



Detection of hypoglycemic events with the FreeStyle Navigator® Continuous Glucose Monitoring System



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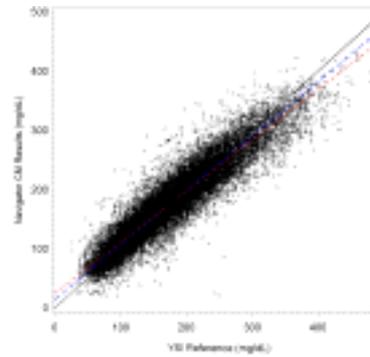
FreeStyle Navigator



The FreeStyle Navigator Continuous Glucose Monitoring System measures interstitial fluid glucose every minute using a patient-inserted electrochemical sensor. The system was developed by Abbott Diabetes Care and is currently available for Investigational Use Only.

Study Protocol

In this study, frequent YSI venous reference measurements were taken in order to assess the accuracy of continuous data from the monitor.



- Three study sites
- 58 subjects with T1DM
- One sensor on upper arm and one on abdomen worn for 5 days
- Subjects masked to sensor data
- Venous data taken at 15 minute intervals for 50 of 120 hours
- Glucose and insulin challenges
- N = 20,362 data pairs

Detection Methods

Threshold Alarm – Alarm activates when glucose is below a user-selected threshold between 60-139 mg/dL.

Projected Alarm – Alarm activates when current glucose level and rate of change predicts crossing of the threshold alarm value at a future time selected by the user - 10, 20, or 30 minutes. Alarm will only activate when the rate can be calculated with adequate precision; it is more likely to activate when rates of change are high.

Glucose Value - The displayed glucose value can also alert the user to low glucose. With an understanding of measurement error, a glucose value within reasonable error bounds of the threshold should initiate treatment.

Analytical Methods

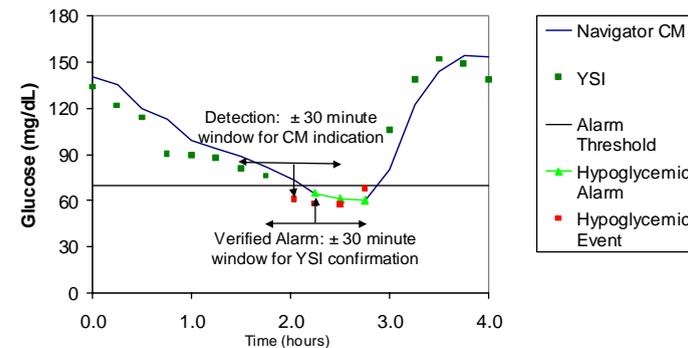
Sensitivity - Detected hypoglycemic events as a fraction of total hypoglycemic events. A hypoglycemic event was defined as two YSI measurements <70 mg/dL (events lasting >15 minutes). Sensor detection had to occur within ± 30 minutes from the start of the event.

True Alarm Rate - Alarms verified by YSI <70 mg/dL as a fraction of total alarms. An alarm must be verified by a YSI measurement within ± 30 minutes from the start of the alarm.

False Alarm Rate - Alarms not verified by YSI as a fraction of total alarms.

Detected by accurate glucose value (No Alarm, Accurate Glucose) - ISO 15197 International Standard for glucose monitors considers a glucose value within ± 15 mg/dL of 70 mg/dL an accurate value. If there was no alarm, Navigator CM (continuous mode) glucose between 70-85 mg/dL was considered detection by accurate glucose.

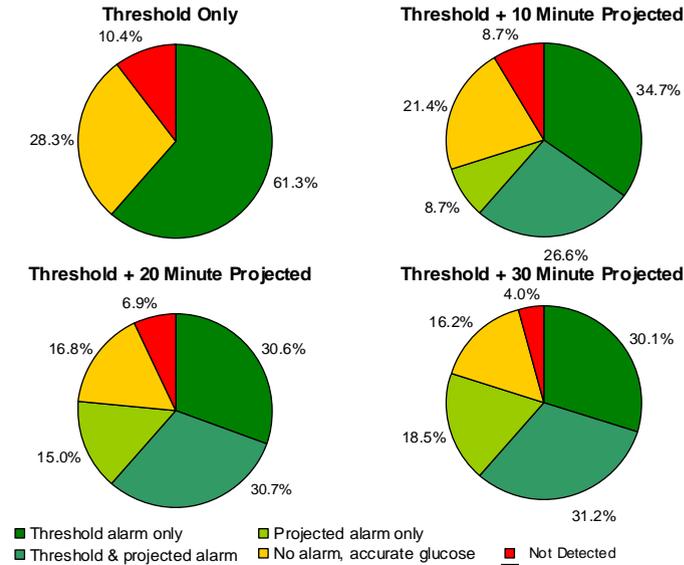
Verified by accurate glucose value (Alarm, Accurate Glucose) - Using ISO 15197 error limit, alarm verified by YSI between 70-85 mg/dL.



Results – Sensitivity of Detection

Alarm Setting	Alarm performance	Results
Threshold only	Detected by Alarm	106 (61.3%)
	No Alarm, Accurate Glucose	49 (28.3%)
	Not Detected	18 (10.4%)
+10 min projected	Detected by Alarm	121 (69.9%)
	No Alarm, Accurate Glucose	37 (21.4%)
	Not Detected	15 (8.7%)
+20 min projected	Detected by Alarm	132 (76.3%)
	No Alarm, Accurate Glucose	29 (16.8%)
	Not Detected	12 (6.9%)
+30 min projected	Detected by Alarm	138 (79.8%)
	No Alarm, Accurate Glucose	28 (16.2%)
	Not Detected	7 (4.0%)
Total Number of Hypoglycemic Events		173

Results – Sensitivity of Detection



Results – False Alarms

Threshold False Alarms		
Glucose Reference Result	Threshold Glucose Alarm Performance	Results
YSI < 70 mg/dL	True Alarm	132 (79.0 %)
YSI 70-85 mg/dL	Alarm, Accurate Glucose	23 (13.8 %)
YSI > 85 mg/dL	False Alarm	12 (7.2 %)
Total Alarms		167

Projected alarms are false alarms by definition since the glucose concentration is above the threshold at the time of alarm. To determine projected alarm accuracy, true and false alarms were defined as follows:

True Alarm - YSI projection was <70 mg/dL at time of alarm.

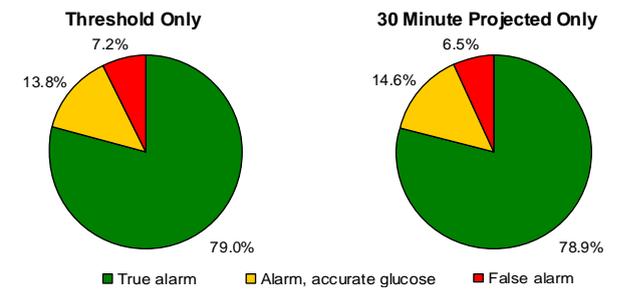
Alarm, Accurate Glucose - YSI projection was not <70 mg/dL but the CM glucose value within 15 mg/dL or 20% of YSI (ISO 15197).

False Alarm - YSI projection was not <70 mg/dL and the CM glucose value at the time of the alarm was not accurate.

30 Minute Projected False Alarms (the most likely alarms to be false)

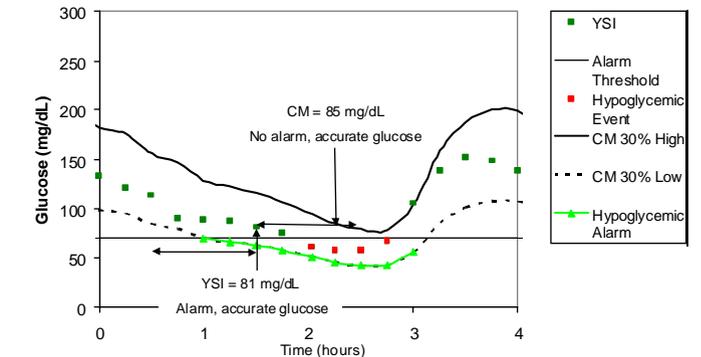
Glucose Reference Result	Projected Glucose Alarm Performance	Results
Projected YSI < 70 mg/dL	True Alarm	157 (78.9 %)
YSI within 15 mg/dL or 20%	Alarm, Accurate Glucose	29 (14.6 %)
YSI > 15 mg/dL or 20%	False Alarm	13 (6.5 %)
Total Alarms		199

Results – False Alarms



Discussion – Power of the Time Axis

Continuous monitors describe the changing glycaemic state on glucose and time axes. The power of the time axis is exploited when ± 30 minutes are allowed to detect or verify hypoglycemia, because inaccuracy on the glucose axis can be offset by the continuous nature of the readings. In the example, when continuous readings are 30% high, the hypoglycemic event is detected within 15 minutes by an accurate CM reading of 85 mg/dL. When continuous glucose readings are 30% low, the alarm is verified in 30 minutes by an accurate YSI reading of 81 mg/dL.



Conclusion

In this study, the FreeStyle Navigator system had a high rate of hypoglycemia detection with a low frequency of false alarms. The detection rate was highest when all three modes of detection were used in combination. The system may allow patients with diabetes to be warned of hypoglycemia or impending hypoglycemia. Other considerations for alarm settings may be based on patient ability to detect, respond, and treat hypoglycemia in a timely manner.

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