

Association between Patient Unconscious or Not Alert Conditions and Cardiac Arrest or High-Acuity Outcomes within the Medical Priority Dispatch System “Falls” Protocol

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Abstract

Introduction: *Falls* are one of the most common types of complaints received by 9-1-1 emergency medical dispatch centers. They can be accidental or may be caused by underlying medical problems. Though *not alert* falls patients with severe outcomes mostly are “hot” transported to the hospital, some of these cases may be due to other acute medical events (cardiac, respiratory, circulatory, or neurological), which may not always be apparent to the emergency medical dispatcher (EMD) during call processing.

Objectives: The objective of this study was to characterize the risk of cardiac arrest and “hot-transport” outcomes in patients with “not alert” condition, within the Medical Priority Dispatch System (MPDS[®]) Falls protocol descriptors. **Methods:** This retrospective study used 129 months of de-identified, aggregate, dispatch datasets from three US emergency communication centers. The communication centers used the Medical Priority Dispatch System version 11.3-OMEGA type (released in 2006) to interrogate Emergency Medical System callers, select dispatch codes assigned to various response configurations, and provide pre-arrival instructions. The distribution of cases and percentages of cardiac arrest and hot-transport outcomes, categorized by MPDS[®] code, was profiled. Assessment of the association between MPDS[®] Delta-level 3 (D-3) “not alert” condition and cardiac arrest and hot-transport outcomes then followed.

Results: Overall, patients within the D-3 and D-2 “long fall” conditions had the highest proportions (compared to the other determinants in the “falls” protocol) of cardiac arrest and hot-transport outcomes, respectively. “Not alert” condition was associated significantly with cardiac arrest and hot-transport outcomes ($p < 0.001$).

Conclusions: The “not alert” determinant within the MPDS[®] “fall” protocol was associated significantly with severe outcomes for short falls (<6 feet; 2 meters) and ground-level falls. As reported to 9-1-1, the complaint of a “fall” may include the presence of underlying conditions that go beyond the obvious traumatic injuries caused by the fall itself.

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Abbreviations:

CAQ = cardiac arrest quotient
EMD = emergency medical dispatcher
EMS = emergency medical services
EMSA = Emergency Medical Services Authority
IAED = International Academies of Emergency Dispatch

MPDS = Medical Priority Dispatch System
MEDIC = Mecklenburg EMS Agency
PSAP = public safety access point
RAA = Richmond Ambulance Authority

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Introduction

Falls are one of the most frequent complaint types received by 9-1-1 emergency medical dispatch centers. Data from several urban communication centers in North America and the UK indicate that between 8 and 12% of patients who contact the emergency medical services (EMS) present to dispatch with the chief complaint of *fall*. Perhaps the biggest challenge for the emergency medical dispatcher (EMD) in fall cases is to determine the specific nature or cause. A *fall* can be the result of an accidental or intentional slip, trip, or misstep; or it can occur due to a sudden, complete, or near loss of consciousness, or even electrical shock.¹ The cause of the *fall* is an important factor in patient triage and treatment, and often determines the type and urgency of the EMS response.

The authors' previous examination of Montreal data collected from September 1998 to May 1999 yielded a surprising result—a high number of victims of cardiac arrest found by paramedics after arriving at the scene with a dispatch complaint of fall.² Out of 4,282 cardiac arrest cases in a database of 142,507 ProQA cases (comprising 34 chief complaints), 50 (1.2%) cardiac arrest cases were recorded in the Medical Priority Dispatch System (MPDS®) "Falls" protocol. When the initial chief complaint reported to the EMD was a *fall*, and the caller subsequently identified the patient as being "not alert", cardiac arrest outcomes were more frequent. *Falls* identified later as cardiac arrests actually are caused by acute medical factors most likely preceding the fall, and that the caller's observance of the patient falling inspired the complaint, not the root cause of the fall. The actual "not alert" condition is determined only later in the course of the structured interrogation by the EMD.

Linking the dispatch description of a "not alert" fall to the paramedic-determined cardiac arrest upon arrival at the patient's side allowed a quantifiable value originally termed cardiac arrest quotient (CAQ), to be assigned.³ The CAQ is the number of paramedic-determined cardiac arrest for a specific dispatch-generated code as a fraction of the total number of cases for that code. Generally, the frequency of cardiac arrest appearing within the spectrum of the six clinical levels (Alpha [A], Bravo [B], Charlie [C], Delta [D], Echo [E], and Omega [O]) within the MPDS® can be studied.⁴ In total, there are 351 determinant codes within the Omega version of the MPDS® protocol, each identifying a specific clinical or situational condition reported to the EMD. Several recent studies⁵⁻¹⁰ shifted the focus of research from looking at the general validity of EMD-assigned, presumptive, patient care (looking at sensitivities and specificities) to the appropriateness of the level of acuity found later. The MPDS® protocols also have successfully identified high acuity illness or injury patients and have shown that the likelihood of a "hot-transport" outcome increases with increasing MPDS protocol determinant levels.^{5,7,10,11} *Hot transport* is used herein as a clinical surrogate for high acuity.

In a large, outcome-linked, London Ambulance Service dataset, several published studies¹¹⁻¹⁶ have demonstrated associations between types of dispatch codes and findings of cardiac arrest after responder arrival. These studies have value in assigning the proper level of response to determinant

codes within the MPDS. In addition, they provide a fertile research ground for understanding the mechanisms by which EMDs, utilizing a structured protocol, initially assign certain codes to these patients. A multi-center approach is required to give a comprehensive look at the distribution of cardiac arrest within the dispatch coding system. This study enabled further examination of the distribution of patients with the chief complaints of *falls* and determine what specifics identified during the EMDs evaluation may be associated with the presence of cardiac arrest and/or hot transport. The findings of this study should help to refine the EMD protocol, including interrogation methods and dispatch code-based response recommendations. Therefore, it is hypothesized that the "not alert" condition within the MPDS® Falls protocol is associated with on-scene cardiac arrest and hot transport patient outcomes.

Objectives

The aims of this study were to: (1) categorize the distributions of patients and cardiac arrest and hot transport outcomes by the MPDS® Falls determinant codes; and (2) assess association between the "not alert" condition and cardiac arrest and hot transport patient outcomes.

Methods

This was a retrospective study utilizing de-identified, aggregate, cumulative dispatch datasets from three International Academies of Emergency Dispatch (IAED) Accredited Centers of Excellence (ACE) US sites, using MPDS® Protocol version 11.3-OMEGA type (released in 2006): Richmond Ambulance Authority (RAA), Richmond, Virginia (81 months)—ACE since 2001; Emergency Medical Services Authority (EMSA), Tulsa and Oklahoma City, Oklahoma (12 months)—ACE since 2000; and Mecklenburg EMS Agency (MEDIC), Charlotte, North Carolina (36 months)—ACE since 2004.

The EMSA covers approximately 1,080 square miles, and has two divisions—Eastern and Western. As a secondary public safety access point (PSAP), EMSA processes all EMS 9-1-1 (7 digits emergency and non-emergency) telephone call requests—>10,000 calls monthly, including regional trauma referral center calls.

The RAA provides emergency medical care to the city of Richmond, Virginia, covering 62 square miles, with a baseline population of 200,000, increasing to >600,000 people during the workweek. The RAA is a secondary PSAP to the Richmond Emergency Communications Center and responds to nearly 50,000 calls for transport annually.

The MEDIC is responsible for all ambulance transports in Mecklenburg County, North Carolina, and provides emergency care to approximately 828,000 residents across 542 square miles. The MEDIC communication center coordinates all EMS resources within Charlotte-Mecklenburg. Efficient use of these resources is achieved by a computer-aided dispatch system, MPDS®, global positioning satellite tracking equipment, on-board mobile status terminals, electronic patient care reporting, and system status management. There was no universal set of criteria for determining when to use hot-transport at the study sites (Table 1). Each local

	Site	Patient Cases Categorization Criteria
1	Emergency Medical Services Authority (EMSA)	<i>Trauma definition:</i> Blunt or penetrating trauma with unstable vital signs, hemodynamic and/or respiratory compromise, altered mentation
		<i>Anatomical criteria:</i> Penetrating to head, neck, torso or groin; Amputation above wrist or ankle; paralysis; flail chest; two or more obvious proximal long bone fractures; open or suspected depressed skull fracture; unstable or suspected pelvic fracture; tender or distended abdomen; burns associated with priority 1 trauma
		<i>Neurologic criteria:</i> Adult—Acute stroke symptoms (within two hours of onset) with positive Cincinnati stroke scale, closed head trauma with clinical picture of a possible intracranial hematoma. Pediatric—Status epilepticus or multiple seizures without regaining consciousness between seizures, acute sustained loss of consciousness without apparent reason, Focal neurological deficits.
2	Richmond Ambulance Authority (RAA)	<i>Priority A:</i> Vital signs stable and within normal limits. Patient is conscious, may have no complaint or may be slightly uncomfortable. Indicators show recovery is potentially excellent. Minimum prehospital care required (e.g., vital signs, psychological support, transport); psychological patient who is alert and oriented X 3
		<i>Priority B:</i> Vital signs are stable but may not be within normal limits. Patient is conscious and may be in pain. Recovery is expected with proper treatment. Moderate prehospital care is required (e.g., vital signs, oxygen therapy, splinting of simple fractures, control of non-life threatening hemorrhage, maintenance IV); minor MVA or uncomplicated seizure patient
		<i>Priority C (Hot-transport):</i> Vital signs may be unstable and are not within normal limits. Patient is acutely ill. Maximum prehospital care is required (e.g., oxygen therapy, IV, drug therapy, intubation, chest decompression); Multi-system trauma or critical medical patients. Any life determining intervention as decided by the provider
3	Mecklenburg Emergency Medical (MEDIC) Services Agency	<i>Priority 1 (Emergent):</i> Immediately life-threatening, high potential for decompensation, use of warning lights and siren indicated
		<i>Priority 2 (Urgent):</i> Emergent, not immediately life-threatening, intermediate potential for decompensation, use of warning lights and siren not indicated
		<i>Priority 3 (Non-urgent):</i> Non-emergent, minimal potential for decompensation, use of warning lights and siren not indicated
		<i>Priority 4 (Scheduled):</i> Non-emergent, minimal potential for decompensation use of warning lights and siren not indicated

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Table 1—Categorization criteria for hot-transport patients at each site (IV = intravenous; MVA = motor vehicle accident)

EMS agency determines this, typically through standard policy and physician-directed medical oversight.

Intercooled STATA for Windows® software [STATA Statistical Software: Release 9 ©2007, StataCorp, College Station, TX] was used for data analysis. Risk difference (RD) with 95% confidence interval (CI) and the *p*-value, from the Fisher's exact test, were used to assess associations between groups at 0.05 significance level. The distributions of patients, cardiac arrest and hot-transport outcome categorized by MPDS® determinants were characterized. Next, the risks of cardiac arrest and hot-transport outcomes between "not alert" and "alert" cases were assessed.

Results

Overall (all sites combined), the MPDS® Bravo-1 (B-1) descriptor code recorded the highest volume of "Falls" cases, followed by Alpha-1 (A-1), while the Delta 3 (D-3) code recorded the highest percentage of cardiac arrest outcomes, and Delta-2 (D-2) code recorded the highest percentage of hot-transport outcomes (Table 2). However, the percentage of hot-transport in the D-3 determinant (8.67%) was not significantly different from that in D-2 (9.59%) (RD (95% CI) = -0.009 (-0.028, 0.009), *p* = 0.335).

The EMSA site dispatched 122,236 cases during the study period, and 1,917 (1.6%) cardiac arrest and 6,756 (5.5%) hot-transport outcomes were recorded by EMSA responders, either at the scene or during transport. The *Falls* protocol con-

MPDS Priority Level	Code	Determinant Descriptors	Cases n (%*)	Cardiac Arrest n (%†)	“Hot-Transport” n (%‡)
ALPHA	A-1	Not dangerous proximal body	10,977 (78.54)	4 (0.04)	260 (2.37)
	A-2	Non-recent injuries§	2,999 (21.46)	0 (0.00)	35 (1.17)
	All Alphas		13,976 (28.25)	4 (0.03)	295 (2.11)
BRAVO	B-1	Possibly dangerous body	17,075 (82.31)	5 (0.03)	256 (1.50)
	B-2	Serious hemorrhage	390 (1.88)	0 (0.00)	10 (2.56)
	B-3	Unknown status	3,280 (15.81)	5 (0.15)	77 (2.35)
	All Bravos		20,745 (41.93)	10 (0.05)	343 (1.65)
DELTA	D-1	Dangerous body area	2,490 (29.08)	8 (0.32)	151 (6.06)
	D-2	Long fall (≥6ft/2m)	1,763 (20.59)	2 (0.11)	169 (9.59)
	D-3	Unconscious or Not alert	2,008 (23.45)	18 (0.90)	174 (8.67)
	D-4	Abnormal breathing	2,303 (26.89)	2 (0.09)	80 (3.47)
	All Deltas		8,564 (17.31)	30 (0.35)	574 (6.70)
OMEGA	O-1	Public assistance¶	3,812 (61.56)	2 (0.05)	20 (0.52)
	O-2	Not dangerous distal body area	2,010 (32.46)	0(0.00)	58 (2.89)
	O-3	Non-recent injuries**	370 (5.98)	0 (0.00)	8 (2.16)
	All Omegas		6,192 (12.51)	2 (0.03)	86 (1.39)
Total (Falls Protocol CC)			49,477	46 (0.09)	1,298 (2.62)
Total (all MPDS CCs)			504,438	4,446 (0.88)	44,240 (8.77)

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Table 2—Distribution of cases and outcomes by *Falls* protocol determinant codes

*The percentage of cases as a fraction of the total number of cases in each individual MPDS priority level; †The percentage of cardiac arrest outcomes as a fraction of the number of cases in each individual MPDS descriptor; ‡The percentage of “hot-transport” outcomes as a fraction of the number of cases in each individual MPDS descriptor; §≥6 hours except distal body area; ||The percentage of cases as a fraction of the total number of cases in the MPDS *Falls* protocol; ¶No injuries and no priority symptoms; **≥6 hours to distal body area. *Portions of this protocol were used with permission of the LAED*

stituted 12.8% (15,620/122,236) of all cases, and 1.0% (20/1,917) and 4.8% (326/6,756) of all cardiac arrest and hot-transport outcomes, respectively. Within the *Falls* protocol, 0.1% (20/15,620) cardiac arrest and 2.1% (326/15,620) hot-transport outcomes were recorded by the responders. Although the B-1 code had the highest percentage of cases, it had one of the lowest percentages of cardiac arrest and hot-transport outcomes within the *Falls* protocol. The D-3 descriptor code had the highest percentage of cardiac arrest (1.2%) and hot-transport (11.3%) outcomes, and the D-2 code also had a high percentage of hot-transport (10.9%) outcome.

The RAA dispatched 210,624 cases during the study period, and 1,347 (0.6%) cardiac arrest and 25,364 (12.0%) hot-transport outcomes were recorded. The *Falls* protocol constituted 8.4% (17,600/210,624) of all the cases, and 1.6% (21/1,347) and 2.7% (691/25,364) of all of the cardiac

arrest and hot-transport outcomes, respectively. Within the *Falls* protocol, 0.1% (21/17,600) cardiac arrest and 3.9% (691/17,600) hot-transport outcomes were recorded by RAA responders. The D-2 and D-3 codes had the highest percentages of cardiac arrest (1.1%) and hot-transport (8.7%) outcomes, respectively.

The MEDIC dispatched 171,578 cases during the study period, and 1,182 (0.7%) cardiac arrest and 12,120 (7.1%) hot-transport outcomes were recorded. The *Falls* protocol constituted 9.5% (16,257/171,578) of all the cases, and 0.4% (5/1,182) and 2.3% (282/12,120) of all cardiac arrest and hot-transport outcomes, respectively. Within the *Falls* protocol, responders recorded 0.03% (5/16,257) cardiac arrest and 1.7% (282/16,257) hot-transport outcomes. Again, the D-2 and D-3 codes had the highest percentages of hot-transport (9.6%) and cardiac arrest (0.3%) outcomes, respectively.

Site	Medical condition	n	Cardiac Arrest			"Hot-Transport"		
			n (%)*	RD (95%CI)†	p‡	n (%)*	RD (95%CI)†	p‡
EMSA	Not alert or Unconscious	654	8 (1.22)	0.011 (0.003, 0.020)	<0.001	74 (11.31)	0.096 (0.072, 0.121)	<0.001
	Alert	14,966	12 (0.08)			252 (1.68)		
RAA	Not alert or Unconscious	703	8 (1.14)	0.011 (0.003, 0.018)	<0.001	61 (8.68)	0.049 (0.028, 0.070)	<0.001
	Alert	16,897	13 (0.08)			630 (3.73)		
MEDIC	Not alert or Unconscious	651	2 (0.31)	0.003 (-0.001, 0.007)	0.015	39 (5.99)	0.044 (0.026, 0.063)	<0.001
	Alert	15,606	3 (0.02)			243 (1.56)		
Overall	Not alert or Unconscious	2,008	18 (0.90)	0.008 (0.004, 0.013)	<0.001	174 (8.67)	0.063 (0.051, 0.075)	<0.001
	Alert	47,469	28 (0.06)			1,125 (2.37)		

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Table 3—Association between "not alert" condition and outcome, by site

*The percentage of cardiac arrest and "hot-transport" outcomes as a fraction of the number of cases in each individual medical condition; †Risk difference and 95% confidence interval; ‡Two-sided Fisher's Exact *p*-value. Portions of this protocol were used with permission of the IAED

Patients who were "not alert" were at significantly higher risk of cardiac arrest and hot-transport outcomes than those who were "alert" (Table 3).

Overall, Falls chief complaint patients were significantly less likely to have cardiac arrest and hot-transport than patients within the other MPDS® chief complaints combined (RD (95% CI) = -0.0087 (-0.0091, -0.0084)). Delta patients were at significantly higher risks of cardiac arrest and hot-transport than Alpha (RD (95% CI) = 0.003 (0.002, 0.004); 0.046 (0.040, 0.052), respectively) or Bravo (RD (95% CI) = 0.003 (0.002, 0.004), 0.050 (0.045, 0.056), respectively) patients. The Omega patients were significantly less likely to have cardiac arrest and hot transport than Delta patients (RD (95% CI) = -0.003 (-0.005, -0.002); -0.053 (-0.059, -0.047), respectively). The Bravo and Omega patients also were significantly less likely to have hot-transport than Alpha patients (RD (95% CI) = -0.007(-0.011, -0.003)).

Discussion

The D-2 "long fall ≥6ft/2m" code produces a relatively low number of cardiac arrest cases, but a high number of hot-transport cases. One explanation for this is that these patients—more than those in any of the other Delta codes—are likely to meet local trauma center transport criteria. Because of the potential for serious internal injury, trauma center transport protocols often require an immediate (i.e., "hot") transport for all patients who fall a distance equal to or greater than a given height (generally 10 feet or 3 meters). This procedure could be skewing the hot-transport data to the higher side for the D-2 code.

When compared against each other, the three sites provided rather consistent percentages of cases by determinant codes—a

high percentage (11.05%) of B-1 "unknown status" code at EMSA being the most notable exception. This suggests that regional demographic differences in types of falls cases reported to 9-1-1 are not great. However, a substantial difference in hot-transport occurred in a number of the determinant codes, by site. This could be due to the lack of a universal set of criteria for initiating "hot" transport.⁹ The cardiac arrest outcome percentage was consistent for EMSA and RAA, but much lower for MEDIC. This inconsistency may be a resultant of the small cardiac arrest sample sizes in some descriptor codes.

At times, more than one code fits the patient's condition (e.g., D-2 "long fall" and D-3 "unconscious or not alert"). The automated protocol software has a system for sorting those patients to help provide a better understanding of the type of patients that present in the D-3 code set. A phenomenon known as hierarchy bias is an inherent feature in automated protocols that places a ranked order (or hierarchy) to each coded condition within an MPDS® priority level.¹³ Here, the ranking in the Delta level starts with the Delta level-1 (D-1) "dangerous body area" descriptor code. The D-2 code is placed second in the hierarchy, followed by D-3, and D-4 "abnormal breathing". When several codes fit, the system always recommends the code with the higher listed order in the hierarchy. Therefore, the D-3 code only is recommended and selected by the EMD when the D-1 and D-2 conditions do not exist. In most cases, this allows for the elimination of severe trauma as the reason for the decreased consciousness in patients coded as D-3. Hence, the majority of patients coded as D-3 actually might have fallen due to an acute, non-traumatic, systemic event such as stroke, acute coronary syndrome, dysrhythmia/arrhythmia, aneurysm, respiratory failure, or grand-mal seizure.¹

A second process in the software logic affected how patients were sorted and included or excluded from the falls chief complaint codes. As part of the EMD interrogation in the falls protocol sequence, the caller is queried with the following: "How far did he fall?" plus, "What caused the fall?" When the answers to these questions are "less than 6 feet" and "fainting or near fainting," respectively, then the protocol logic automatically moves the EMD to the "unconscious/fainting" chief complaint (i.e., Protocol 31) as the pre-eminent problem. Therefore, when fainting or near-fainting is the discovered cause of the fall, the results will not record this as a "fall" per se. To investigate these cases, a study must be conducted to look specifically at cases in which the protocol logic shunted to the "unconscious/fainting" chief complaint. In a preliminary analysis of three years dispatch data from MEDIC, the frequency of these shunts was examined. A total of 3.2% (553/17,218) of falls cases were shunted this way. This finding indicates that a more detailed study that examines the outcome of these cases must be performed.

These results lend credence to the assumption that some cases reported to 9-1-1 as "falls" actually are caused by acute medical events—cardiac, respiratory, circulatory, or neurological in nature—rather than by accidental causes. Such medically caused cases, which typically show up in the MPDS[®] D-3 coding, generally are ground-level or short-distance falls that do not present with severe, traumatic injuries. The D-3 coding constituted just more than 4% of all cases coded under the "falls" chief complaint, but these patients had a higher percentage of cardiac arrest outcomes than all other types of "falls". The 9-1-1 medical dispatch protocols must account for such events with proper questioning and call classification, in order to provide the correct EMS response to the scene and pre-arrival instructions to callers.

Among all of the Delta cases, the D-4 code yields the lowest percentage of cardiac arrest and hot-transport outcomes. This finding is useful in that it provides a better understanding of the relative importance of the "not alert or unconscious" condition in comparison to the condition of "abnormal breathing" in falls cases. Again, hierarchy bias filtering makes this a "pure" code. As a result, and from similar results elsewhere,¹⁶ the D-4 code has been replaced in the latest MPDS[®] protocol version 12 with a new description that better deals with specific situations in which fall injuries may be causing respiratory compromise: "chest or neck injury (with difficulty breathing)". This change is expected to increase the overall specificity of the Delta priority level as predictor of severe outcomes.

Limitations

The small sample sizes, especially for the cardiac arrest outcome, made for less-than-ideal comparisons by site. The aggregate numbers for all sites, however, provided a more sufficient sample from which to draw conclusions. As mentioned, the automatic protocol shunt to the MPDS[®] Protocol 31 chief complaint did not allow for the investigation of these details and for sufficient conclusions to be made on the outcomes for these cases. The fact that the criteria for initiating a hot-transport were not universal across all sites may make the interpretation of these results somewhat less reliable for the hot-transport data element.

Conclusions

The "not alert" condition demonstrated significant association with cardiac arrest and hot-transport patient outcomes. Since "not alert" cases were separated from long falls (≥ 6 feet), the vast majority of them were reported to 9-1-1 as short-distance or ground-level falls. Therefore, EMDs and responders must be aware of the potential for acute cardiac, respiratory, and neurological events in these reported "fall" patients. The study also showed that the use of hot-transport is more subjective and less standardized than other data elements used in this study. Emergency medical services agencies should work toward a universally accepted set of clinical signs and conditions that define hot-transport use.

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