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Evaluating the accuracy and use of continuous glucose monitoring in hospitalized patients: a systematic review and meta-analysis

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Introduction

- Background
  - Hyperglycemia and hypoglycemia in hospitalized patients are associated with poor clinical outcomes, longer length of stay, and increased cost [1-4]
- Rationale
  - Fingerstick blood glucose monitoring is the standard of care for hospitalized diabetic patients
  - Advances in subcutaneous continuous glucose monitoring (CGM) technology provide the opportunity to more closely monitor blood glucose levels in hospitalized patients and improve the dosage and timing of insulin delivery to minimize episodes of hypo/hyperglycemia and improve clinical outcomes

Image Source

Image Source

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Introduction

- Gaps in knowledge
  - 2017 Consensus Statement on Inpatient Use of Continuous Glucose Monitoring[5]
    - *"CGM use in the outpatient setting is increasing and will continue to increase. Panel members unanimously agreed that continuation of outpatient CGM in the hospital should be considered under specific circumstances if proper institutional procedures and guidelines are developed. Patients will expect to be allowed to continue use of this technology in the inpatient setting and protocols must be in place to allow their safe and continued use. We feel that continued CGM use in the hospital has the potential to improve outcomes by assisting professionals with identifying hypoglycemic and hyperglycemic events. In addition to the possibility of improved outcomes, continued use of these devices will increase patient satisfaction. Well-powered studies are needed to examine outcomes and accuracy with these devices"*

- Objectives
  - Review and summarize the evidence on use of CGM in hospitalized diabetic patients

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Objectives & Hypothesis

- Research Question
  - Has subcutaneous CGM been demonstrated to be an accurate means of measuring blood glucose in hospitalized diabetic patients?
- Hypothesis
  - Subcutaneous CGM accurately reflects blood glucose levels in hospitalized diabetic patients

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Study Design

- Study design: systematic review and meta-analysis
  - Published literature since 2015
- Population: inpatients with diabetes (T1/T2) excluding ICU
- Intervention: CGM
- Comparison: YSI whole blood glucose or capillary (fingerstick) blood glucose measurement
- Outcome: Accuracy
  - Mean absolute relative difference (MARD), coefficient of variation, bias, Clarke Error Grid Analysis

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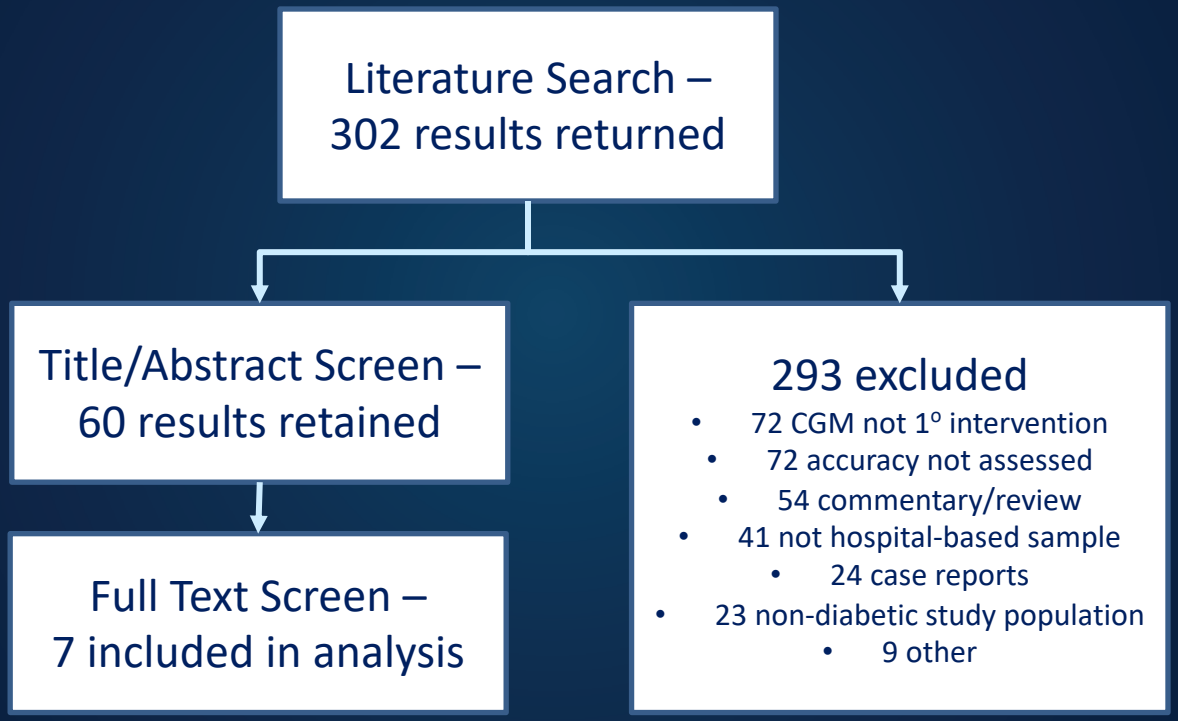
Methods



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Analysis

- Analysis
  - Qualitative review of measures of accuracy
  - Meta-analysis of accuracy as assessed by MARD requires individual patient data
    - MARD: average of the absolute error between all CGM values and matched reference values
      - Small percentage: CGM readings are close to reference
    - Unable to conduct meta-analysis

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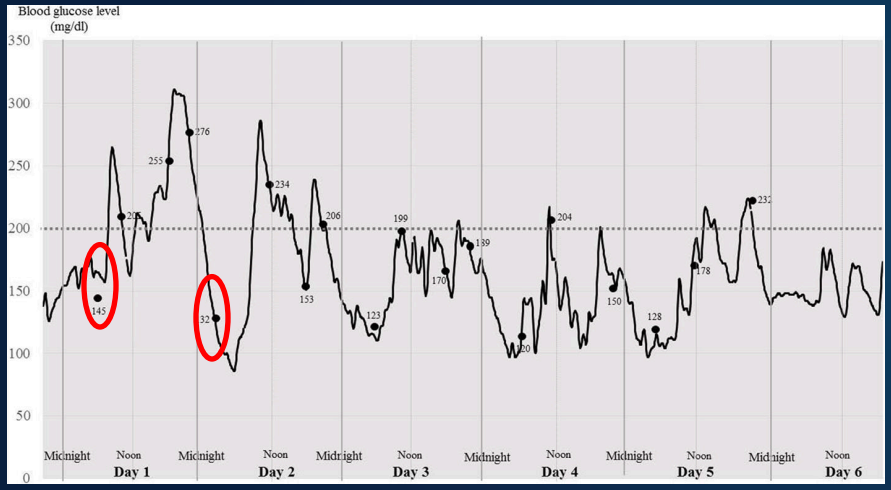
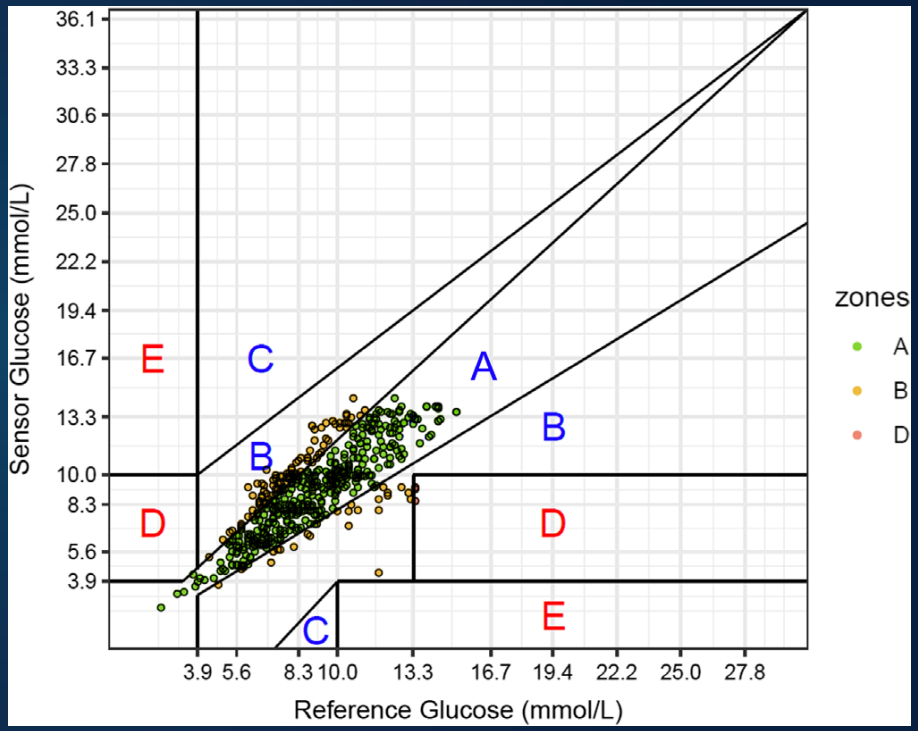
Analysis



Maeda Y, Nakamura N, Tsujimoto T, Sugano N. Higher blood glucose and larger fluctuations detected postoperatively using continuous glucose monitoring: a preliminary study following total knee or hip arthroplasty. *J exp orthop*. 2019;6(1):15. doi:10.1186/s40634-019-0181-9



Tripyla A, Herzig D, Joachim D, et al. Performance of a factory-calibrated, real-time continuous glucose monitoring system during elective abdominal surgery. *Diabetes Obes Metab*. 2020;(dw9, 100883645). doi:10.1111/dom.14073

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Results

Study	Intervention	Comparison	N
Reutrakul et al. (2020)	Dexcom G6	Capillary POC Glucose	9
Galindo et al. (2020)	FreeStyle Libre Pro	Capillary POC Glucose	97
Migdal et al. (2020)	Dexcom G6	Capillary POC Glucose	49
Tripyla et al. (2020)	Dexcom G6	Capillary POC Glucose	20
Nair et al. (2020)	Dexcom G6	Capillary POC Glucose	10
Gomez et al. (2016)	iPro2	Capillary POC Glucose	38
Schaupp et al. (2015)	iPro2	Capillary POC Glucose	84
			307

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Results

Study	N	Duration, days	Correlation Coefficient	MARD	% CGM w/in range of POC	Clarke Zone A (A & B)
Reutrakul et al. (2020)	9	4.3 (3.1)*	0.927	9.77%	*NR*	84.8% (100%)
Galindo et al. (2020)	97	7.5 (2-30)^	*NR*	Overall – 14.8% BG <70 – 27.9% BG 70-180 – 16.7% BG >180 – 12.1%	± 15%/15 mg/dL – 61.5% ± 20%/20 mg/dL – 75.8% ± 30%/30 mg/dL – 90.4%	75.1% (98.0%)
Migdal et al. (2020)#	49	1	*NR*	13.3%	± 15%/15 mg/dL – 69% ± 20%/20 mg/dL – 80% ± 30%/30 mg/dL – 94%	*NR* (98.1%)
Tripyla et al. (2020)+	20	1	*NR*	Overall – 12.7% BG <70 – *NR* BG 70-180 – 12.8% BG >180 – 12.1%	*NR*	78.8% (99.2%)
Nair et al. (2020)+	10	2.5	0.76	9.4%	*NR*	89% (*NR)*
Gomez et al. (2016)	38	6	0.79	12.9%	*NR*	*NR* (91.9%)
Schaupp et al. (2015)	84	7.5 (6-12)~	*NR*	Overall – 9.6% BG <70 –21.3% BG 70-180 – 9.6% BG >180 – 8.4%	*NR*	88.2% (98.75)

* Mean, (SD)
^ Median (range)
# Pre-imaging values only
+ surgical population
NR not reported
~ Median (Interquartile range)

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Conclusions

- MARD varies across studies and across ranges of blood glucose
  - Cannot control for the numerous sources of heterogeneity (inclusion criteria, population, intervention, outcome measurement, analysis)
- Small sample sizes limit precision
- Outcome measures used to assess CGM data cannot be pooled using traditional meta-analysis methods

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Future Directions

- Study design and reporting guidelines
  - Standardization across study is necessary to allow for determination of suitability of CGM for use in hospitalized patients
- Larger trials to allow for greater precision
- Assessment of accuracy within various subgroups
  - Ex. Surgical patients, insulin dependent vs. non-insulin dependent DM
- Assessment of clinical outcomes and process measures:
  - Number of hyper/hypo glycemic episodes, nursing workload, patient satisfaction

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