HUMAN VS. MACHINE: A COMPARATIVE STUDY ON CGM EVENT DETECTION & CLASSIFICATION

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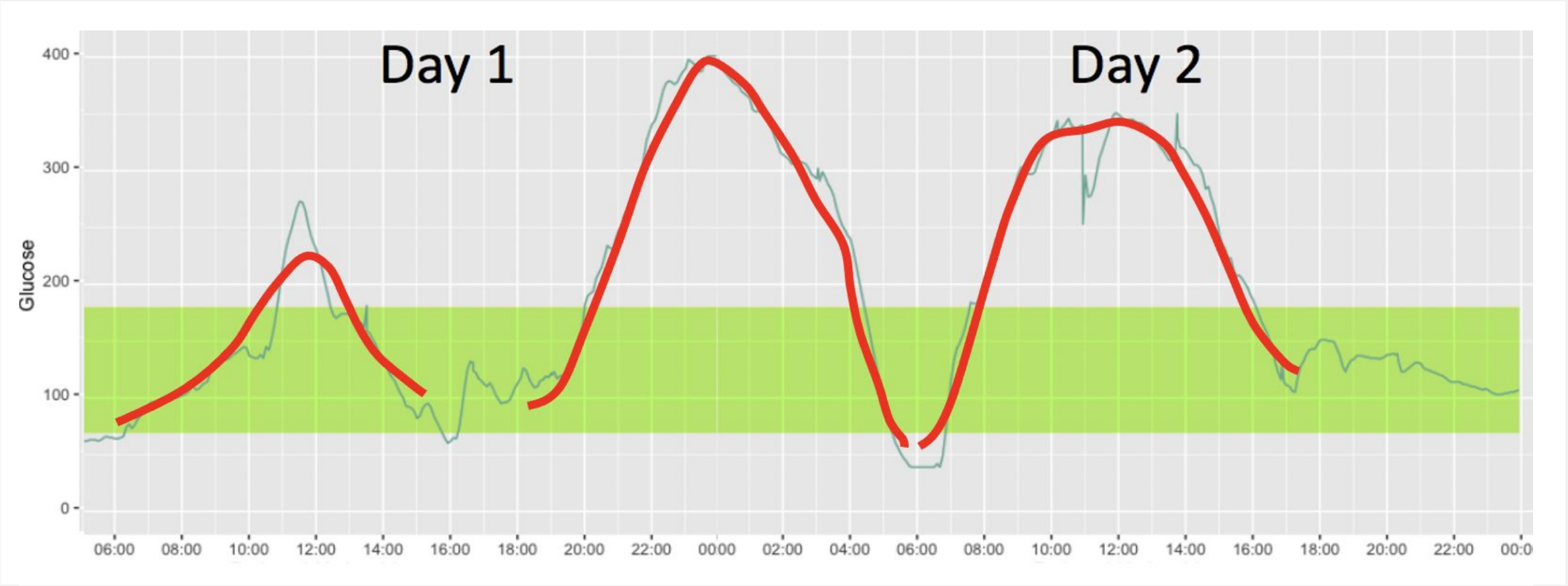
INTRODUCTION

- The Centers for Disease Control has reported that the number of people with diabetes in the United States has exceeded 34 million
- Maintaining glucose control requires more than the intermittent and infrequent testing that is afforded by finger stick-based blood glucose monitoring (BGM)
- Use of continuous glucose monitoring (CGM) has the potential to help improve glucose management by collecting continuous glucose samples throughout the day
- However, interpreting the hundreds of CGM data points generated per day can be challenging for both patients and healthcare providers to discriminate between patterns or events of concern and those that are considered normal
- We have built an automated method to detect significant glucose events and further classify events by level of severity
- In this study, we evaluated the performance of our automated system by comparing event detection and classification to that performed by a group of diabetes experts

DEVELOPMENT OF THE AUTOMATED SYSTEM

- We developed an AI method to automatically detect and classify discernable CGM patterns which we call “CGM events”
  - The method combined multiple techniques in time series analysis and other techniques
    - Distance measuring, clustering, and averaging subgroup time series
    - Smoothing and differentiating
    - Pattern matching
- The model is optimized using a set of training data, and its performance is evaluated by applying the model to separate test data from the same group of patients
  - Two optimization strategies are employed: individual-level optimization and global-level optimization
  - The globally-optimized model performed better than its individual-level counterpart

AN EXAMPLE OF EVENT DETECTION



- Thin blue lines show raw CGM data
- Thick red lines show events detected by the automated system
- Green zone shows the standard glucose in-target range of 70 to 180 mg/dl

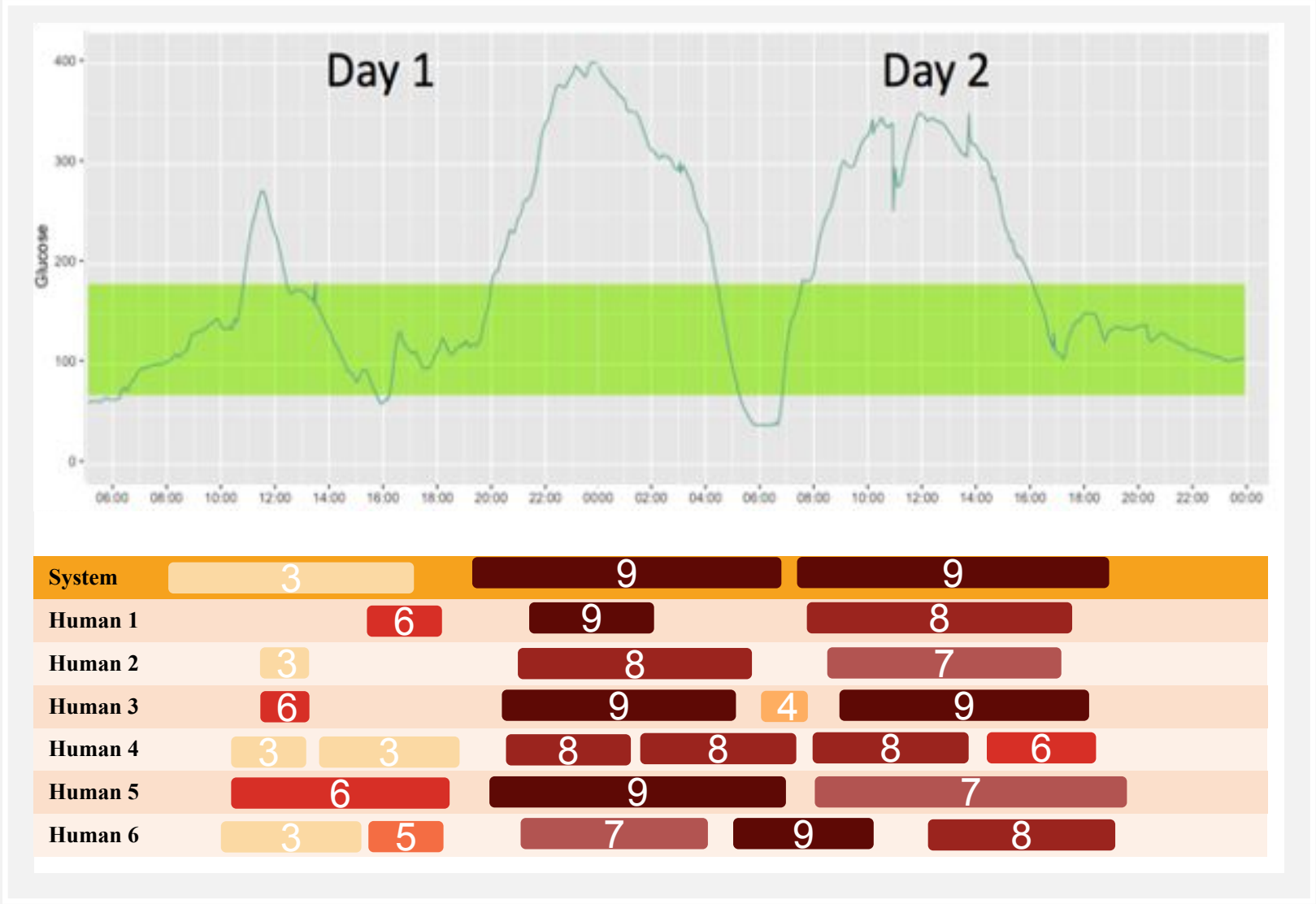
METHODS

- This protocol was reviewed by the University of Maryland Institutional Review Board
- Material
  - Six days of CGM data from a deidentified person with diabetes contained in a publicly available dataset*
- Comparison
  - 2 Approaches (using the same raw data):
    - The automated detection algorithm
    - Six diabetes experts in an endocrinology practice (reviewed independently)
  - 2 Attributes:
    - Event detection: Identification of event start and end times
    - Severity score: Ranging from 0 to 9

*__Disclaimer:__ The source of the data is the T1D Exchange, but the analyses, content and conclusions presented herein are solely the responsibility of the authors and have not been reviewed or approved by the T1D Exchange.

RESULTS

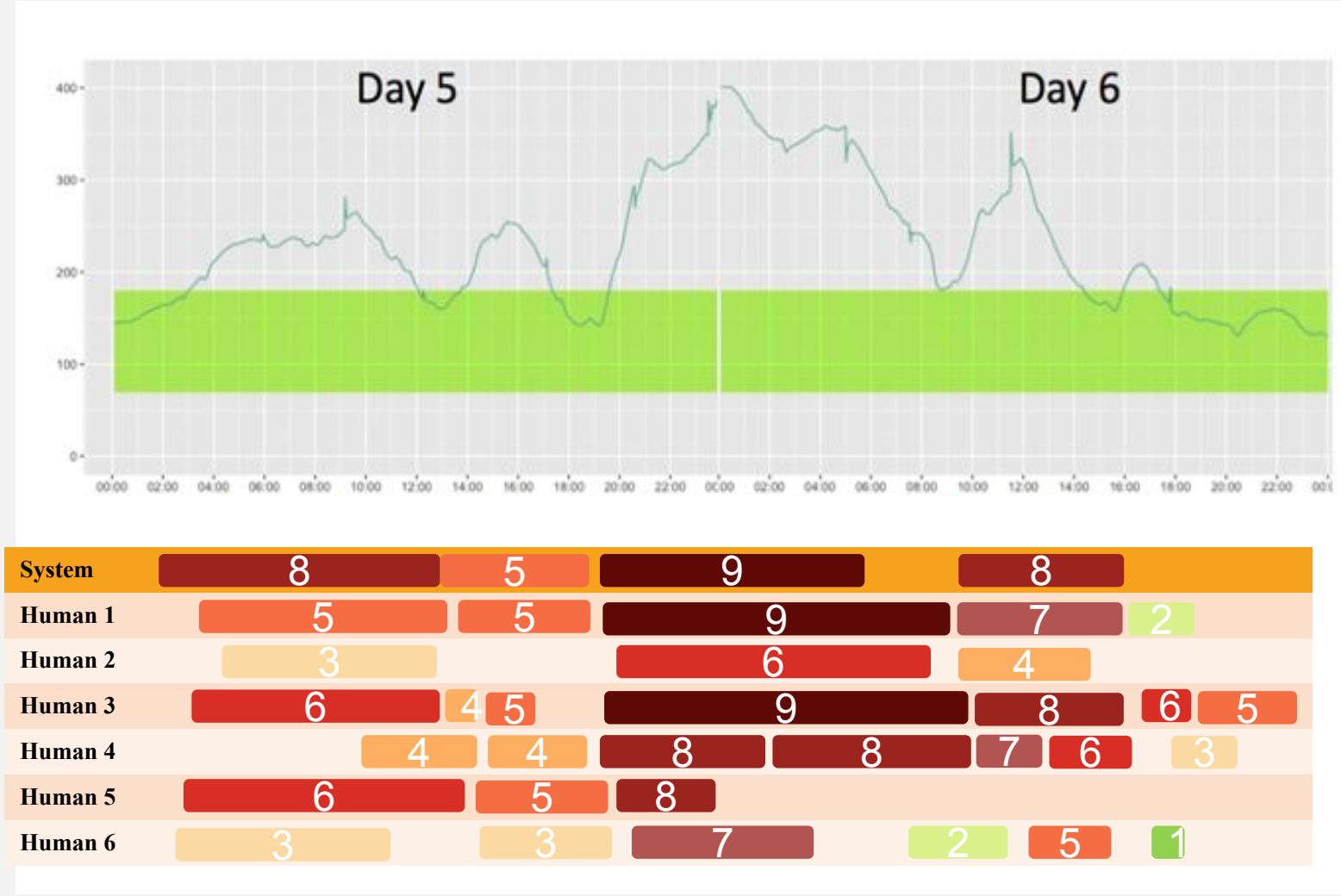
- The horizontal-colored bars show different events and event durations as detected by the automated system and six diabetes experts
- Color of bars represents the level of severity



RESULTS


Day 3
Day 4
Glucose
400
300
200
100
0
08:00
10:00
12:00
14:00
16:00
18:00
20:00
22:00
00:00
02:00
04:00
06:00
08:00
10:00
12:00
14:00
16:00
System 2 0 5 4 3
Human 1 3 5 4 4 9 3
Human 2 2 4
Human 3 3 3 5 4 7 5 5
Human 4 3 3 0 3 3 3 4 4 3
Human 5 2 0 4 3 8
Human 6 2 1 4 2 4 6 5 8 3

RESULTS

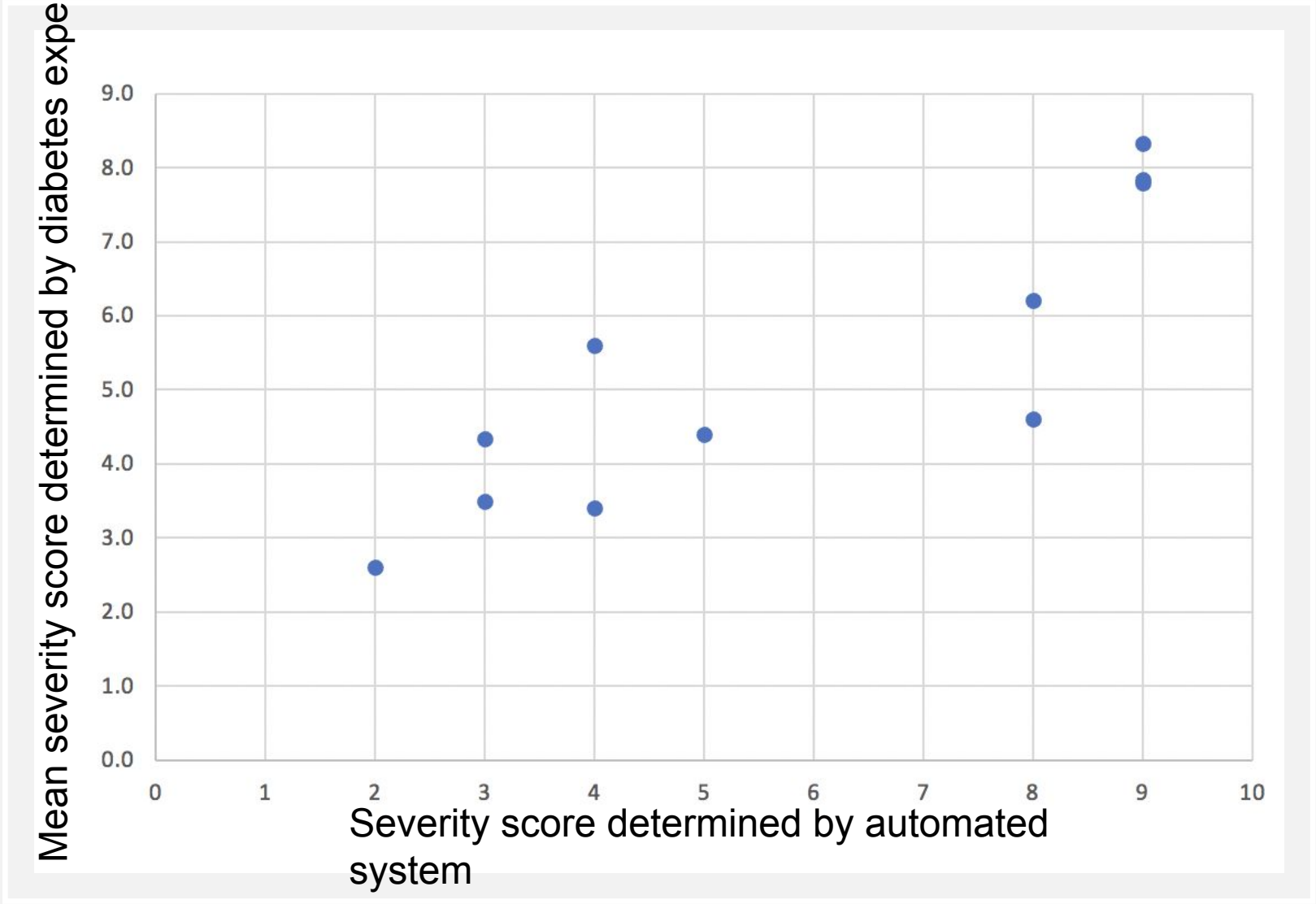

Day 5
Day 6
400
300
200
100
0
System 8 5 9 8
Human 1 5 5 9 7 2
Human 2 3 6 4
Human 3 6 4 5 9 8 6 5
Human 4 4 4 8 8 7 6 3
Human 5 6 5 8
Human 6 3 3 7 2 5 1

RESULTS

- The human experts took an average of 14.5 minutes to complete the CGM worksheet (range 8 to 22 minutes)
- The automated system instantaneously identified 12 events over the 6 days of CGM data, compared with 15.7 +/- 5.4 events in the human expert group (range 8 to 22 events)
- 11 events were detected by both the system and the human experts, though 3 of those events had significant differences in the duration of the event
- One event was detected by the system but not by the human group, and there were 2 events detected by the human group and not by the system

RESULTS

- The severity scores computed by the system and those assigned by the human group were highly correlated
- Pearson's r = 0.87



CONCLUSIONS

An automated CGM event detection and classification system performed similarly to that achieved by human diabetes experts

The system can be trained to detect and classify the CGM patterns with different degrees of resolution as needed for different applications

Such a system to detect and classify CGM events may be useful in automated patient coaching applications, remote monitoring of people with diabetes, and diabetes care decision support for clinicians

THANK YOU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