Longitudinal Analysis of Real-World Performance of an Implantable Continuous Glucose Sensor Over Multiple Sensor Insertion and Removal Cycles

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BACKGROUND

The Eversense long-term implantable glucose sensor has been commercially available in Europe and South Africa since 2016 and in the US since June 2018 for adults with diabetes. The accuracy of the system, measured by the mean absolute relative difference [MARD] against Yellow Springs Instrument [YSI] reference glucose analyzer, was 8.5%[1, 2, 3]. The real-world, long-term European registry demonstrated low rates of infection (2.46/100 patient-years) and the need for secondary procedures to remove the sensor (1.90 events per 100 patient-years)[4]. Real-world data from first US commercial users demonstrated promising %Time in Range (TIR) of 62.3% and MARD of 11.2% against fingerstick values over a 90-day sensor cycle wear[5].

The performance of the sensor over multiple, sequential 90- or 180-day cycles from the European registry was analyzed.

METHODS

The Eversense CGM System: The Eversense CGM System consists of: 1) an implantable, fluorescence-based glucose sensor placed into the subcutaneous tissue of the upper arm; 2) a transmitter which powers the sensor, is held on top of the skin with a silicone-based adhesive, and can be removed as desired; and 3) a mobile application for monitoring real-time and historical glucose values on a Bluetooth Low Energy (BLE)-enabled device such as a smart phone. Historical glucose values are displayed in the Data Management System (DMS) using numerous report formats, including the Ambulatory Glucose Profile (AGP), to inform health care providers and users. Real-time data can be shared with up to 5 individuals. Two calibrations per day are required.

Data Collection: The Eversense Data Management System (DMS) was used to evaluate the accuracy of General Data Protection Regulation (GDPR)-compliant sensor glucose (SG) values against self-monitored blood glucose (SMBG) from June 2016 through August 2019 among patients with at least four sensor cycles from European and South African health care practices; data from 945 users were evaluated.

Data analysis: Sensor accuracy was determined using paired SG and calibration SMBG values (2/day) obtained using the patient's personal blood glucose meter. MARD values were calculated using all SMBG/SG matched pairs, and the SG value used was within 5 minutes of the SMBG. The percentage of paired values within the 20/20% agreement rate, was also calculated.

Descriptive statistics for CGM metrics were calculated per patient using all available SG values, including mean, SD, coefficient of variation (CV), and Glucose Management Indicator (GMI; a mathematical estimate of HbA1c). The percent of SG values and time (in minutes) the patient had readings in each of the following glucose ranges over the 24-hour period were calculated: <54 mg/dL, <3.0 mmol/L; 54-<70 mg/dL, 3.0 - <3.9 mmol/L; <70 mg/dL, <3.9 mmol/L; 70-180 mg/dL, 3.9 - 10 mmol/L; >180 mg/dL, >10 mmol/L; >180-250 mg/dL, >10-13.9 mmol/L; and >250 mg/dL, >13.9 mmol/L.

The median percent transmitter wear time was calculated across each wear cycle for all 945 users included in this analysis.

RESULTS

The Table summarizes the accuracy and CGM metrics from 945 users during each of the first four sensor cycles. The percentage of 180-day sensors used during each cycle increased over time. The percentage of 180-day sensors from cycle 1 to cycle 4 was 9%, 39%, 68% and 88%, respectively. These data include a total of 1,269 patient-years of real-world follow-up. Among the 945 users included in the analysis, the MARD using 152,206, 174,645, 206,024, and 172,587 calibration matched pairs against SMBG was 11.9%, 11.5%, 11.8% and 11.5% during the first four sensor cycles, respectively. Mean values of the CGM metrics did not change from the initial values obtained during the first sensor cycle. The median transmitter wear time over the first cycle was 83.2%. CGM metrics and wear time were similar over the subsequent three cycles.

CONCLUSIONS

This real-world evaluation of nearly a thousand patients with diabetes using the Eversense CGM system for at least 4 sensor cycles demonstrated that the implantable sensor provides consistent, stable accuracy and glucometrics with no indication of degradation of sensor performance.

References

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Table 1: Eversense CGM Metrics and Accuracy Over Four Sequential Sensor Cycles in 945 Patients

Cycle	Sensor Cycle 1		Sensor Cycle 2		Sensor Cycle 3		Sensor Cycle 4	
CGM Metric	**Mean (SD)**		**Mean (SD)**		**Mean (SD)**		**Mean (SD)**	
SG Mean, mg/dL [mmol/L]	156.5 [8.7] (24.6)		158.2 [8.8] (25.9)		157.4 [8.7] (26.1)		156.5 [8.7] (26.5)	
SG SD, mg/dL [mmol/L]	54.7 [3] (12.4)		55.8 [3] (12.8)		55.5 [3.1] (12.8)		55.5 [3.1] (13.0)	
SG CV	0.35 (0.06)		0.35 (0.06)		0.35 (0.06)		0.36 (0.06)	
GMI, %	7.04 (0.59)		7.08 (0.62)		7.06 (0.62)		7.04 (0.63)	
Time in Glucose Range, %	**Mean (SD)**	**Time (min)**	**Mean (SD)**	**Time (min)**	**Mean (SD)**	**Time (min)**	**Mean (SD)**	**Time (min)**
<54 mg/dL <3.0 mmol/L	1.1 (1.2)	16	1.2 (1.3)	17	1.2 (1.3)	17	1.3 (1.6)	19
54-<70 mg/dL 3.0 - <3.9 mmol/L	3.5 (2.7)	50	3.5 (2.8)	50	3.6 (2.6)	52	3.7 (3.0)	53
<70 mg/dL <3.9 mmol/L	4.6 (3.8)	66	4.7 (4.0)	68	4.8 (3.8)	69	5.0 (4.4)	72
70-180 mg/dL 3.9 - 10 mmol/L	64.5 (15.1)	929	63.2 (15.7)	910	63.7 (15.7)	917	64.0 (15.6)	922
>180 mg/dL >10 mmol/L	30.9 (16.1)	445	32.0 (16.7)	461	31.5 (16.8)	455	31.0 (16.8)	446
>180-250 mg/dL >10-13.9 mmol/L	22.8 (9.5)	328	23.2 (9.4)	334	22.9 (9.5)	330	22.4 (9.5)	323
>250 mg/dL >13.9 mmol/L	8.1 (8.4)	117	8.8 (9.1)	127	8.6 (9.2)	124	8.6 (9.2)	124
Sensor Performance	**Mean (SD)**		**Mean (SD)**		**Mean (SD)**		**Mean (SD)**	
MARD	11.9 (3.6)		11.5 (4.0)		11.8 (4.7)		11.5 (4.1)	
20/20%	83.0 (8.9)		83.9 (9.3)		82.9 (10.4)		83.8 (9.7)	
Median Wear Time per day (%)	83.2		83.6		84.8		85.8	