, the studied patients may not accurately represent a generalizable population of elderly falls. For example, we excluded patients who were not transported, which limits our sample of patients who fell and would have met tier 3 criteria, but may also limit our sample of those later found to have a time-sensitive intervention at follow-up. Table 3 indicates that the study sample indeed has a smaller percentage of delta-level (possibly "sicker") patients than the general population of fall calls. In contrast, there was a higher percentage of alpha-level (possibly "not as sick") calls in the general population. Table 1 indicates that patients who have another primary medical or traumatic concern may also have fallen. Nonetheless, our purpose was to study a select group of falls patients: those without complication who have a hypothetically "less serious" fall. While future study should carefully consider how to obtain as unbiased a sample as possible to fully test the breadth of all 3 tiers of the protocol, the protocol is inherently intended to apply only to "simple" uncomplicated falls.

Lastly, the emergency medical dispatch process may also miss or misclassify some falls patients. In addition, conditions delineated in the protocol may be managed differently in patients at assisted-living facilities with primary care follow-up, as opposed to elderly patients living at home. Nonetheless, the demographics and characteristics of study patients were similar to the populations of other studies reporting outcomes of elderly falls.[11–15]

In the next phase of this project, we intend to study this protocol prospectively. Prospective validation of the protocol's sensitivity, the contribution of each criterion to the overall test characteristics of the protocol, reliability of EMS–primary care communication, and protocol specificity should all be evaluated further prior to widespread implementation. We found a specificity of 54% in this retrospective evaluation, which is not ideal, but an improvement from the

current situation in which everyone is transported and also represents the desire to err on the side of caution when determining the need for time-sensitive medical evaluation.

Future projects should also include a formal cost–benefit analysis of the protocol. A rudimentary cost description[27] of our cohort, utilizing Medicare payments[28,29] as a metric of cost to the health-care system indicates that the 447 falls patients who did not require time-sensitive intervention resulted in at least $435,000 in payments from Medicare. This represents approximately $1,000 in ED costs per case, not including hospital observation stays, admissions, or transport back to the facility for ED discharges. This $435,000 includes over $5,000 in laboratory fees, approximately $100,000 in professional and technical fees for imaging, $50,000 in payments to physicians, $100,000 in payments to facilities, and almost $180,000 for ambulance transports. While a comprehensive analysis of all costs and benefits for the entire cohort of 644 falls was outside the scope of this project, we feel that formal cost–benefit analysis would show that significant savings to the health-care system can be safely accomplished.

Conclusions

This retrospective cohort study found that a novel EMS protocol may be able to safely prevent unnecessary EMS transports and ED visits for patients who suffer simple falls in assisted-living facilities. While elderly patients who fall can suffer significant injury, a majority of patients are not seriously ill or injured. Our analysis confirms our hypothesis that the EMS protocol would be able to retrospectively distinguish between those who require time-sensitive intervention and those who do not with sufficient sensitivity to warrant prospective evaluation. Although our findings require significant further study, successful implementation of this protocol would "get the right resource to the right patient at the right place at the right time."[22,23]

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