Ability Of a Diabetic Problems Protocol to Predict Patient Severity Indicators Determined by On-Scene EMS Crews

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ABSTRACT

Introduction: Diabetes mellitus is a leading cause of human disease, with 25.8 million Americans affected. It is estimated that 7 million (27%) of these patients are still formally undiagnosed. Diabetes can cause chronic or sudden signs and symptoms, which often result in observers calling 911 for assistance. The Emergency Dispatcher’s interpretation of these calls affects dispatch triage and pre-arrival patient care.

Objectives: To determine the relationship between the EMDs’ assigned Medical Priority Dispatch System (MPDS) determinant codes and patient severity indicators as determined by paramedic (or EMT) on-scene findings and treatments.

Methods: This was a retrospective study involving six hospitals in Salt Lake City (SLC), Utah, USA. Upon receipt of Institutional Review Board approval from all six hospitals, data were collected over a two-year period (2000 to 2001). All calls assigned to the MPDS Diabetic Problems Chief Complaint Protocol were included. Dispatch data and patient care reports were collected and examined. The association between MPDS determinant codes and patient severity measures was assessed at a 0.05 significance level.

Results: 714 patient-cases were analyzed, of which 99.3% (709/714) had specific MPDS code information recorded. Callers who had an abnormal breathing (MPDS code 13-C-3) medical condition had the highest “first” blood glucose levels, pulse rate, and respiratory rate. 50.4% of patients assigned a 13-D-1 determinant code (Unconscious) received Dextrose 50% (D50) treatment; these patients had the lowest (most severe) GCS scores overall. The group of cases assigned to the Not alert determinant code yielded the second-highest acuity.

Conclusions: This study showed a high association between the acuity levels determined by EMDs using the MPDS Diabetic Problems Protocol and paramedic (and EMT) on-scene findings. Patients coded as 13-D-1 (Unconscious) were likely to be hypoglycemic, and a large majority of them received D50 treatment. However, patients coded as 13-C-3 (Abnormal breathing) were more likely to be hyperglycemic.
tions by identifying the success of EMDs in predicting a true diabetes-triggered event when selecting MPDS Protocol 13 as the dispatch Chief Complaint. This study will build on that previous work by examining the ability of the MPDS, when used by certified EMDs, to predict the acuity levels of patients handled on the Diabetic Problems Chief Complaint protocol.

The patient’s first interaction with the public safety system is the 911 dispatch center. The certified EMD uses a protocol with medically approved, scripted questions to determine a dispatch code, a provisional description of the patient’s condition, an acuity level, upon which mobile unit responses are predicated and telephone Dispatch Life Support (DLS) Pre-Arrival Instructions are given. A dispatch code comprises a Chief Complaint code, priority level (ECHO, DELTA, CHARLIE, BRAVO, ALPHA, OMEGA—in order of generally perceived severity from most to least severe, per MPDS specifications), and a determinant descriptor code (Figure 1).

The wide range of responses available in many EMS systems can be applied to a similarly wide range of presenting patient acuity levels as described by the caller to the EMD. For example, the provision of first responders and advanced life support (ALS) teams to a verified conscious and alert patient with a “diabetic problem” might be considered an overuse of important resources, as such inappropriate multi- unit emergency responses could be potentially dangerous to response crews as well as to citizens suddenly finding themselves in the path of a HOT response (i.e., responders driving with emergency lights-and-siren). Additionally, overtriage can deplete valuable resources that may be needed for critically ill or injured patients. Since the goal of the EMD is “to do the right thing, for the right patient, at the right time,” the appropriate prioritization of mobile response can be applied to a wide range of diabetic situations routinely encountered by EMDs and responding EMS crews. However, this depends on the EMD’s ability to determine, non-visually via telephone, the seriousness of the diabetic event being experienced by the patient.

The foremost indicator of urgency in diabetic patients is level of consciousness. A patient with apparent diabetic symptoms, or a history of diabetes who is unconscious, will often be sent the closest crew. For most of these patients, their level of consciousness will determine whether BLS or ALS responders are sent, as well as the use of lights and siren.

Hypoglycemia is a common cause of unconsciousness or altered level of consciousness in patients with true diabetes-triggered events. Intravenous dextrose is the typical pre-hospital treatment of choice for hypoglycemic patients. Therefore, diabetic patients determined to have any altered level of consciousness require response and treatment by an ALS crew. Prolonged insulin deficiency may also cause the diabetic patient to exhibit an altered level of consciousness, due to two possible physiological conditions: diabetic ketoacidosis (DKA), and hyperglycemic hyperosmolar state (HHS). Level of consciousness can also determine or suggest the need for airway evaluation and provision of Post-Dispatch and Pre-Arrival Instructions by the EMD over the phone. For cases in which hypoglycemia is the precipitating factor, usually because of excessive amounts of insulin but sometimes resulting from lack of food intake or strenuous exercise, the level of the patient’s consciousness (alertness) has been deemed the gold standard for EMD evaluation. Other signs and symptoms may also be present and, if quantified, might add to an improved understanding of the true pre-arrival condition of these patients.

Using first encounter data from arriving EMTs and paramedics allows for an initial, at-scene evaluation of patient severity that can help validate the earlier symptom-based classification assigned by the EMD using the MPDS. At-scene responders’ patient assessment and treatments—particularly a Glasgow Coma Score (GCS), initial blood glucose level, and whether the patient was treated with intravenous dextrose or oral glucose—can identify whether the MPDS accurately predicted the acuity levels of the patients handled on Protocol 13. That premise forms the basis of this study.

**OBJECTIVES**

The objective of this study was to determine the relationship between EMDs’ assigned MPDS determinant codes and patient severity indicators as determined by paramedic (or EMT) on-scene patient findings and treatments.

**METHODS**

**Design and Setting**

This retrospective study was conducted in Salt Lake City (SLC), Utah, USA and involved six hospitals. The SLC communication center has been an International Academies of Emergency Dispatch (IAED) Accredited Center of Excel-
lence since 1998—a best-practices designation that requires a minimum of either 90% or 95% compliance to various processes utilized within the MPDS protocols. The actual compliance rates during the study period were: 95.9% overall score, 97.9% for the Diabetic Problems protocol interrogation/evaluation process use, 100% for initially selecting the Diabetic Problems as the correct Chief Complaint, and 98.3% for the correct selection of all Chief Complaints. The data were collected using MPDS version 11.0 (1999 release); as the Diabetic Problems protocol has remained unchanged up to the most current MPDS version, 12.2 (2012 release), the study data remain relevant even to current version protocol users. The study was approved by the Institutional Review Boards of the six participating hospitals and by the Salt Lake EMS/Inter-Hospital Council.

**Patient Severity Determination**

Patient severity was primarily determined by the Glasgow Coma Score (GCS), by which patients are placed into Severe, Moderate, Mild, and Normal categories based on level of consciousness and reactions to stimuli. GCS was selected as the primary measure because of the recognized importance of level of consciousness in determining the severity of diabetic events. Because blood glucose level generally determines, for diabetic patients, both level of consciousness and severity of symptoms, first blood glucose level was selected as a secondary measure of patient severity. Administration of Dextrose 50% (D50) and/or oral glucose was assessed to identify the overall numbers of patients that paramedics and EMTs determined required medication on scene due to abnormally low blood sugar levels.

In order to determine the relative ability of each MPDS code (as selected by EMDs using the automated logic version of the MPDS Protocol) to predict patient severity levels, we compared the percentage of patients of each severity level assigned to a specific code against the percentage of patients of that severity level assigned to the reference code, 13-A-1 (Alert and behaving normally). 13-A-1 was selected as the reference code because when used correctly, it captures patients who are alert and both breathing and behaving normally—patients, in other words, with very low severity conditions as determined by MPDS questions and caller answers.

The ability of the MPDS to predict patient severity levels was determined by the number of patients whose symptoms (as determined by paramedic findings of GCS, blood glucose, and medication) fit the specific MPDS determinant codes to which they were assigned.

**Data Collection and Processing**

The data were collected over a two-year period (2000 to 2001), and the study sample included all calls assigned to the Diabetic Problems Chief Complaint Protocol. Dispatch data (collected by the EMDs) and patient care reports (collected by the paramedics) were collected and examined.

**Data Analysis**

STATA for Windows® software (STATA Statistical Software: Release 11.2 ©2009, StataCorp, College Station, TX, USA) was used for data analysis. Significance of the differences between study groups was assessed at a 0.05 significance level. Two-sided Fisher’s Exact Test, including Odds Ratio (OR) and 95% Confidence Interval (CI), were used to assess the differences between various severity measures in the categorical data (e.g., D50 and oral glucose treatments). Median and Interquartile range were assessed for paramedic on-scene-assessed measures (i.e., blood glucose, diastolic and systolic blood pressure, Glasgow Coma Score [GCS], pulse rate, and respiratory rate), and stratified by MPDS determinant codes. Additionally, blood glucose level was grouped to assess hypoglycemic (blood glucose < 70 mg/dL), normoglycemic (blood glucose 70 to 180 mg/dL), and hyperglycemic (blood glucose > 180 mg/dL) categories.

<table>
<thead>
<tr>
<th>Measure</th>
<th>Instant</th>
<th>13-D-1 (Q1, Q3)* for each determinant code</th>
<th>13-C-1</th>
<th>13-C-2</th>
<th>13-C-3</th>
<th>13-A-1</th>
<th>Overall</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blood glucose</td>
<td>First</td>
<td>51 (33, 151)*</td>
<td>167 (114, 234)</td>
<td>128 (73, 179)</td>
<td>113 (74, 158)</td>
<td>127 (69, 180)</td>
<td>141 (97, 207)</td>
</tr>
<tr>
<td></td>
<td>Second</td>
<td>64 (37, 153)*</td>
<td>90 (47, 209)*</td>
<td>113 (74, 158)</td>
<td>166 (128, 298)*</td>
<td>131 (97, 246)</td>
<td>87 (41, 182)*</td>
</tr>
<tr>
<td>GCS</td>
<td>First</td>
<td>10 (6, 15)*</td>
<td>14 (11, 15)</td>
<td>15 (14, 15)</td>
<td>15 (14, 15)</td>
<td>15 (15, 15)</td>
<td>15 (12, 15)</td>
</tr>
<tr>
<td>Diastolic BP</td>
<td>First</td>
<td>82 (71, 92)</td>
<td>82 (76, 94)</td>
<td>82 (71, 92)</td>
<td>88 (72, 98)</td>
<td>83 (72, 94)</td>
<td>82 (72, 94)</td>
</tr>
<tr>
<td></td>
<td>Second</td>
<td>79 (63, 84)</td>
<td>84 (68, 92)</td>
<td>83 (75, 102)</td>
<td>70 (59, 80)</td>
<td>92 (80, 97)</td>
<td>80 (66, 94)</td>
</tr>
<tr>
<td>Systolic BP</td>
<td>First</td>
<td>140 (120, 160)</td>
<td>140 (120, 160)</td>
<td>140 (120, 160)</td>
<td>140 (120, 160)</td>
<td>133 (119, 158)</td>
<td>133 (119, 158)</td>
</tr>
<tr>
<td></td>
<td>Second</td>
<td>136 (113, 158)</td>
<td>156 (122, 170)</td>
<td>144 (112, 170)</td>
<td>116 (105, 129)</td>
<td>140 (120, 154)</td>
<td>140 (116, 160)</td>
</tr>
<tr>
<td>Pulse rate</td>
<td>First</td>
<td>88 (80, 100)</td>
<td>88 (80, 100)</td>
<td>88 (80, 100)</td>
<td>88 (80, 100)</td>
<td>88 (80, 100)</td>
<td>88 (80, 100)</td>
</tr>
<tr>
<td></td>
<td>Second</td>
<td>86 (72, 112)</td>
<td>93 (80, 104)</td>
<td>83 (80, 102)</td>
<td>90 (80, 98)</td>
<td>93 (84, 100)</td>
<td>90 (80, 104)</td>
</tr>
<tr>
<td>Respiratory rate</td>
<td>First</td>
<td>18 (16, 20)*</td>
<td>18 (16, 20)*</td>
<td>18 (16, 20)*</td>
<td>18 (16, 20)*</td>
<td>18 (16, 20)*</td>
<td>18 (16, 20)*</td>
</tr>
<tr>
<td></td>
<td>Second</td>
<td>18 (16, 20)</td>
<td>20 (16, 20)</td>
<td>16 (16, 24)</td>
<td>24 (20, 30)</td>
<td>18 (16, 18)</td>
<td>18 (16, 20)</td>
</tr>
</tbody>
</table>


*The 25th and 75th percentiles, respectively, for the median of each measure.

**Table 1.** Overview of on-scene measures for all callers.
hyperglycemic (blood glucose >180 mg/dL) cases. Finally, GCS was categorized to assess the level of severity of the cases: Severe (GCS ≤ 8), Moderate (GCS 9 – 12), Mild (GCS 13-14), and Normal (GCS 15).

RESULTS

714 patient-cases were analyzed in this study, of which 99.3% (709/714) had specific MPDS dispatch code information recorded. Callers who had an abnormal breathing (MPDS code 13-C-3) medical condition had the highest “first” blood glucose levels, pulse rate, and respiratory rate (Table 1). The second blood glucose levels recorded by the paramedics were substantially higher than the initial field measurements in each MPDS determinant code except in the 13-C-3 determinant code, where the levels decreased. The initial blood glucose and respiratory rate measures in each of the MPDS determinant codes were significantly lower than for 13-A-1 (the reference measure), except in the 13-C-3 determinant code where the two measures were higher than the reference measure. Blood pressures and GCS values did not substantially change between the “first” and “second” measurements. However, the initial GCS for 13-D-1 was significantly lower than GCS in 13-A-1. Conversely, initial pulse rate for 13-C-3 was significantly higher than for 13-A-1.

D50 treatment was administered to 25.4% (180/709) of all patients (Table 2). Patients assigned a 13-D-1 determinant code (unconscious) received the highest percentage of D50 (50.4% [67/133]) but the lowest percentage of oral glucose (1.5% [2/133]) treatments. The highest percentages of oral glucose treatment were administered to patients who had been assigned the 13-C-1 (not alert) (8.6% [25/291]) and 13-C-2 (abnormal behavior) 8.1% [12/148]) determinant codes.

Overall, a blood glucose level was assessed in 87.2% (618/709) of all the patients, of whom 32.0% (n=198) had blood glucose levels <50 mg/dL.

The highest percentages of hypoglycemic patients were recorded under the 13-D-1 (59.3% [70/118]) and 13-C-1 determinant codes (56.7% [38/67]) and 13-C-3 (53.7% [22/41]) determinant codes recorded the highest percentage of patients with normal blood glucose levels and hyperglycemia. Among hypoglycemic patients, 13-A-1 had a significantly lower percentage than any of the other codes except 13-C-3. Otherwise, 13-A-1 recorded a significantly higher percentage of patients with normal blood glucose levels than any of the other codes. Interestingly, the percentage of hyperglycemia recorded in 13-A-1 (34.3%) was significantly higher than 13-C-1 (18.8%), but lower than 13-C-3 (53.7%).

Half of all the patients had Normal blood glucose levels (Table 4). 13-D-1 (Unconscious) patients had the highest percentage of Moderate (GCS: 9-12) (18.9% [24/127]) and severe (GCS: ≤8) (41.7% [53/127]) medical conditions, while 13-A-1 (Alert and behaving normally) patients had the highest percentage of Normal (86.1% [68/79]) medical conditions as defined. The 13-C-2 (Abnormal behavior) patients had the highest percentage of Mild medical conditions (32.6% [47/144]).

DISCUSSION

This study demonstrated a strong association between

<table>
<thead>
<tr>
<th>MPDS® determinant</th>
<th>Code</th>
<th>n</th>
<th>D50 (%)</th>
<th>Oral glucose (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>DELTA 13-D-1</td>
<td>Unconscious</td>
<td>133</td>
<td>67 (50.4)*</td>
<td>2 (1.5)</td>
</tr>
<tr>
<td>CHARLIE 13-C-1</td>
<td>Not alert</td>
<td>291</td>
<td>80 (27.5)*</td>
<td>25 (8.6)</td>
</tr>
<tr>
<td>13-C-2 Abnormal behavior</td>
<td>148</td>
<td>27 (18.2)*</td>
<td>12 (8.1)</td>
<td></td>
</tr>
<tr>
<td>13-C-3 Abnormal breathing</td>
<td>48</td>
<td>6 (12.5)*</td>
<td>1 (2.1)</td>
<td></td>
</tr>
<tr>
<td>ALPHA 13-A-1</td>
<td>Alert and behaving normally</td>
<td>68</td>
<td>0 (0.0)</td>
<td>4 (4.5)</td>
</tr>
<tr>
<td>Overall</td>
<td></td>
<td>709</td>
<td>180 (25.4)</td>
<td>44 (6.2)</td>
</tr>
</tbody>
</table>

*Medical Priority Dispatch System

*The percentage was significantly higher than that of patients with alert and behaving normally condition.

Table 2. On-scene treatment with D50 and oral glucose

<table>
<thead>
<tr>
<th>MPDS Determinant</th>
<th>n (N=618)</th>
<th>Blood glucose level (First measurement taken on scene)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Hypoglycemic</td>
</tr>
<tr>
<td></td>
<td>n (%)</td>
<td>OR (95%CI)*</td>
</tr>
<tr>
<td>DELTA (D) 13-D-1</td>
<td>118</td>
<td>70 (59.3)</td>
</tr>
<tr>
<td>CHARLIE (C) 13-C-1</td>
<td>256</td>
<td>135 (52.7)</td>
</tr>
<tr>
<td>13-C-2</td>
<td>136</td>
<td>58 (42.7)</td>
</tr>
<tr>
<td>13-C-3</td>
<td>41</td>
<td>7 (17.0)</td>
</tr>
<tr>
<td>ALPHA (A) 13-A-1</td>
<td>67</td>
<td>6 (9.0)</td>
</tr>
</tbody>
</table>


Table 3. Comparison of patient blood glucose level assessment by MPDS determinant.
MPDS codes and patient outcome severity indicators as determined by paramedics and EMTs on scene. These findings indicate that the Diabetic Problems Protocol is capturing the most acutely ill patients in the DELTA-coding level and that the MPDS dispatch codes are able to predict the spectrum of the highest- and lowest-severity diabetic events as defined by blood glucose levels, GCS, and prehospital medication administration.

**GCS Highly Associated with Dispatch Codes**

GCS, the primary measure of patient severity, was overall highly associated with dispatch codes. 13-D-1 had the highest incidence of Severe GCS reports (41.7%). This supported our expectation that, with correct use of the MPDS by certified EMDs, patients assigned a 13-D-1 should be unconscious and should therefore have a GCS in the “Severe” range. It is expected that these patients are more likely to have very low, rather than very high, blood glucose levels (to be hypoglycemic rather than hyperglycemic) because hypoglycemic patients are more likely to become quickly less alert and unconscious than hyperglycemic patients.

Similarly, it was expected that a patient assigned one of the CHARLIE-level codes (13-C-1, 13-C-2, 13-C-3) would have GCS scores in the “Moderate” or “Mild” categories because they are either not alert (13-C-1), not breathing normally (13-C-2), or not breathing normally (13-C-3) but are conscious. This expectation was also supported, as the CHARLIE codes (n=478)—those capturing the level between high-acuity unconscious patients and low-acuity patients without priority symptoms—were most often assigned to patients with Moderate (13.6%), Mild (27.8%), or Normal (50.4%) GCS reports. Within this group, the highest percentage of Moderate (17.4%) GCS scores appeared in the 13-C-1 code, while the highest percentage of Mild (32.6%) appeared in the 13-C-2 code. Patients assigned the 13-A-1 code were by far most likely to be assigned to the Normal GCS category (86.1%). No patients assigned the 13-A-1 code were found in the Severe GCS category. This finding broadly supports the use of the 13-A-1 dispatch code as a reference code against which to measure the strengths of associations between the other, higher-acuity codes and the various severity indicators measured.

Assigning an appropriate acuity-level code to each call is particularly important in terms of resource allocation. Most agencies send Advanced Life Support (ALS) responses to comatose or near-comatose patients (see Figure 1), especially since Medicare, the basis for many resource allocation decisions, defines an unconscious patient in need of D50 as a sufficient basis for sending ALS responders. Thus, correctly identifying unconscious patients in the Severe GCS range helps ensure that these patients receive the ALS response they need. On the opposite end of the spectrum, correctly identifying low-acuity patients in the Mild and Normal GCS ranges helps ensure that expensive and limited ALS resources are not assigned to low-acuity patients and instead are available for truly severe cases.

**Hypoglycemia and Hyperglycemia Outcomes Associated with DELTA and CHARLIE Codes**

Paramedic first blood glucose was also highly associated with dispatch codes. Patients coded as 13-D-1 (Unconscious), the highest-severity code, had the highest incidence of hypoglycemia (59.3%), as well as the lowest median first blood glucose (51) and the lowest individual first blood glucose (33 mg/dL). 13-C-1 (Not alert), the next-highest code in terms of predicted severity, was the only other code with a median first blood sugar in the hypoglycemic range (64 mg/dL); the majority of patients coded as 13-C-1 (52.7%) were identified as hypoglycemic at first paramedic blood glucose. Patients coded as 13-C-2 (Abnormal behavior) also saw a high incidence of hypoglycemia (42.7%).

Interestingly, 13-C-3 (Abnormal breathing) was most strongly associated with hyperglycemia (53.7%) and a median first blood glucose slightly above the normal range (186 mg/dL). There is some possibility that this may be an artifact of the coding process; because EMDs (and the MPDS software) generally select the highest-level applicable code, any patient that is, for example, both breathing abnormally and not alert will generally be assigned to 13-C-1 (Not alert). This explains the fact that 13-C-1 was assigned to the highest number of cases overall (n=256), as well as the relatively low numbers of cases coded 13-C-2 (n=136) and the very small number coded as 13-C-3 (n=41). However, it may also be the case that hyperglycemic or simply non hypo-, or normoglycemic patients are more likely to present with breathing difficulties (abnormal breathing) as their primary symptom rather than unconsciousness or lowered level of alertness.

Some studies have also indicated that patients generally must have severely elevated blood glucose levels before cognitive or other priority symptoms occur, whereas hypoglycemia—and even slightly low blood sugar not within the hypoglycemic range—causes cognitive function to decline rather quickly. This explains why the highest percentages of hypoglycemia by far were captured by the 13-D-1 (Unconscious) and 13-C-1 (Not alert) codes, whereas the highest percentage of hyperglycemic patients were not in these highest-priority codes but in the 13-C-3 (Abnormal breathing) and even the 13-A-1 (Alert and breathing nor-
MPDS Codes vs. Diabetic Severity Indicators

CONCLUSION

By comparing on-scene paramedic findings and initial treatment with MPDS determinant codes assigned by EMDs using the Diabetic Problems Chief Complaint Protocol, we can now better understand the relationship between those codes and actual patient medical condition. This knowledge will help us refine the protocol-based evaluation of these patients so that EMS agencies can provide the proper resources, reduce wasteful and risky over-response, and create meaningful response planning models for these patients. Clearly, patients coded as 13-D-1 (Unconscious) have the lowest (most severe) GCS scores overall, as well as the highest likelihood of hypoglycemia, as determined by the paramedic’s first GCS and glucose level measurements. As a result, these patients were also most likely to receive intravenous D50 treatment. Patients assigned to 13-C-3 (Abnormal breathing), however, were more likely to be hyperglycemic.

Patients coded as 13-C-1 (Not alert) also had a significantly higher incidence of severe GCS, hypoglycemia, and subsequent D50 treatment than the 13-A-1 (Alert and breathing normally) patients—our baseline comparison group. Patients assigned to 13-C-3 (Abnormal breathing) had the highest incidence of hyperglycemia. Finally, patients coded as 13-A-1 (Alert and breathing normally) had no incidences of a severe GCS, the fewest incidences of hypoglycemia, and no incidences of D50 treatment. A significant relationship exists between the MPDS code as assigned by the EMD and on-scene paramedic findings and initial treatment. Further studies should examine hospital outcome data for similar patients to help determine the morbidity and mortality of patients classified by EMDs in the “Diabetic Problems” Chief Complaint.

ACKNOWLEDGMENTS

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Conflict of interest: JC is the inventor of the MPDS studied herein and the Chief Executive Officer (CEO)/Medical Director of Priority Dispatch Corporation. TB, GS, BP, IG, and CO are employees of the IAED.

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References


