# Does Emergency Medical Dispatch Priority Predict Delphi Process-Derived Levels of Prehospital Intervention?

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## Abstract

**Objective:** The Medical Priority Dispatch System (MPDS) is an emergency medical dispatch system widely used to prioritize 9-1-1 calls and optimize resource allocation. This study evaluates whether the assigned priority predicts a Delphi process-derived level of prehospital intervention in each emergency medical dispatch category.

**Methods:** All patients given a MPDS priority in a suburban California county from 2004–2006 were included. A Delphi process of emergency medical services (EMS) professionals in another system developed the following categories of prehospital treatment representing increasing acuity, which were adapted for this study: advanced life support (ALS) intervention, ALS–Stat, and ALS-Critical. The sensitivities and specificities of MPDS priority for level of prehospital intervention were determined for each MPDS category. Likelihood ratios of low and high priority dispatch codes for the level of prehospital intervention also were calculated for each MPDS category.

**Results:** A total of 65,268 patients met inclusion criteria, representing 61% of EMS calls during the study period. The overall sensitivities of high-priority dispatch codes for ALS, ALS-Stat, and ALS-Critical interventions were 83% (95% confidence interval 83–84%), 83% (82–84%), and 94% (92–96%). Overall specificities were: ALS, 32% (31–32%); ALS-Stat, 31% (30–31%); and ALS-Critical 28% (28–29%). Compared to calls assigned to a low priority, calls with high-priority dispatch codes were more likely to receive ALS interventions by 22%, ALS-Stat by 20%, and ALS-Critical by 32%. A low priority dispatch code decreased the likelihood of ALS interventions by 48%, ALS-Stat by 45%, and ALS-Critical by 80%. Among high-priority dispatch codes, the rates of interventions were: ALS 26%, ALS-Stat 22%, and ALS-Critical 1.5%, all of which were significantly greater than low-priority calls ($p$ <0.05) [ALS 13%, ALS-Stat 11%, and ALS-Critical 0.2%]. Major MPDS were categories with high sensitivities (>95%) for ALS interventions included breathing problems, cardiac or respiratory arrest/death, chest pain, stroke, and unconscious/fainting; these categories had an average specificity of 3%. Medical Priority Dispatch System categories such as back pain, unknown problem, and traumatic injury had sensitivities for ALS interventions <15%.

**Conclusions:** The MPDS is moderately sensitive for the Delphi process derived ALS, ALS-Stat, and ALS-Critical intervention levels, but non-specific. A low MPDS priority is predictive of no prehospital intervention. A high priority, however, is of little predictive value for ALS, ALS-Stat, or ALS-Critical interventions.

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**Abbreviations:**
CPAP = continuous positive airway pressure
ED = emergency department
EMS = emergency medical services
ICU = intensive care unit
LOS = length of stay

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## Introduction

The Medical Prioity Dispatch System (MPDS) is a proprietary, internationally utilized system of categorizing and prioritizing emergency calls in order to send an appropriate ambulance response. Although MPDS is used widely to allocate ambulances and personnel, few comprehensive studies have validated its ability to predict prehospital interventions for all medical complaints. Studies in differing emergency medical services (EMS) configurations have used a variety of emergency medical dispatch programs with both health and non-health trained dispatchers as well as different clinical measures to gauge success.[1–11]

Cardiac arrest has been studied most, both as a dispatch code and an outcome. Sensitivity of MPDS to detect whether a patient was in cardiac arrest has ranged from 53%–88%.[2,12–15] A series by Clawson *et al* examined the efficacy of a number of dispatch codes to detect cardiac arrest as an endpoint.[16–20] Recent studies also have examined other dispatch codes including stroke, seizure, chest pain, and unknown problem (man down).[16–19,21]

Several studies have examined predictive accuracy of the MPDS for a variety of outcomes, including paramedic-assigned acuity score, physician diagnosis of an acute illness, cardiac arrest, "Code 3" or "lights and sirens" return, and the need for advanced life support (ALS) intervention.[9–11,16–21] This study evaluated the sensitivy and specificity of MPDS for a unique endpoint: a Delphi process derived level of prehospital intervention. In doing so, this study addressed a limitation of a number of previous studies on MPDS—whether interventions actually represent acuity—by asking a panel of EMS professionals to categorize interventions in terms of represented acuity.

The majority of prior studies have evaluated a specific MPDS code or small subset. Most research has demonstrated that MPDS identifies most, but not all, urgent calls with a considerable degree of overtriage.[7–10,16,18,22,23] Studies have concluded that MPDS modestly predicts the need for ALS interventions for selected, common determinants.[11,24] Unlike previous studies, this study evaluated both transported and non-transported patients in all MPDS categories.

## Methods

This retrospective study reports the ability of MPDS to predict the level of prehospital intervention. San Mateo County is an urban/suburban county with a population of 700,000, a size of 552 square miles that receives approximately 40,000 calls for emergency medical assistance annually. All calls receive an ALS response under a tiered system, consisting of a fire department first response team with one paramedic and a private ambulance staffed with at least one paramedic. An electronic, prehospital care record is established for each patient that includes patient demographics, medical history, symptoms and signs, and clinical interventions. The National Academy of Emergency Medical Dispatch (NAEMD) recognizes the county-operated emergency communications center as a Center of Excellence.

Each 9-1-1 caller is asked a series of scripted questions that include the patient's level of consciousness, age, chief complaint, and other complaint-specific questions. A computer-aided dispatch system records general information regarding each call, including date, time, and location of call, dispatch time, dispatch code, and disposition. The Medical Priority Dispatch System (Versions 11.2 and 11.3 (May 2006), NAEMD, Salt Lake City, UT) uses callers' responses to categorize cases into standardized, complaint-based categories, which are prioritized as Alpha or Bravo (denoted as "low priority" in this study), which receive a no "lights and sirens" response, and Charlie, Delta, or Echo ("high priority" in this study), which receive a "lights and sirens" response. Non-MPDS dispatch codes, which are calls that do not go through the MPDS process, typically are calls for medical assistance by police units, fire apparatus, or other ambulances.

All EMS patients from 01 January 2004 to 01 December 2006 were identified from the Computer Aided Dispatch system and linked to an electronic prehospital care record. All patients assigned a priority by MPDS were included in this study. Two non-EMD codes, MED 2/3 ("medical aid requested by police-details to follow") and 252ALS/BLS ("aid requested by police for a psychiatric patient") are assigned a priority by MPDS and were included. Patients catgorized "MED 2" are considered low priority, and those who are MED 3 are high priority. Similarly, 252BLS is low priority, and 252ALS is high priority.

Craig *et al* developed a hierarchy for prehospital interventions that was adapted for this study.[10] During a three-round modified Delphi process, an expert panel of 15 local EMS physicians, EMS supervisors (such as paramedic instructors), and currently practicing ALS paramedics ranked each of Toronto EMS system's 136 prehospital interventions on a five-point Likert scale representing increasing acuity. The three-round process provided successive opportunities for the panel members to anonymously and independently express their opinions using spreadsheets circulated electronically, and to revise their rankings by viewing the group's results from prior rounds. In addition, panelists were asked to decide whether an ALS response was warranted for a patient who required a particular intervention. Each intervention was assigned a minimum response package (a minimum number of certain types of personnel and equipment) based on the panel's rating on the five-point acuity scale. Ultimately, every prehospital intervention was assigned a level of acuity, ALS response (yes/no), and a minimum response package.

The following categories were adapted from Craig *et al* to fit the San Mateo County EMS's scope of practice: ALS, ALS-Stat, and ALS-Critical.[10] Advanced life support interventions were defined a procedure, a medication, and/or an intravenous (IV) fluid infusion (Table 1). Medications available in the San Mateo County EMS system included adenosine, albuterol, aspirin, atropine, diphenhydramine, dextrose 50%, dopamine, epinephrine, glucagon lidocaine, naloxone, midazolam, morphine, nitroglycerin, sodium bicarbonate, activated charcoal, oral glucose, glucose cola, and intravenous fluid. Oxygen was not included as a medication. Intravenous fluid was defined either as an infusion of a volume greater than 100 ml or as a chart in which the phrases "wide open" or "infusion" were noted. Procedures included endotracheal intubation,

| Prehospital Intervention Level | Interventions Included |
|---|---|
| ALS | *Medications:* adenosine, albuterol, aspirin, atropine, diphenhydramine, dextrose 50%, dopamine, epinephrine, glucagon lidocaine, naloxone, midazolam, morphine, nitroglycerin, sodium bicarbonate, activated charcoal, oral glucose, glucose cola, and intravenous fluid<br>*Intravenous fluid infusion* |
| ALS-Stat | *Medications:* albuterol aspirin, midazolam, morphine, naloxone, and/or nitroglycerin<br>*Intravenous fluid infusion* |
| ALS-Critical | *Procedures:* endotracheal intubation, Combitube placement, defibrillation, transcutaneous pacing, cardioversion, needle cricothyrotomy, and/or needle thoracostomy<br>*Medications:* adenosine, atropine, dopamine, epinephrine, lidocaine, and/or sodium bicarbonate |



**Table 1**—Delphi process derived levels of prehospital interventions. (Adapted from the categories derived by Craig *et al*;[10] ALS = Advanced Life Support)

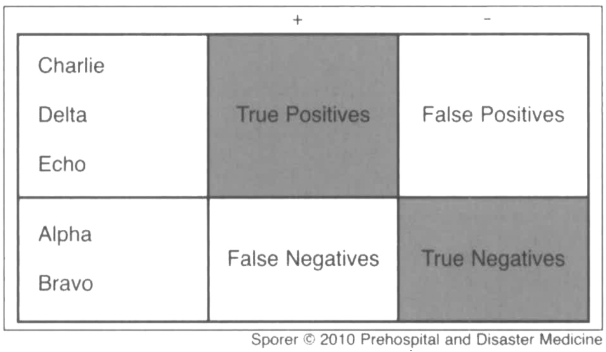


**Figure 1**—Schematic of EMD priority versus prehospital intervention level. Sensitivity was calculated as true positives/(true positives + false negatives); specificity, as true negatives/(false positives + true negatives). Positive predictive value was calculated as true positives/(true positives + false positives); negative predictive value, as true negatives/(true negatives + false negatives) (ALS= Advanced Life Support; EMD = emergency medical dispatch)

Combitube® placement, defibrillation, transcutaneous pacing, cardioversion, needle cricothyrotomy, and/or needle thoracostomy. Blood glucose measurement, wound care, splinting, 12-lead electrocardiography, and pulse oximetry were not included as procedures. Non-transported patients, those who received an IV catheter without infusion, and patients who received basic life support level of care were considered to have not received a prehospital intervention.

*ALS-Stat* interventions were defined as aspirin, nitroglycerin, midazolam, morphine, IV infusion, naloxone, and/or albuterol. ALS-Critical interventions were defined as all procedures and/or the administration of: adenosine, atropine, epinephrine, lidocaine, dopamine, and/or bicarbonate.

In the EMS system in this study, high-priority calls are designated Charlie, Delta, or Echo; these calls receive a "lights and sirens" or "Code 3" responses. Low-priority calls are designated Alpha or Bravo; these calls receive a "no lights and sirens" or "Code 2" response. Since every EMS call receives an ALS ambulance in this EMS system, every patient in this study was eligible to receive every interventions regardless of dispatch priority.

Based on these intervention group classifications, the sensitivities and specificities for each intervention group in every MPDS complaint-based category were determined. A true positive was defined as a high priority call that received an ALS, ALS-Stat, or ALS-Critical intervention (Figure 1). A true negative was defined as a low-priority call that did not receive a prehospital intervention. A false positive was defined as a high-priority call that did not receive a prehospital intervention, and a false negative was defined as a low-priority call that received a prehospital intervention. Sensitivities, specificities, and likelihood ratios were calculated. Also, 95% confidence intervals (CI) were determined using the Newcombe-Wilson method without continuity correction using Confidence Interval Calculator v4 (Rob Herbert). Percentages of prehospital interventions in each category also were compared directly, and statistical significance was assessed via a two-tailed, paired $t$-test using Statistics Calculator (StatPac Inc., Bloomington, MN).

This study will measure the sensitivity and specificity of each MPDS category to predict several Delphi derived severity classes (ALS, ALS Stat, and ALS Cardiac Arrest). The University of California, San Francisco Committee on Human Research approved this study.

## Results

There were a total of 106,635 EMS patients during the study period. Of these patients, 77,394 were assigned a priority by MPDS. There were 12,126 that were mismatched (most commonly due to discrepancies between the dispatch-generated run number and the number entered by the paramedic into the electronic prehospital care record) leaving 65,268 for final analysis. A total of 14,863 (23%) of patients received ALS interventions, 12,322 (18%) received ALS-Stat interventions, and 762 (1%) patients received ALS-Critical interventions.

| | | ALS Intervention | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| MPDS | Description | Sens | (95% CI) | Spec | (95% CI) | LR+ | (95% CI) | LR- | (95% CI) |
| 1 | Abdominal pain | 0.59 | (0.52–0.66) | 0.44 | (0.41–0.46) | 1.06 | (0.94–1.20) | 0.92 | (0.78–1.10) |
| 2 | Allergies/envenomations | 0.93 | (0.88–0.95) | 0.23 | (0.18–0.28) | 1.20 | (1.11–1.29) | 0.32 | (0.19–0.57) |
| 3 | Animal bites/attacks | 0.00 | (0.00–0.79) | 0.85 | (0.71–0.93) | 0.00 | (0.00–0.00) | 1.18 | (1.03–1.35) |
| 4 | Assault/sexual assault | 0.25 | (0.07–0.59) | 0.59 | (0.52–0.66) | 0.62 | (0.18–2.07) | 1.26 | (0.82–1.92) |
| 5 | Back pain | 0.04 | (0.02–0.09) | 0.89 | (0.86–0.91) | 0.33 | (0.14–0.82) | 1.08 | (1.04–1.13) |
| 6 | Breathing problems | 1.00 | (0.99–1.00) | 0.00 | (0.00–0.00) | 1.00 | (1.00–1.00) | -- | -- |
| 7 | Burns/explosion | 0.48 | (0.29–0.67) | 0.67 | (0.53–0.79) | 1.46 | (0.82–2.63) | 0.77 | (0.50–1.20) |
| 8 | Carbon monoxide/ inhalation/HAZMAT | 1.00 | (0.21–1.00) | 0.05 | (0.01–0.24) | 1.05 | (0.95–1.16) | 0.00 | (0.00–0.00) |
| 9 | Cardiac or respiratory arrest/death | 1.00 | (0.78–1.00) | 0.00 | (0.00–0.01) | 1.00 | (1.00–1.00) | -- | -- |
| 10 | Chest pain | 0.99 | (0.99–0.99) | 0.02 | (0.01–0.02) | 1.01 | (1.00–1.01) | 0.35 | (0.19–0.63) |
| 11 | Choking | 0.85 | (0.68–0.94) | 0.32 | (0.27–0.38) | 1.25 | (1.05–1.50) | 0.46 | (0.19–1.16) |
| 12 | Convulsions/seizures | 0.82 | (0.78–0.85) | 0.29 | (0.27–0.31) | 1.15 | (1.09–1.21) | 0.63 | (0.51–0.79) |
| 13 | Diabetic problems | 0.92 | (0.89–0.94) | 0.18 | (0.16–0.21) | 1.12 | (1.10–1.17) | 0.45 | (0.33–0.61 |
| 14 | Drowning/diving/SCUBA accident | 1.00 | (0.34–1.00) | 0.23 | (0.08–0.50) | 1.30 | (0.97–1.75) | 0.00 | (0.00–0.00) |
| 15 | Electrocution/lightning | 1.00 | (0.21–1.00) | 0.00 | (0.00–0.19) | 1.00 | (1.00–1.00) | -- | -- |
| 16 | Eye problems/injuries | -- | -- | 0.96 | (0.87–0.99) | -- | -- | -- | -- |
| 17 | Falls | 0.23 | (0.21–0.26) | 0.77 | (0.76–0.78) | 1.02 | (0.90–1.14) | 1.00 | (0.96–1.03) |
| 18 | Headache | 0.91 | (0.76–0.97) | 0.19 | (0.16–0.23) | 1.12 | (1.00–1.27) | 0.47 | (0.16–1.42) |
| 19 | Heart problems/AICD | 0.96 | (0.93–0.98) | 0.07 | (0.05–0.09) | 1.03 | (1.00–1.06) | 0.57 | (0.30–1.09) |
| 20 | Heat/cold exposure | 0.50 | (0.22–0.78) | 0.67 | (0.50–0.80) | 1.50 | (0.65–3.45) | 0.75 | (0.36–1.56) |
| 21 | Hemorrhage/lacerations | 0.68 | (0.61–0.73) | 0.54 | (0.52–0.57) | 1.48 | (1.33–1.65) | 0.60 | (0.49–0.73) |
| 22 | Inaccessible accident/other entrapments | 0.00 | (0.00–0.56) | 0.44 | (0.19–0.73) | 0.00 | (0.00–0.00) | 2.25 | (1.08–4.67) |
| 23 | Overdose/poisoning | 0.75 | (0.69–0.80) | 0.21 | (0.18–0.25) | 0.95 | (0.87–1.03) | 1.19 | (0.92–1.54) |
| 24 | Pregnancy/childbirth/ miscarriage | 0.86 | (0.65–0.95) | 0.15 | (0.11–0.21) | 1.01 | (0.84–1.21) | 0.94 | (0.32–2.82) |
| 25 | Psychiatric/suicide attempt | 0.24 | (0.13–0.41) | 0.85 | (0.82–0.88) | 1.61 | (0.85–3.02) | 0.89 | (0.73–1.09) |
| 26 | Sick person | 0.56 | (0.52–0.59) | 0.54 | (0.52–0.56) | 1.21 | (1.12–1.31) | 0.82 | (0.75–0.90) |
| 27 | Stab/gunshot/penetrating trauma | 0.85 | (0.69–0.93) | 0.37 | (0.26–0.50) | 1.35 | (1.06–1.73) | 0.41 | (0.17–0.97) |
| 28 | Stroke | 0.99 | (0.97–1.00) | 0.01 | (0.00–0.01) | 1.00 | (0.99–1.01) | 0.86 | (0.11–6.73) |
| 29 | Traffic/transportation accident | 0.48 | (0.41–0.56) | 0.71 | (0.69–0.73) | 1.66 | (1.39–1.97) | 0.73 | (0.63–0.85) |
| 30 | Traumatic injuries | 0.14 | (0.11–0.18) | 0.75 | (0.73–0.78) | 0.56 | (0.42–0.75) | 1.14 | (1.08–1.21) |
| 31 | Unconscious/fainting | 0.98 | (0.97–0.99) | 0.03 | (0.03–0.04) | 1.01 | (1.00–1.02) | 0.57 | (0.39–0.83) |
| 32 | Unknown problem (man down) | 0.14 | (0.10–0.19) | 0.85 | (0.82–0.87) | 0.90 | (0.62–1.30) | 1.02 | (0.96–1.08) |
| MED2/3 | Medical aid requested—details to follow | 0.90 | (0.88–0.91) | 0.21 | (0.20–0.21) | 1.13 | (1.11–1.15) | 0.49 | (0.43–0.57) |
| 252ALS/ BLS | Aid requested by police for psych. patient | 0.90 | (0.60–0.98) | 0.00 | (0.00-0.01) | 0.90 | (0.73-1.11) | 25.30 | (2.87–222.80) |
| | **Total:** | **0.83** | **(0.83–0.84)** | **0.32** | **(0.31–0.32)** | **1.22** | **(1.21–1.23)** | **0.52** | **(0.50–0.54)** |



**Table 2a**—Sensitivities, specificities, and likelihood ratios in each EMD category for (a) ALS, (b) ALS-Stat, and (c) ALS-Critical interventions. Sens = sensitivity, Spec = specificity, 95% CI = 95% Confidence Interval, LR+ = likelihood ratio for a positive test (high-priority dispatch code), LR- = likelihood ratio for a negative test (low-priority dispatch code)

| | | ALS-Stat | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| MPDS | Description | Sens | (95% CI) | Spec | (95% CI) | LR+ | (95% CI) | LR- | (95% CI) |
| 1 | Abdominal pain | 0.57 | (0.50–0.64) | 0.44 | (0.41–0.46) | 1.02 | (0.89–1.16) | 0.97 | (0.82–1.16) |
| 2 | Allergies/envenomations | 0.97 | (0.91–0.99) | 0.19 | (0.16–0.23) | 1.20 | (1.13–1.28) | 0.14 | (0.04–0.56) |
| 3 | Animal bites/attacks | 0.00 | (0.00–0.79) | 0.85 | (0.71–0.93) | 0.00 | (0.00–0.00) | 1.18 | (1.03–1.34) |
| 4 | Assault/sexual assault | 0.33 | (0.10–0.70) | 0.60 | (0.52–0.67) | 0.83 | (0.26–2.60) | 1.11 | (0.62–1.99) |
| 5 | Back pain | 0.04 | (0.02–0.09) | 0.89 | (0.86–0.91) | 0.34 | (0.14–0.84) | 1.08 | (1.04–1.13) |
| 6 | Breathing problems | 1.00 | (1.00–1.00) | 0.00 | (0.00–0.00) | 1.00 | (1.00–1.00) | -- | -- |
| 7 | Burns/explosion | 0.48 | (0.29–0.67) | 0.67 | (0.53–0.79) | 1.46 | (0.82–2.63) | 0.77 | (0.50–1.20) |
| 8 | Carbon monoxide/inhalation/ HAZMAT | 1.00 | (0.21–1.00) | 0.05 | (0.01–0.24) | 1.05 | (0.95–1.16) | 0.00 | (0.00–0.00) |
| 9 | Cardiac or respiratory arrest/death | 1.00 | (0.72–1.00) | 0.00 | (0.00–0.01) | 1.00 | (1.00–1.00) | -- | -- |
| 10 | Chest pain | 0.99 | (0.99–1.00) | 0.02 | (0.01–0.02) | 1.01 | (1.00–1.02) | 0.37 | (0.20–0.66) |
| 11 | Choking | 0.83 | (0.64–0.93) | 0.32 | (0.26–0.38) | 1.22 | (1.00–1.48) | 0.53 | (0.21–1.31) |
| 12 | Convulsions/seizures | 0.81 | (0.76–0.85) | 0.28 | (0.26–0.30) | 1.13 | (1.06–1.20) | 0.67 | (0.53–0.86) |
| 13 | Diabetic problems | 0.85 | (0.78–0.90) | 0.14 | (0.12–0.16) | 0.99 | (0.92–1.06) | 1.07 | (0.70–1.62) |
| 14 | Drowning/diving/SCUBA accident | 1.00 | (0.34–1.00) | 0.23 | (0.08–0.50) | 1.30 | (0.97–1.80) | 0.00 | (0.00–0.00) |
| 15 | Electrocution/lightning | 1.00 | (0.21–1.00) | 0.00 | (0.00–0.19) | 1.00 | (1.00–1.00) | -- | -- |
| 16 | Eye problems/injuries | -- | -- | 0.96 | (0.87–0.99) | -- | -- | -- | -- |
| 17 | Falls | 0.22 | (0.20–0.25) | 0.77 | (0.76–0.78) | 0.95 | (0.83–1.07) | 1.02 | (0.98–1.05) |
| 18 | Headache | 0.89 | (0.72–0.96) | 0.19 | (0.15–0.23) | 1.10 | (0.95–1.26) | 0.59 | (0.20–1.74) |
| 19 | Heart problems/AICD | 0.97 | (0.94–0.99) | 0.07 | (0.06–0.09) | 1.05 | (1.02–1.08) | 0.39 | (0.17–0.89) |
| 20 | Heat/cold exposure | 0.50 | (0.22–0.78) | 0.67 | (0.50–0.80) | 1.50 | (0.65–3.45) | 0.75 | (0.36–1.56) |
| 21 | Hemorrhage/lacerations | 0.67 | (0.60–0.73) | 0.54 | (0.51–0.57) | 1.46 | (1.30–1.63) | 0.61 | (0.50–0.75) |
| 22 | Inaccessible accident/other entrapments | 0.00 | (0.00–0.56) | 0.44 | (0.19–0.73) | 0.00 | (0.00–0.00) | 2.25 | (1.09–4.67) |
| 23 | Overdose/poisoning | 0.92 | (0.84–0.96) | 0.24 | (0.21–0.28) | 1.21 | (1.13–1.31) | 0.33 | (0.16–0.68) |
| 24 | Pregnancy/childbirth/miscarriage | 0.94 | (0.72–0.99) | 0.16 | (0.12–0.21) | 1.11 | (0.97–1.28) | 0.40 | (0.06–2.72) |
| 25 | Psychiatric/suicide attempt | 0.26 | (0.12–0.49) | 0.85 | (0.82–0.87) | 1.73 | (0.80–3.75) | 0.87 | (0.66–1.14) |
| 26 | Sick person | 0.52 | (0.48–0.57) | 0.53 | (0.52–0.55) | 1.12 | (1.02–1.22) | 0.90 | (0.81–0.99) |
| 27 | Stab/gunshot/penetrating trauma | 0.84 | (0.68–0.93) | 0.37 | (0.26–0.49) | 1.33 | (1.04–1.70) | 0.43 | (0.18–1.02) |
| 28 | Stroke | 1.00 | (0.96–1.00) | 0.01 | (0.00–0.01) | 1.01 | (1.00–1.01) | 0.00 | (0.00–0.00) |
| 29 | Traffic/transportation accident | 0.49 | (0.40–0.57) | 0.71 | (0.69–0.72) | 1.65 | (1.38–1.98) | 0.73 | (0.62–0.86) |
| 30 | Traumatic injuries | 0.13 | (0.10–0.18) | 0.75 | (0.73–0.78) | 0.54 | (0.40–0.73) | 1.15 | (1.09–1.22) |
| 31 | Unconscious/fainting | 0.98 | (0.97–0.99) | 0.03 | (0.03–0.04) | 1.01 | (1.00–1.02) | 0.55 | (0.36–0.86) |
| 32 | Unknown problem (man down) | 0.13 | (0.09–0.19) | 0.84 | (0.82–0.87) | 0.83 | (0.56–1.26) | 1.03 | (0.97–1.10) |
| MED2/3 | Medical aid requested—details to follow | 0.92 | (0.90–0.93) | 0.20 | (0.20–0.21) | 1.15 | (1.13–1.17) | 0.41 | (0.34–0.48) |
| 252ALS/ BLS | Aid requested by police for psych. patient | 0.80 | (0.38–0.96) | 0.00 | (0.00–0.01) | 0.80 | (0.52–1.24) | 50.93 | (6.33–409.88) |
| | **Total:** | 0.83 | (0.82–0.84) | 0.31 | (0.30–0.31) | 1.20 | (1.19–1.21) | 0.55 | (0.53–0.57) |



Table 2b—Sensitivities, specificities, and likelihood ratios in each EMD category for (a) ALS, (b) ALS-Stat, and (c) ALS-Critical interventions. Sens = sensitivity, Spec = specificity, 95% CI = 95% Confidence Interval, LR+ = likelihood ratio for a positive test (high-priority dispatch code), LR- = likelihood ratio for a negative test (low-priority dispatch code)

| | | ALS-Critical | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| MPDS | Description | Sens | (95%CI) | Spec | (95%CI) | LR+ | (95%CI) | LR- | (95%CI) |
| 1 | Abdominal pain | 0.40 | (0.12–0.77) | 0.43 | (0.41–0.46) | 0.71 | (0.24–2.07) | 1.38 | (0.67–2.83) |
| 2 | Allergies/envenomations | 0.88 | (0.70–0.96) | 0.17 | (0.13–0.21) | 1.06 | (0.24–2.11) | 0.72 | (0.43–5.06) |
| 3 | Animal bites/attacks | -- | -- | 0.85 | (0.72–0.93) | -- | -- | -- | -- |
| 4 | Assault/sexual assault | 0.50 | (0.09–0.91) | 0.60 | (0.53–0.67) | 1.26 | (0.31–5.08) | 0.83 | (0.21–3.33) |
| 5 | Back pain | 0.00 | (0.00–0.79) | 0.90 | (0.88–0.92) | 0.00 | (0.00–0.00) | 1.11 | (1.08–1.14) |
| 6 | Breathing problems | 1.00 | (0.98–1.00) | 0.00 | (0.00–0.00) | 1.00 | (1.00–1.00) | -- | -- |
| 7 | Burns/explosion | -- | -- | 0.63 | (0.51–0.73) | - | -- | -- | -- |
| 8 | Carbon monoxide/ inhalation/HAZMAT | -- | -- | 0.05 | (0.01–0.23) | - | -- | -- | -- |
| 9 | Cardiac or restpiratory arrest/death | 1.00 | (0.72–1.00) | 0.00 | (0.00–0.01) | 1.00 | (1.00–1.00) | -- | -- |
| 10 | Chest pain | 1.00 | (0.95–1.00) | 0.01 | (0.01–0.02) | 1.01 | (1.01–1.02) | -- | -- |
| 11 | Choking | 1.00 | (0.57–1.00) | 0.31 | (0.26–0.36) | 1.45 | (1.34–1.56) | -- | -- |
| 12 | Convulsions/seizures | 0.88 | (0.66–0.97) | 0.27 | (0.26–0.29) | 1.21 | (1.02–1.45) | 0.43 | (0.12–1.59) |
| 13 | Diabetic problems | 0.70 | (0.40–0.89) | 0.14 | (0.12–0.15) | 0.81 | (0.54–1.12) | 2.20 | (0.85–5.72) |
| 14 | Drowning/diving/SCUBA accident | 1.00 | (0.21–1.00) | 0.21 | (0.08–0.48) | 1.27 | (0.97–1.67) | -- | -- |
| 15 | Electrocution/lightning | -- | -- | 0.00 | (0.00–0.18) | -- | -- | -- | -- |
| 16 | Eye problems/injuries | -- | -- | 0.96 | (0.87–0.99) | -- | -- | -- | -- |
| 17 | Falls | 0.65 | (0.41–0.83) | 0.77 | (0.76–0.78) | 2.81 | (1.97–4.01) | 0.46 | (0.24–0.87) |
| 18 | Headache | 1.00 | (0.21–1.00) | 0.18 | (0.15–0.22) | 1.23 | (1.17–1.23) | -- | -- |
| 19 | Heart problems/AICD | 0.95 | (0.87–0.98) | 0.06 | (0.05–0.08) | 1.02 | (0.96–1.08) | 0.74 | (0.24–2.29) |
| 20 | Heat/cold exposure | -- | -- | 0.64 | (0.49–0.76) | -- | -- | -- | -- |
| 21 | Hemorrhage/lacerations | 1.00 | (0.51–1.00) | 0.52 | (0.49–0.54) | 2.06 | (1.96–2.17) | -- | -- |
| 22 | Inaccessible accident/ other entrapments | -- | -- | 0.58 | (0.32–0.81) | -- | -- | -- | -- |
| 23 | Overdose/poisoning | 0.91 | (0.62–0.98) | 0.23 | (0.20–0.26) | 1.18 | (0.97–1.42) | 0.40 | (0.06–2.60) |
| 24 | Pregnancy/childbirth/ miscarriage | -- | -- | 0.15 | (0.11–0.20) | -- | -- | -- | -- |
| 25 | Psychiatric/suicide attempt | 0.00 | (0.00–0.79) | 0.84 | (0.81–0.87) | -- | -- | 1.18 | (1.15–1.22) |
| 26 | Sick person | 0.89 | (0.73–0.96) | 0.53 | (0.51–0.54) | 1.89 | (1.66–2.16) | 0.20 | (0.07–0.59) |
| 27 | Stab/gunshot/penetrating trauma | 1.00 | (0.44–1.00) | 0.30 | (0.22–0.41) | 1.44 | (1.25–1.65) | -- | -- |
| 28 | Stroke | 1.00 | (0.76–1.00) | 0.01 | (0.00–0.01) | 1.01 | (1.00–1.01) | -- | -- |
| 29 | Traffic/transportation accident | 0.40 | (0.17–0.69) | 0.70 | (0.68–0.71) | 1.31 | (0.61–2.81) | 0.86 | (0.52–1.43) |
| 30 | Traumatic injuries | 1.00 | (0.34–1.00) | 0.78 | (0.76–0.80) | 4.52 | (4.10–4.98) | -- | -- |
| 31 | Unconscious/fainting | 1.00 | (0.98–1.00) | 0.03 | (0.03–0.03) | 1.03 | (1.03–1.04) | -- | -- |
| 32 | Unknown problem (man down) | 0.36 | (0.16–0.61) | 0.85 | (0.83–0.87) | 2.41 | (1.18–4.95) | 0.75 | (0.51–1.16) |
| MED2/3 | Medical aid requested—details to follow | 0.99 | (0.95–1.00) | 0.19 | (0.18–0.20) | 1.22 | (1.20–1.25) | 0.05 | (0.01–0.36) |
| 252ALS/ BLS | Aid requested by police for psych. patient | -- | -- | 0.01 | (0.00–0.01) | -- | -- | -- | -- |
| | **Total:** | **0.94** | **(0.92–0.96)** | **0.28** | **(0.28–0.29)** | **1.32** | **(1.30–1.34)** | **0.20** | **(0.15–0.27)** |



Table 2c—Sensitivities, specificities, and likelihood ratios in each EMD category for (a) ALS, (b) ALS-Stat, and (c) ALS-Critical interventions. Sens = sensitivity, Spec = specificity, 95%CI = 95% Confidence Interval, LR+ = likelihood ratio for a positive test (a high priority dispatch code), LR- = likelihood ratio for a negative test (a low priority dispatch code)

| MPDS | Description | # Calls | # ALS-Critical | % ALS-Critical |
|---|---|---|---|---|
| 9D | Cardiac or respiratory arrest/death | 61 | 10 | 16.4 |
| 6E | Breathing problems | 26 | 4 | 15.4 |
| 2B | Allergies/envenomations | 14 | 2 | 14.3 |
| 14D | Drowning/diving/SCUBA accident | 9 | 1 | 11.1 |
| 19B | Heart problems/AICD | 27 | 2 | 7.4 |
| 19D | Heart problems/AICD | 550 | 38 | 6.9 |
| 19C | Heart problems/AICD | 367 | 23 | 6.3 |
| 2D | Allergies/envenomations | 324 | 19 | 5.9 |
| 23D | Overdose/poisoning | 89 | 5 | 5.6 |
| 2C | Allergies/envenomations | 61 | 3 | 4.9 |
| 27D | Stab/gunshot/penetrating trauma | 65 | 3 | 4.6 |
| 31D | Unconscious/fainting | 4,048 | 130 | 3.2 |
| 32D | Unknown problem (man down) | 165 | 5 | 3.0 |
| 19A | Heart problems/AICD | 34 | 1 | 2.9 |
| 11D | Choking | 202 | 5 | 2.5 |
| 10D | Chest pain (non-traumatic) | 2,478 | 61 | 2.5 |
| 6D | Breathing problems | 8,148 | 167 | 2.0 |
| 2A | Allergies/envenomations | 62 | 1 | 1.6 |
| 13D | Diabetic problems | 188 | 3 | 1.6 |
| 13A | Diabetic problems | 197 | 3 | 1.5 |



**Table 3**—Top 20 MPDS determinants by percentage of patients receiving ALS-critical interventions (AICD = Automated Implantable Cardiac Defibrillator; MPDS = Medical Priority Dispatch System Code)

*Overall Emergency Medical Dispatch Priority*

The MPDS had an overall sensitivity of 83% (95% CI = 83–84%) and overall specificity of 31% (31–32%) for ALS interventions (Table 2a). Similar results were seen for ALS-Stat interventions (overall sensitivity 83%, 95% CI = 82–84%, specificity 31%, 95% CI = 30–31%; Table 2b). The overall sensitivity of MPDS for ALS-Critical interventions was 94% (92–96%) and the overall specificity was 28%, 95% CI = 28–29%; Table 2c. Among calls with high-priority dispatch codes, 26% of patients received ALS, 22% received ALS-Stat, and 1.5% received ALS-Critical interventions, all of which were significantly greater ($p$ <0.05) than the rates of ALS (13%), ALS-Stat (11%), and ALS-Critical interventions (0.2%) for calls with low-priority dispatch codes. Compared to low-priority calls, calls with high priority dispatch codes were more likely to receive an ALS intervention by 22%, 95% CI = 21–23%, ALS-Stat interventions by 20%, 95% CI = 19–21%, and ALS-Critical interventions by 32%, 95% CI = 30–34%. A low priority dispatch code decreased the likelihood of ALS interventions by 48%, 95% CI = 46–50%, ALS-Stat interventions by 45%, 95% CI = 43–47%, and ALS-Critical interventions by 80%, 95% CI = 73–85%.

*Performance of Individual EMD Categories for ALS and ALS-Stat Interventions*

The MPDS complaint-based categories with high sensitivities (>90%) for ALS interventions included breathing problems (100%, 95% CI = 99–100%), chest pain (99%, 95% CI = 99–99%), heart problems/automated internal cardiac defibrillator (AICD) (96%, 95% CI = 93–98%), stroke (99%, 95% CI = 97–100%), and unconscious/fainting (98%, 95% CI = 97–99%); these categories had an average specificity of 5%. The MPDS categories such as back pain, unknown problem, and traumatic injury had sensitivities for ALS interventions <20% (Table 2a). Similar patterns were seen with ALS-Stat interventions (Table 2b).

Sensitivities of other major MPDS categories for ALS interventions varied widely (Table 2a). These include abdominal pain (59% [95% CI = 52–66%]), seizures (82%, 95% CI = 78–85%), diabetic problems (92%, 95% CI = 89–94%), falls (23%, 95% CI = 21–26%), hemorrhage/laceration (68%, 95% CI = 61–73%), sick person (56%, 95% CI = 52–59%), and traffic/transportation accident (48%, 95% CI = 41–56).

A high-priority dispatch code increased likelihood that one or more ALS interventions in only nine of 34 EMD categories, while a low priority dispatch code decreased likelihood of ALS interventions in seven categories. Of note, a low priority dispatch code actually increased the likelihood of ALS interventions in the following five MPDS categories: animal bites/attacks, back pain, inaccessible accidents/other entrapments, traffic/transportation accident, traumatic injuries, and aid requested by police for a psychiatric patient.

*Performance of Individual MPDS Categories for ALS-Critical Interventions*

The breathing problems category had the highest absolute number (180) of ALS-Critical interventions. Many categories, including unconscious/fainting, breathing problems, and chest pain were nearly perfectly sensitive for ALS-Critical interventions, but their specificities approached zero. Categories with low sensitivities (<80%) for ALS-Critical interventions included abdominal pain (40% [12–77%]), back pain (0% [0–79%]) assault/sexual assault (50% [9–91%]), falls (65% [41–83%]), psychiatric/suicide attempt (0% [0–79%]), and traffic/transportation accident (40% [17–69]; Table 2c). Of note, there was only one ALS-Critical intervention in the back pain category and one in the psychiatric/suicide attempt category; both were coded as low priority. Categories with the highest rates of ALS-Critical interventions include cardiac/respiratory arrest/death, breathing problems, and heart problems/AICD; Table 2c).

## Discussion

An ideal Emergency Medical Dispatch system would triage calls with high sensitivity (all patients requiring an intervention would receive a high priority code) and high specificity (all patients not requiring an intervention would receive a low priority codes). In this study, MPDS priority correctly identified most calls that received ALS, ALS-Stat, or ALS-Critical interventions as high priority, but had poor specificity. This finding supports past research that has shown that this process will identify most but not all urgent calls with considerable over-triage.[7–10,16,18,22,23] As noted in prior studies, a low priority was predictive of no ALS intervention[3,5,6] (Table 2a–c). A high priority, however, has low predictive value for ALS, ALS-Stat, or ALS-Critical interventions. This study used a process measure, a Delphi-derived hierarchy of interventions, to evaluate the sensitivity and specificity of MPDS. This process measurement has been used in a major urban EMS system to develop an evidence-based set point for ALS dispatch.[10]

A previous study in this system showed high rates of IV insertions in low-acuity patients, which indicates that some prehospital interventions may not serve as a proxy for acuity.[25] In the current study, the collective opinions of an expert panel of EMS professionals with experience in assessing the need for prehospital interventions were sought to determine which of them represent true acuity. Interventions thought to represent a "standard procedure" such as pulse oximetry, blood glucometry, and IV insertions were ranked as "low acuity" by this Delphi process and exluded from the definitions of ALS, ALS-Stat, and ALS-Critical interventions.

In an ideal MPDS system, calls that will receive time-sensitive interventions should more often receive a high-priority dispatch code than should those receiving interventions that are not time-sensitive. The risks of a "Code 3" or "lights and sirens" ambulance response highlight the importance of improving detection by MPDS of calls that might require time-sensitive interventions.[26] Future studies are necessary to evaluate which prehospital interventions truly are time sensitive and consequently, warrant a high-priority response.

The MPDS process detected calls requiring ALS-Critical procedures and medications with excellent sensitivity. This category included medications and some procedures indicated, at least in the prehospital setting, for cardiac arrest. Other studies have shown a wide range in the sensitivity of MPDS for detecting cardiac arrest, but many of these studies evaluated the ability of a dispatcher to properly diagnose cardiac arrest rather than simply to code it as high priority[2,12,14,16,18] In EMS systems in which cardiac arrest victims receive distinct response packages, accurate dispatcher diagnosis may be essential. In other systems, dispatcher diagnosis may be less important as all high-priority calls receive the same response package. In this study, patients who received ALS-Critical interventions and were "missed" by MPDS (coded as low priority) typically were placed into MPDS categories for complaints not often associated with cardiac arrest events such as back pain or assault/sexual assault.

The unknown problem (man down) category had a markedly low sensitivity for ALS, ALS-Stat, and ALS-Critical interventions; nearly 20% of calls eventually requiring ALS interventions were coded as low priority. In a recent study of another EMS system, a high dispatch priority in the unknown problem (man down) category was associated with an increased odds of cardiac arrest and "Code 3" or "lights and sirens" return.[17] In the current study, only 14 patients in the unknown problem ("man down") dispatch category received ALS-Critical interventions, but nine of them were coded as low priority. This highlights the difficulty of detecting acuity when little information can be gathered about the status of the patient.

In the EMS system in this study, the stroke dispatch category had an extremely high sensitivity and a low specificity for ALS interventions. Another recent study showed that dispatchers had a sensitivity of 83% in diagnosing a patient with physician-verified stroke.[21] Endpoints other than prehospital interventions, such as physician diagnosis or stroke scale score, might be more useful for evaluating dispatch priority of a patient with suspected stroke as the preferred prehospital treatment is stabilization and rapid transport to an appropriate receiving hospital rather than an intervention.

Categories relating to injury or trauma such as back pain, traffic/transportation accident, and traumatic injury had markedly low sensitivities for all levels of intervention (Tables 2a–c). Although few studies have evaluated these dispatch categories, one demonstrated that they had low sensitivities for a paramedic-assigned acuity score [back pain (5%), traffic/transportation accident (42%), traumatic injury (17%)].[9] This may indicate that the MPDS system does not adequately differentiate level of acuity in traumatic injury-related categories. The low specificities in these categories may be explained by the fact that some interventions for minor traumatic injuries such as wound care, splinting, and IV access were not included as ALS, ALS-Stat, or ALS-Critcal interventions.

### *Limitations*

A number of limitations must be noted. By protocol, all calls receive an ALS response; this may lead to higher delivery of ALS measures. The findings in this single-tiered EMS system may differ from those derived in multi-tiered EMS systems. The local EMS system has a more aggressive rate of treating patients in the prehospital setting with intravenous morphine as compared to other communities.[5,11] This study was unable to measure protocol compliance with the use of ALS interventions or outcomes, and this may not necessarily imply the need for these interventions. Approximately 11% of MPDS calls were unmatched by the system and excluded, potentially introducing a selection bias. This occurred commonly because of a mismatch between the dispatch-generated run number and the number entered by the paramedic. A large percentage of calls (28%) were not given a dispatch priority, and also, may have had an effect on data analysis. Two versions of MPDS (11.2

and 11.3) were used during the study period, which may have affected the analysis.

## Conclusions

Overall, this MPDS system shows moderate sensitivity for Delphi-derived levels of prehospital intervention, but has low specificity. A considerable amount of over- and under-triage occurs. As demonstrated in previous studies, a low MPDS priority is highly predictive of receiving no prehospital interventions. A high priority, however, is of low predictive value for ALS, ALS-Stat, or ALS-Critical interventions. Significantly, the current study demonstrated considerable variability in the performance of MPDS across complaint categories. Modifying dispatcher protocols to increase the specificity of common medical complaints such as breathing problems, chest pain, and unconscious/fainting and the sensitivity of complaints related to trauma or injury may result in improved resource allocation and detection of true acuity.

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# Predictive Ability of Emergency Medical Priority Dispatch System Protocols Should Be Assessed at the Atomic Level of the Determinant Code

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We commend Sporer *et al* for their work in determining predictive ability of the Medical Priority Dispatch System (MPDS™)[1,2] in determining eventual Advanced Life Support (ALS)-level interventions in a wide variety of patient conditions.

However, there are some critical flaws. One significant flaw is in the artificial way the data initially were grouped for this study. An incorrect assumption that CHARLIE-level conditions should be placed in the same category of acuity as DELTA-level calls, and the same with ECHO-level problems, hides a great deal of what could have made this study much more valuable in refining the MPDS Protocols based on its findings. Per the National Academies of Emergency Dispatch (NAED) response matrix (Figure 1), each of the six clinical levels in this study represents a different but clinically-related grouping of potential evaluations, treatments, and response types and modes. By also grouping the ALPHA and BRAVO, and apparently the OMEGA level, into a single category, a similar important loss of code level detail occurred.

The CHARLIE level itself is defined as *not* having necessarily high acuity cases, but ones that the current standard of care and practice requires an ALS scene *assessment*—not necessarily ALS *treatment*. Chest Pain in a cardiac age patient (>35 years) is a good example. Many of these patients ultimately are determined as not having Acute Myocardial Infarction (AMI), but no one would say they do not need an ALS-type evaluation down the line. Examination of the general CHARLIE definition in the NAED response matrix shows a COLD ALS response default recommendation.

We also understand that in order to estimate sensitivities, specificities, and predictive values, the authors needed to dichotomize the "priority" levels into a high and low category. However, a better design would include: (1) establishing an overall trend analysis by analyzing association between MPDS priority levels as a categorical variable (ECHO, DELTA, CHARLIE, BRAVO, ALPHA, OMEGA) and each of the Delphi process categories (ALS-Intervention, ALS-Stat, ALS-Critical); and (2) taking each pair, (e.g., ECHO vs. DELTA) and assess their respective association with the Delphi process categories used in this study.

In addition, the sensitivity and specificity statements made regarding the general categories (chief complaint groups) such as Abdominal Pain, Falls, and Traffic/Transportation Incidents are unclear. Since each of these groups contains a spectrum of code levels, including four to 14 individual codes, such groupings are not useful to those involved in improving specific areas within the dispatch protocols. This paper lacks a clear message as to what specific determinant codes should be modified in the dispatch protocols, or how. The authors simply conclude that the protocols need modification so as to increase specificity of chief complaints, such as breathing problems, chest pain, and unconscious/fainting. Realistically, the acuity value of an entire "lumped" chief complaint is not of any particular use in formulating responses or urgencies—thus, the specific wide spectrum of the six levels and more than 600 individual codes therein contained in the MPDS. The authors had a great idea on these pertinent issues, but analy-

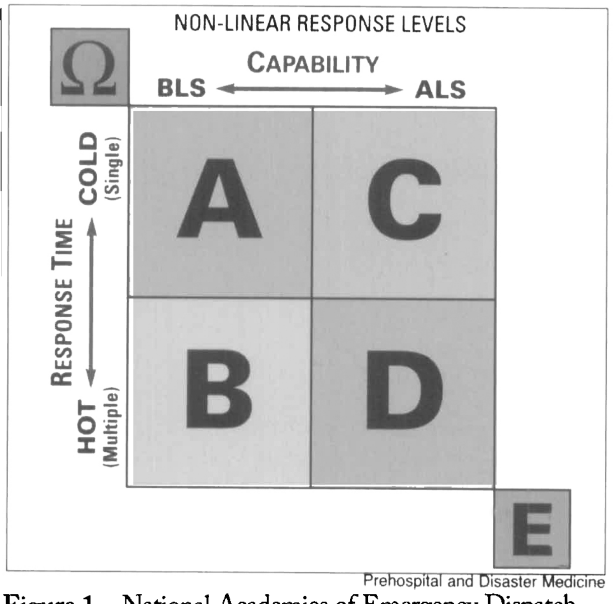


**Figure 1**—National Academies of Emergency Dispatch (NAED) response matrix

sis to demonstrate the need for the modifications essentially is lacking.

This paper also leaves the reader wondering if some of the low sensitivities and specificities observed in some chief complaints simply could be due to small sample sizes in each chief complaint. As the authors did not provide the sample sizes in each chief complaint, we are not able to verify this issue.

Finally, the conclusion leaves us right where we started by restating the obvious: that the MPDS is more sensitive than it is specific. This is a well-known fact, since this is inherent in its ongoing design to maintain patient safety, especially when things are not clear in the non-visual dispatch environment. Of much more value in "modifying dispatcher protocols to increase specificity" is looking individually at codes within levels in a chief complaint—the "atomic level". Trying to study the entire dispatch protocol as a whole is akin to trying to study "internal medicine". By design, dispatch protocols differ significantly from diagnostic tools in their levels of sensitivities, specificities, and predictive values to capture levels of acuity.

Having read and reread this interesting study, we unfortunately failed to find the information necessary to submit any Proposal for Change request documents to the NAED for protocol improvement. Therefore, without analysis at the determinant level, and more specifically, the individual code level, we find no new message in the conclusions of this study. We look forward to further discussion with authors to see what we may have missed and which should be further evaluated.

Nevertheless, we are happy that collaborative dispatch research efforts have been initiated recently. We are aware and grateful that Dr. Sporer has been, and continues to be, a keen proponent of more collaborative efforts to improve medical dispatch protocol study effectiveness and relevance. We truly look forward to working with these dedicated dispatch scientists in the future.

**References**

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