An Evaluation of EMD Coding in Livingston County

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ABSTRACT

This research evaluated the Emergency Medical Dispatch (EMD) code implementation in Livingston County, New York. The Livingston County Dispatch Office is an International Academics of Emergency Dispatch (IAED) certified agency that codes jobs for Emergency Medical Services (EMS) with EMD codes. Using data obtained from Livingston County EMS (LCEMS)'s emsCHARTS from 2015 to 2020, we evaluated the accuracy of EMD code implementation by both comparing the EMD code used to the impressions put on the patient's chart and by comparing the resources sent to the patient with the resources that were needed to treat/transport the patient (disposition). In addition, we evaluated which EMD codes were undertriaged the most and which were overtriaged the most. In our sample, the EMD code matched the impressions on the patient's chart about 47.30%. The appropriate resources were dispatched to patients roughly three quarters of the time. Undertriage and overtriage were found to be not independent of the EMD code. Four EMD codes were identified that were dispatched BLS but went ALS more often than others and it is our recommendation that, in EMS systems similar to Livingston County's, these codes be dispatched ALS.

Introduction

The Livingston County Dispatch Office is an IAED certified agency that utilizes the Medical Priority Dispatch System (MPDS). This system utilizes EMD codes to classify jobs for EMS. Each code has a priority that has been assigned to it that has been determined by the Livingston County Dispatch Office. The priority of a job determines what resources are sent to the patient, whether those be Basic Life Support First Responders (BLSFR), Basic Life Support Ambulances (BLS), or Advanced Life Support Ambulances (ALS), as well as if the response is HOT (lights and sirens) or COLD (no lights and sirens). Priority 4 jobs are dispatched BLS COLD, priority 3 jobs are dispatched ALS COLD, priority 2 jobs are dispatched ALS HOT, and priority 1 jobs are dispatched ALS with BLSFR HOT. The resources utilized in Livingston County's EMS system are ALS ambulances, ALS flycars, and BLS ambulances. Other than Livingston County EMS, only one other agency staffs ALS ambulances and ALS flycars; the remainder have only BLS ambulances. If a priority 1-3 call is dispatched in the ambulance district of an agency that has only BLS ambulances, that agency's BLS ambulance and an ALS resource from another agency will respond to that call. We will define undertriage as dispatching a call BLS when the disposition is ultimately ALS and overtriage as dispatching a call ALS when the disposition is ultimately BLS. The key for determining the priorities associated with the EMD codes is shown in Appendix 1.

Previous research has investigated the accuracy of implementations of MPDS to send appropriate resources to patients. Bailey (2000) investigated changes in rate of inappropriate use of ALS after implementation of an EMD system. The EMS system that they performed their analysis in had both BLS and ALS level care and priorities assigned using chief complaint and EMD criteria. Their study concluded that implementation of their EMD system significantly decreased inappropriate ALS dispatching as defined by a decreased rate of ALS cancellations and BLS releases. Hinchey (2007) performed a retrospective study that evaluated the appropriateness of requests assigned the MPDS alpha determinant. They concluded that 99% of alpha level calls had patients that did not receive treatment for ACS, respiratory distress, altered mental status, stroke, allergic reactions, or abnormal vital signs. Sporer (2007) investigated the sensitivity, specificity, and positive and negative predictive values of MPDS to predict the need for ALS interventions. They concluded that MPDS coding for all medical calls had a high sensitivity and low specificity for the prediction of calls that required ALS interventions. In other words, they were good at predicting what calls require ALS but not

at predicting patient complaints. A meta-analysis of studies examining sensitivity, specificity, positive predictive value and negative predictive value, and/or over- and undertriage was performed by Bohm (2018). This included 18 publications and concluded that there was a low overall level of evidence for the accuracy of MPDS. They concluded that some of the most common complaints that are undertriaged are convulsions/seizures and breathing problems. They also found that some of the most overtriaged are chest pain, heart problems / automatic defibrillator, collapse, and headache. These studies reveal substantial variability in the accurate use of MPDS to dispatch appropriate resources.

A potential reason for the variability in appropriate resource dispatching is error by dispatchers. One possible error is hierarchy bias. Hierarchy bias occurs when, during evaluation, the caller reports more than one of the listed sign/symptoms on the EMD card and the dispatcher choses the first code listed (Clawson, 2015). Another possible source of error is a dispatcher overriding the MPDS recommended EMD code if they feel that a faster or more advanced response is necessary. Clawson (2007) performed a retrospective study to investigate the association between cardiac arrest outcomes and emergent transports to the hospital with dispatcher's overriding the MPDS recommended codes. They found that the automated MPDS protocols had higher rates of identification for cardiac arrest encounters and emergent transports than when they were overridden by the dispatchers. These are potential sources for error when dispatching resources to calls.

This retrospective study serves to investigate the ability of Livingston County's implementation of MPDS to predict patient problems and dispatch the necessary resources to them. We also hope to identify the EMD codes that lead to under- and over- triage more than others. We speculate that the EMD codes are generally bad predictors of patient complaints. We also predict that the MPDS is implemented to have a significantly higher instance of overtriage than undertriage.

Methods

Data from calls between January 1st, 2015 and December 31st, 2020 was acquired from LCEMS's emsCHARTS. LCEMS was dispatched to a total of 28,715 calls in this period. A 100% chart audit was performed and a variety of calls were removed from the final analysis for a multitude of reasons. For example, any calls that were missing an EMD code, had a non-existent EMD code, were for an interfacility transfer from Noyes Memorial Hospital (a community hospital in Livingston County), were originally a police officer only response but had EMS requested, or were for standbys were removed from the analysis. A total of 22,136 calls remained after inclusion criteria were met. Because the codes for many dispositions and impressions had changed between 2015 and 2020, and because many impressions could be grouped together with similar impressions to better match them to the EMD codes, the following modifications were made to dispositions (see Table 1) and Impressions (see Table 2).

Table 1. Adjustments made to the dispositions.

Old Disposition	New Disposition
ALS Assist (old)	ALS Assist with BLS Ambulance
Cancelled, On Scene (old)	Cancelled On Scene
Treated, Transported ALS (old)	Treated, Transported ALS
Cancelled, Enroute (old)	Cancelled Enroute
Treated, Transported BLS (old)	Treated, Transported BLS
Release to BLS (old)	Release to BLS
Dead on Arrival >=65 Dead on Arrival <65 Dead on Scene	Dead on Arrival
Standby (old)	Stand By
Treated, Transferred Care	Transported to LZ for Air Transport
Dead on Scene (old)	Dead on Scene

Table 2. Adjustments made to the impressions.

Old Impression	New impression
Abdominal pain / problems	Abdominal Pain
Syncope / fainting	Syncope or Near Syncope
Drug Use - Accidental Drug Use - Intentional Drug Use - Potential Poisoning / drug ingestion Alcohol Use with Intoxication	Drug / Alcohol Use
Respiratory - Asthma Respiratory - COPD Respiratory - Congestive Heart Failure Respiratory - Croup Respiratory - Failure Respiratory - Pulmonary Edema (not CHF) Respiratory - Tachypnea Emphysema/COPD Congesitve Heart Failure Asthma	Respiratory Problem
EDP - Anxiety EDP - Depression EDP - Hostile (verbal) EDP - Mental Disorder Not Otherwise Listed EDP - Post Traumatic Stress EDP - Strange Behavior EDP - Violent (physical) EDP- Psychiatric Behavioral / psychiatric disorder	Psychiatric
General Illness.Malaise	General Illness / Malaise
Respiratory Distress	Respiratory Distress (not otherwise specified)
Dizziness Dizziness - Non Faint	Dizziness (not otherwise specified)
Altered level of consciousness	Neuro - Altered Mental Status
Chest pain / discomfort	Cardiac - Pain / Angina
Cardiac rhythm disturbance	Cardiac - Dysrhythmia
See Comments Below (Use ONLY if Impression Not Listed)	Other
Stroke / CVA	Neuro - Stroke or TIA
Seizure	Neuro - Seizures
Airway obstruction	Respiratory - Airway Obstruction / Choking
Burns	Injury - Burn
Pain - Acute - not otherwise specified	Pain
Trauma - No Obvious Injury No Patient/Problem	No Reported Patient Problem
Traumatic Injury - Significant	Traumatic injury

Fracture/Dislocation	
Respiratory arrest	Respiratory Arrest
Allergic reaction	Allergic Reaction
Environmental – Cold Hypothermia	Environmental - Hypothermia / Cold Exposure
Hyperthermia Environmental - Heat	Environmental - Hyperthermia / Heat Exposure
Vaginal hemorrhage	Bleeding – Vaginal / Uterine
Stings / venomous bites	Allergy/Environmental - Envenomation / Sting / Insect Bite (without anaphylaxis)
Sexual assault / rape	Sexual Assault / Rape (Suspected)
Electrocution	Injury - Electrocution
Pain - Pelvic	Pain - Pelvic / Perineal
STEMI Symptoms	Cardiac - STEMI
Infectious Disease Exposure (Unspecified type)	Exposure - Infectious Disease (Suspected)
Neuro - Seizures - Status Epilepticus	Neuro - Status Epilepticus
Sepsis	Infection - Sepsis

Next, the EMD codes for each call were matched with their priority according to the thirteenth version of the EMD key. Following that, a key was created to match each EMD code with impressions you would expect to find on the patient's chart if the code reflected the patient's complaints. This key was then vetted by Jon Lindskoog, NREMT-P and Aaron Farney, MD, NREMT-P. To apply this key to the 23,681 calls, code in Java was created to determine if each call had the impressions ascribed to its EMD code on the key. After this was done, Java code was implemented to determine if the patient disposition matched the priority (i.e., priority 4 calls were handled by BLS and priority 1-3 calls were handled by ALS).

To analyze the accuracy of the EMD codes to the expected impressions, a significance test for a proportion was done for every call that had an impression ascribed to the patient. The null hypothesis was that the proportion of calls whose EMD code matched the impressions was 0.90 (the IAED standard for coding compliance with the EMD cards (Clawson, 2007)) and the alternative hypothesis was that the proportion of calls whose EMD codes matched the impressions was less than 0.90 To analyze undertriage, a significance test for proportions was performed. The null hypothesis was that the proportion of priority 4 calls with a BLS disposition was 0.90 and the alternative hypothesis was that the proportion of priority 4 calls with a BLS disposition was less than 0.90. Similarly, to analyze overtriage, a significance test for proportions was performed. Here again, the null hypothesis was that the proportion of priority 1-3 calls with an ALS disposition was 0.90 and the alternative hypothesis was that the proportion of priority 1-3 calls with an ALS disposition was less than 0.90.

To analyze if calls whose impressions do not match their EMD codes are the same calls whose disposition does not match their priority, McNemar's test is performed on the calls that have impressions. To determine if there are specific EMD codes that are undertriaged more than others, a Chi-Squared Goodness of Fit test is performed on the priority 4 EMD codes. Similarly, to determine if there are specific EMD codes that are overtriaged more than others, a Chi-Squared Goodness of Fit test is performed on the priority 1-3 EMD codes. For these Chi-Squared tests, our null hypothesis is that the proportion of times each EMD code is under- or overtriaged is the same as the proportion of times that the code is utilized. Our alternative hypothesis is that at least one EMD code is under- or overtriaged at a different proportion of times that the code is utilized. For both Chi-Squared Goodness of Fit tests, two sample proportion tests with Benjamini-Hochberg correction were performed as Post Hoc tests for those codes that had been used, on average, once every two months (thirty-six times). The Benjamini-Hochberg procedure is a tool to help pinpoint the problematic EMD codes that led our Chi-Squared Goodness of Fit tests to have a P-value of less than

0.001. To determine if ALS interventions were performed on the calls with codes that were undertriaged more often than others, another data report from emsCHARTS, containing “add-actions" is acquired.

Results

The significance test for the proportion of calls whose EMD code matched the impression had a P-value of less than 0.001, lending strong evidence to suggest that the proportion of calls whose EMD code matched the impression is less than 0.90. The 95% confidence interval for this proportion is roughly (0.464835, 0.481089). The significance test for the proportion of priority 4 calls that had a BLS disposition had a P-value of less than 0.001, lending evidence to suggest that the proportion priority 4 calls that are undertriaged is less than 0.90. The 95% confidence interval for this proportion is roughly (0.729586, 0.750184). The significance test for the proportion of priority 1-3 calls that had an ALS disposition had a P-value of less than 0.001, lending evidence to suggest that the proportion priority 1-3 calls that are overtriaged is less than 0.90. The confidence interval for this proportion is roughly (0.745471, 0.759211). The McNemar’s test had a P-value of less than 0.001, suggesting that the calls whose impressions do not match the EMD codes are not necessarily the same as those that have dispositions different than what you would expect based on the priority.

The Chi-Squared Goodness of Fit test performed on the priority 4 codes had a P-value of less than 0.001, suggesting that undertriage is not independent of the priority 4 EMD codes. The two sample proportion tests with Benjamini-Hochberg correction performed as Post Hoc tests revealed that the problematic EMD codes were 30A1, 32B3, 26B1, and 1A1. The proportions of times that these codes were undertriaged are shown in Figure 1.

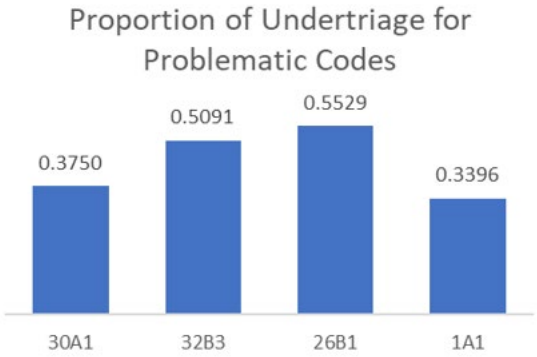

Figure 1. The proportion of undertriage for problematic codes

The Chi-Squared Goodness of Fit test performed on the priority 1-3 codes had a P-value of less than 0.001, suggesting that overtriage is not independent of the priority 1-3 EMD codes. The two sample proportion tests with Benjamini-Hochberg correction performed as Post Hoc tests revealed that the problematic EMD codes were 29D2, 26C2, 11D1, 1C4, 1C6, 23C1, 23C7, 5C4, 10A1, 31A3, 29D1, and 1C5. The proportions of times that these codes were undertriaged are shown in Figure 2.

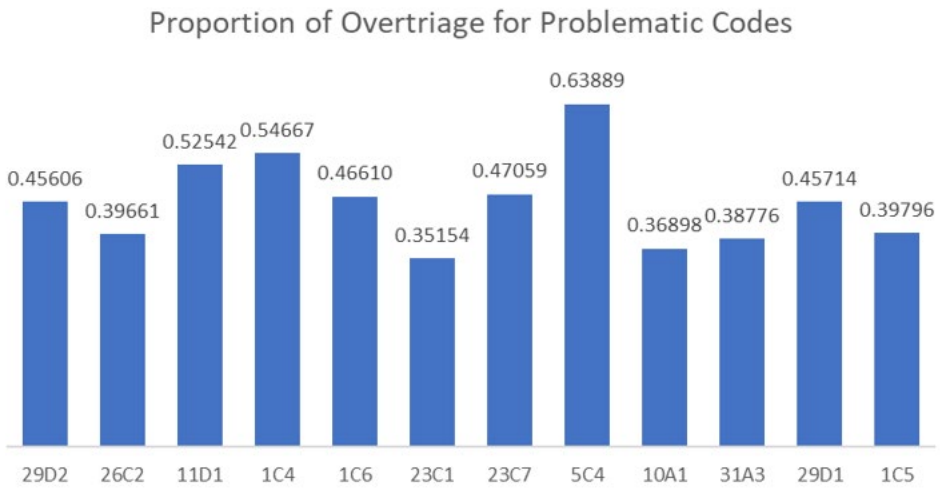

Figure 2. The proportion of overtriage for problematic codes

To attempt to determine if the calls that went ALS for the EMD codes that were undertriaged more often than others had ALS interventions performed, another data report from emsCHARTS was obtained. This data report also included "add-actions" for procedures such as IV insertion, cardiac monitoring, and medication administration were obtained. It should be noted that use of these add-actions, while encouraged by the agency, is not mandatory and any charts that documented these procedures without add-actions would not have been included in this report. From this report, it was revealed that 13.4% of 1A1 calls, 6.4% of 26B1 calls, 14.58% of 30A1 calls, and 21.4% of 32B3 calls had ALS interventions documented as add-actions.

Discussion

From our results, we observe that the EMD code, in general, is not a very good indicator of what EMS providers can expect when they arrive on scene to care for a patient; it reflects patient issues less than half the time (according to the confidence interval for the proportion of calls whose impressions match the EMD code). This is consistent with the results of Bohm (2018) which concluded that there is a low overall level of evidence for the accuracy of MPDS and Sporer (2007) which concluded that MPDS coding has a low specificity for the prediction of calls that require ALS interventions.

The McNemar's test's P-value of less than 0.001 lends evidence to suggest that calls whose impressions do not match their EMD codes are not necessarily the same calls whose disposition does not match their priority. We have seen that Livingston County's implementation of the MPDS to dispatch the appropriate resources is generally pretty good. Overtriage and undertriage both occur in roughly three quarters of these calls. This is not unexpected, as Bailey's (2000) findings suggest that implementation of an EMD system generally reduces instances of inappropriate ALS dispatching. It is also consistent with Hinchey's (2007) research which concluded that alpha level calls are generally very good at predicting the lack of critical patients. It should be noted that the confidence intervals for the proportions of undertriage and overtriage overlap and thus they are not significantly different.

The findings for the Post-Hoc test for investigating undertriage suggests that there are four different codes that are dispatched BLS but have an ALS disposition more often than others. The code 1A1 is for abdominal pain, 26B1 is for general illness where other 26 codes do not apply, 30A1 is for traumatic injuries with deformity to not dangerous body areas, and 32B3 is for unknown statis where other codes are not applicable. These findings are inconsistent with the findings of Bohm (2018) which noted that those calls most undertriaged were for convulsions/seizures

and breathing problems. A potential reason for this discrepancy is that convulsion/seizures and breathing problems are dispatched ALS in Livingston County but may not be in other EMS systems.

The findings for the Post-Hoc test for investigating overtriage suggests that there are twelve different codes that are dispatched ALS but have a BLS disposition more often than others. Three of these (1C4, 1C5, and 1C6) are abdominal pain calls; 1C5 and 1C6 are both for abdominal pain above the naval. Another three of these (5C4, 11D1, and 26C2) involve difficulty breathing. Two of these are for traumatic injuries (29D1 and 29D2) and two for overdoses (23C1 and 23C7). Only one of these is for chest pain (10A1) and another for fainting (31A3). This is different than the findings of Bohm (2018) which noted that those calls most overtriaged were for chest pain, heart problems, collapse, and headache. A potential reason for only one chest pain and one fainting EMD code being overtriaged more than others is the emphasis from medical direction and Quality Improvement to thoroughly evaluate these patients.

Conclusion

We hypothesized that the ability of EMD codes to predict patient problems would be low and our results support this hypothesis. We also predicted that Livingston County's implementation of the MPDS would have significantly more overtriage than undertriage. Our results were inconsistent with this prediction but instead suggest that the system allows for similar levels of overtriage and undertriage. Our results identified four EMD codes that were undertriaged more often than the other BLS dispatched codes and twelve EMD codes that were overtriaged more than the other ALS dispatched codes.

Though there were four EMD codes that were identified to result in undertriage more often than other BLS dispatched codes, only a small percentage of these calls had procedures documented through "add-actions". The percentages of these calls with ALS procedures documented as add-actions should be taken as a lower bound of the calls for these EMD codes that had ALS interventions performed. The reason for this is that it is up to the discretion of the paramedic how to document their procedures and they may have done so in a free text field. Such documentation would not have been able to be picked up by the emsCHARTS data report. Regardless of this, it is our recommendation that these EMD codes have ALS dispatched to them in EMS systems similar to those of Livingston County's.

Though there were twelve EMD codes that were identified to result in overtriage more often than other ALS dispatched codes, we do not recommend that these codes be dispatched BLS. These codes are dispatched ALS because they represent patients who are at a higher risk of having serious conditions; it is beneficial for these patients to be evaluated by a paramedic to rule them out.

Limitations

This study has potential limitations. One limitation is with the availability of data used as only data from LCEMS was used, as it was the only data that we had access to. While LCEMS is dispatched to almost all ALS coded jobs in Livingston County, many townships have their own BLS ambulance agencies that respond to BLS coded jobs. Unless their ambulance was initially unstatused, and thus LCEMS was dispatched, or they requested ALS for a BLS coded job, all BLS coded jobs taken by these agencies were not able to be included in this analysis. A possible venue to correct this limitation in future studies would be to gather data from all transporting EMS agencies in Livingston County.

Another limitation present was the assumption that EMS provider judgement was accurate. While it is reasonable to claim that trained, prehospital medical professionals understand the medical issues that patients present with, it is not reasonable to claim that their judgement is infallible. Because of this, it is possible that mistakes were made with impressions of patient issues and determination to upgrade a call dispatched BLS to ALS or downgrade a call dispatched ALS to BLS. A possible venue to correct this limitation in future studies would be to acquire patient

charts from the hospitals that the patients are transported to and to compare the diagnoses listed there with the EMD codes ascribed.

An additional limitation of this study would be that some of the data may be incomplete. To investigate if ALS interventions were actually performed on calls with the four EMD codes that are more often undertriaged, we looked to see if “add-actions" were added to the activity log of the charts. This method of documentation, while effective at allowing for easy data collection, is not mandatory. Were the paramedics not to document their ALS interventions with an add-action, their interventions would not have appeared in the data report.

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