Reprioritization of 911 Emergency Medical Calls Using Historical Clinical Data

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Background

Emergency Medical Services (EMS) systems often utilize a structured approach to 911 call-taking and emergency medical dispatch (EMD). One such system, Medical Priority Dispatch System (MPDS), categorizes 911 calls into EMD codes based on problem and severity. Response priorities and resources dispatched are determined at the local level through a predetermined response matrix, which is often determined without utilizing outcome-based criteria.

Objectives

In this study, we developed a methodology for utilizing historical clinical data to increase the accuracy of 911 call prioritization of patients with time-sensitive critical illness. The primary objective was to increase the number of patients with time-sensitive critical illness who receive the highest-priority response (Priority 1). The secondary objective was to decrease the number of Priority 1 responses to patients who do not have time-sensitive critical illness. Additional objectives included increasing the number of patients with unstable vital signs who receive the second-highest priority response (Priority 2), as well as decreasing the number of Priority 2 responses to patients who do not have unstable vital signs.

Methods

The electronic patient care reports (ePCRs) for all 911 calls-for-service between December 1, 2015 - November 30, 2016 period were analyzed for time-sensitive critical illness, specifically, any patients who required CPR, assisted ventilations or airway management, and/or electrical therapy (e.g pacing, cardioversion, or defibrillation).

ePCRs were also analyzed for any unstable vital signs, including:

- SBP <90
- HR < 40 or > 160
- RR < 8

The percentage of calls with time-sensitive critical illness and unstable vital signs were calculated for each of the 382 EMD codes in the MPDS. Codes which did not have any calls-for-service during the study period were excluded. In our proposed response matrix, any codes which had at least 1% of patients with time-sensitive critical illness were assigned a theoretical Priority 1 response. Any codes which had at least 5% of patients with unstable vital signs were assigned a theoretical Priority 2 response. Any codes which had 0% of patients with either time-sensitive critical illness or unstable vital signs were assigned a Priority 4 response. The remainder of EMD codes were assigned a Priority 3 response. The threshold criteria of 1% and 5% for EMD code reprioritization were chosen to optimize the number of time-critical and unstable calls in our system included in priority 1 and 2 EMD codes, respectively .

Results

Out of a total of 119,289 actual calls-for-service, 30,123 (25.2%) were assigned a Priority 1 response through the currently utilized response matrix; 1,205 (4%) of these patients had time-sensitive critical illness and 4,687 (15.5%) had unstable vital signs. Utilizing our proposed methodology, these same calls-for-service would have resulted in 25,441 (21.3%) Priority 1 responses, including 1,333 (5.2%) patients with time-sensitive critical illness and 4,849 (19%) with unstable vital signs. The net result would have been an overall 15.5% decrease in Priority 1 responses, with a 10.6% and 3.4% increase in Priority 1 responses to patients with time-sensitive critical illness and unstable vital signs, respectively. Further, utilizing the response matrix developed in our study would increase the number of patients who receive a Priority 2 response by 3.6%, but this would include 3.4% with time-sensitive critical illness and 30.9% more with unstable vital signs.

# of Patients with Time-Sensitive Critical Illness ("Priority 1" Criteria)

Priority	Current Matrix	Proposed Matrix
1	1,205 (80%)	1,333 (89%)
2	229 (15%)	149 (10%)
3	67 (4%)	19 (1%)
4	0 (0%)	0 (0%)
Total	1,501 (100%)	1,501 (100%)

# of Patients with Unstable Vital Signs ("Priority 2" Criteria)

Priority	Current Matrix	Proposed Matrix
1	4,687 (40%)	4,849 (42%)
2	4,592 (39%)	6,014 (52%)
3	2,282 (20%)	796 (7%)
4	98 (1%)	0 (0%)
Total	1,501 (100%)	1,501 (100%)

Number of Calls in Original and Proposed Response Matrix

Priority	Current Matrix	Proposed Matrix
1	30,123 (25%)	25,441 (21%)
2	57,272 (48%)	59,971 (50%)
3	30,370 (25%)	33,990 (28%)
4	1,524 (1%)	487 (<1%)
Total	119,289 (100%)	119,289 (100%)

Determination of % Allowance for Time-Sensitive Critical Illness (P1) & Unstable Vital Signs (P2)

Original	Item	P1 0% P2 0%	P1 0% P2 1%	P1 1% P2 1%	P1 1% P2 5%	P1 5% P2 5%	P1 5% P2 10%	P1 10% P2 10%
109	P1 Codes	108	108	55	55	27	27	21
112	P2 Codes	144	140	192	144	172	92	97
104	P3 Codes	39	43	44	92	92	172	173
2	P4 Codes	36	36	36	36	36	36	36
30,123	# P1 Calls	95,776	95,776	25,441	25,441	4,240	4,240	1,821
57,270	# P2 Calls	22,746	22,098	92,131	59,370	80,571	41,823	44,035
30,370	# P3 Calls	278	926	1,228	33,989	33,989	72,737	72,944
1,524	# P4 Calls	487	487	487	487	487	487	487
1,205	P1: TSCI	1,501	1,501	1,333	1,333	942	942	797
229	P2: TSCI	0	0	167	149	540	421	554
67	P3: TSCI	0	0	1	19	19	138	150
0	P4: TSCI	0	0	0	0	0	0	0
4,687	P1: UV	9,977	9,977	4,849	4,849	1,413	1,413	965
4,592	P2: UV	1,682	1,676	6,801	6,014	9,450	6,478	6,914
2,282	P3: UV	0	6	9	796	796	3,768	3,780
98	P4: UV	0	0	0	0	0	0	0

Limitations

1. Our study is limited due to its retrospective nature and the use of theoretical prediction models.
2. The limited number of responses to certain EMD codes makes the ability to evaluate time-sensitive critical illness and unstable vital signs difficult; there were 123 codes (32%) which had 1-10 calls through the time-frame, as well as 33 codes (8.6%) which had 0 calls. A longer study period would potentially allow for more accurate evaluation of low-frequency EMD codes.
3. There may have been cases which were initially appropriately categorized by EMD, but due to a changing clinical course they subsequently met criteria for time-sensitive critical illness or unstable vital signs. This may have falsely elevated the percentage for some EMD codes. The unstable vital signs evaluated may also have been a result of data entry error. To better understand this would require more detailed and thorough evaluation of individual ePCRs.
4. Other systems may wish to perform their own analysis for EMD code reprioritization, as demonstrated in the determination of % allowance table.

Summary/Conclusion

Historical clinical data may be used to increase the accuracy of call prioritization of patients with time-sensitive critical illness. By limiting the number of high-priority responses to lower-acuity calls, this methodology may also lead to optimized operational efficiency and 911 resource utilization.