Olgu örnekleri ile insülin pompası: Tip 1

57. Ulusal Diyabet Metabolizma ve Beslenme Hastalıkları Kongresi

1 Haziran Teknoloji Kursu

Dr. Meliha Melin Uygur

Marmara Üniversitesi Pendik Eğitim ve Araştırma Hastanesi

Endokrinoloji ve Metabolizma Hastalıkları Bilim Dalı

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DIABETES TECHNOLOGY & THERAPEUTICS
Volume 21, Number 2, 2019

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ORIGINAL ARTICLE

State of Type 1 Diabetes Management and Outcomes from the T1D Exchange in 2016–2018

Nicole C. Foster, MS,[1] Roy W. Beck, MD, PhD,[1] Kellee M. Miller, PhD,[1] Mark A. Clements, MD,[2] Michael R. Rickels, MD, MS,[3] Linda A. DiMeglio, MD, MPH,[4] David M. Maahs, MD, PhD,[5] William V. Tamborlane, MD,[6] Richard Bergenstal, MD,[7] Elizabeth Smith, BS,[1] Beth A. Olson, BAN, RN, CDE,[7] and Satish K. Garg, MD[8]; for the T1D Exchange Clinic Network

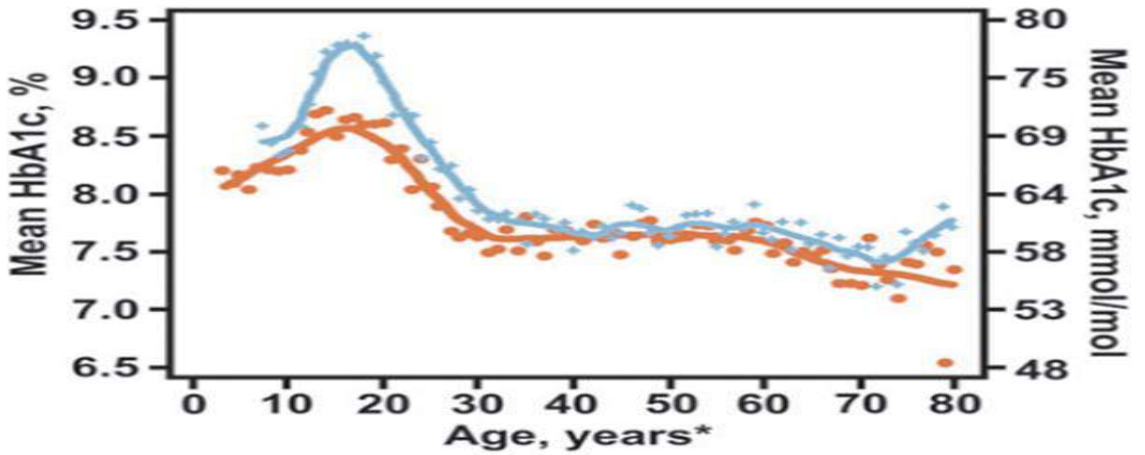

FIG. 2. Average HbA1c by year of age: 2010–2012 versus 2016–2018. Orange line represents 2010–2012 cohort, and blue line represents 2016–2018 cohort. Participants must be contained in both cohorts with at least a 3-year duration for the 2010–2012 collection. * ≥80 years old are pooled.

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DTT

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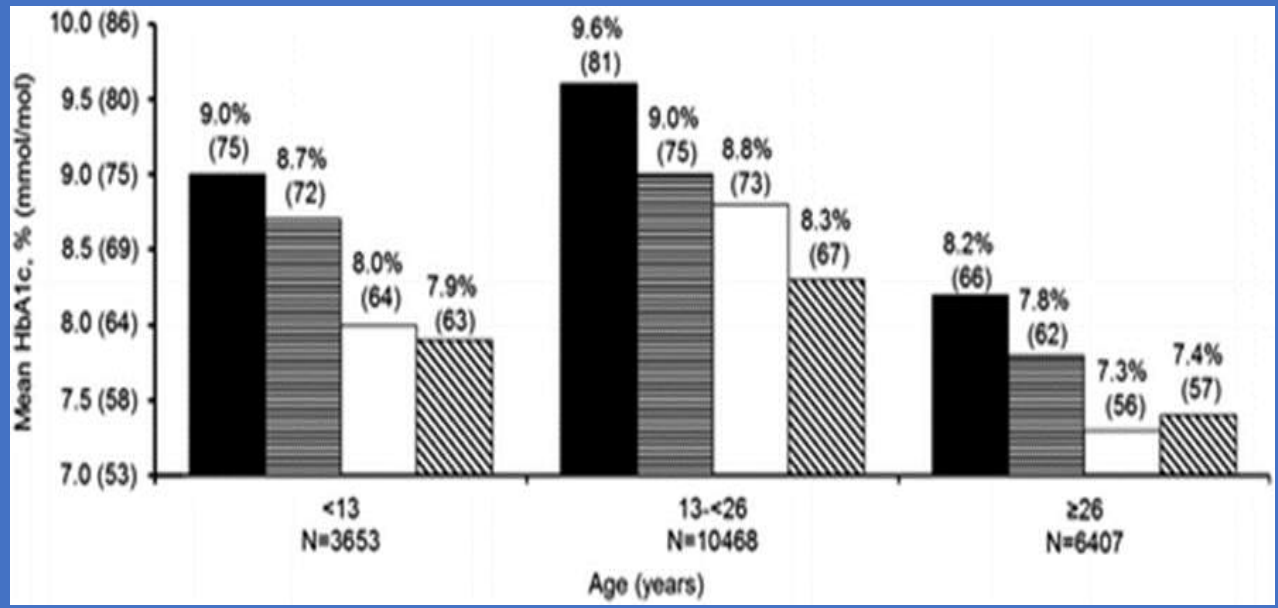


Olgu:

G.Ş. 23 Y K
14 yıldır tip 1 DM
Glukoz regülasyonu kontrolsüz
Diyabetik ketoasidoz nedeniyle acil poliklinik başvurusu
Diyabetik nefropati nedeniyle 3 yıl önce kardeşinden renal transplant
Nefroloji polikliniğinden tarafımıza yönlendirilmiş.

Özgeçmiş: renal transplant -2018, diyabetik retinopati-2015, diyabetik nöropati-2015, hipotiroidi-2010

Soygeçmiş: Anne HT

Kullandığı ilaçlar: certican (everolimus) 2x0.5, deltacortril (prednisolon) 5 mg 1x1, prograf (takrolimus) 2x0.5, levotiron 100 1x1, tiopati (tioktik asit) 1x1, pregabalin 150 mg 1x1, atorvastatin 40 mg tb

MDII:

İnsülin aspart s:16ü ö:14ü a:14ü
İnsülin glarjin gece 48ü

- Boy: 1.55m
- Kilo:66 kg
- TA: 110/60 mmHg
- Nabız: 70/dk

Laboratuvar:

Glukoz	101mg/dl	Total Kolesterol	195mg/dl
HbA1c	%8.4	HDL Kolesterol	52mg/dl
kreatinin	0.66mg/dl	LDL Kolesterol	114mg/dl
Trigliserit	144 mg/dl	TSH	2.5 mIU/L

Glomerüler Filtrasyon Hızı = 117.96 mL/min/1.73 m^2

Evde Glukoz Takibi (Self Monitoring Of Blood Glucose):

Sabah aç	Öğle aç	Akşam aç
190-210- 250 mg/dl	134-178-110 mg/dl	104-168-201 mg/dl
Sabah tok	Öğle tok	Akşam tok
150- 138-186 mg/dl	96-144-206	95-176-256 mg/dl

03.00: 180 mg/dl

Insulin Pompasi (scii) ?????

Insulin pump therapy in children with type 1 diabetes: analysis of data from the SWEET registry

Agnieszka Szypowska[1] | Anke Schwandt[2,3] | Jannet Svensson[4] | Shlomit Shalitin[5,6] | Roque Cardona-Hernandez[7] | Gun Forsander[8,9] | Frida Sundberg[9] | Carine De Beaufort[10,11] | David Maahs[12] | Claudio Maffeis[13] | Stephen M.P. O'Riordan[14] | Iveta Dzivite Krisane[15] | Mauro Scharf[16] | Sofia Castro[17] | Maia Konstantinova[18] | Barbora Obermannova[19] | Kristina Casteels[20,21] | Damla Gökşen[22] | Júlia Galhardo[23] | Christina Kanaka-Gantenbein[24] | Birgit Rami-Merhar[25] | Laszlo Madacsy[26] | the SWEET Study Group

TABLE 2 Comparison between children in different age groups treated with MDI or CSII therapy.[1]

	0-<6 y			6-<12 y			12-18 y		
Type of insulin therapy	MDI median [Q1;Q3]	CSII median [Q1;Q3]	P value	MDI median [Q1;Q3]	CSII median [Q1;Q3]	P value	MDI median [Q1;Q3]	CSII median [Q1;Q3]	P value
Number of patients	435	464	–	2458	2358	–	6321	4534	–
Female/male	184/251	231/233	.049	1193/1265	1165/1193	.582	3054/3267	2217/2290	.582
Diabetes duration (y)	2.1 [1.5; 3.1]	2.2 [1.5; 3.2]	.582	3.6 [2.1; 5.6]	4.7 [2.9; 6.7]	.0001	5.9 [3.4; 9.4]	7.3 [4.6; 10.5]	.0001
HbA1c (%; mmol/mol)	7.9 [7.2; 8.6] 63 [55; 71]	7.4 [6.8; 8.0] 57 [51; 64]	.0001	7.8 [7.0; 8.5)] 62 [53; 69]	7.4 [6.8; 8.1] 57 [51; 65]	.0001	8.2 [7.3; 9.4] 66 [56; 79]	7.8 [7.2; 8.8] 62 [55; 73]	.0001
Daily insulin dose (U/kg/d)	0.73 [0.59; 0.90.	0.72 [0.58; 0.86.	.471	0.83 [0.66; 1.02.	0.76 [0.61; 0.91.	.0001	0.95 [0.75; 1.18.	0.89 [0.71; 1.08.	.0001
BMI-SDS	0.79 [0.21; 1.45.	0.85 [0.34; 1.51.	.143	0.45 [−0.14; 1.14.	0.54 [−0.05, 1.16.	.023	0.52 [−0.16; 1.19.	0.57 [−0.09; 1.17.	.103

Abbreviations: BMI, body mass index standard deviation score; CSII, continuous subcutaneous insulin infusion; MDI, multiple daily injections; n.s., not significant.

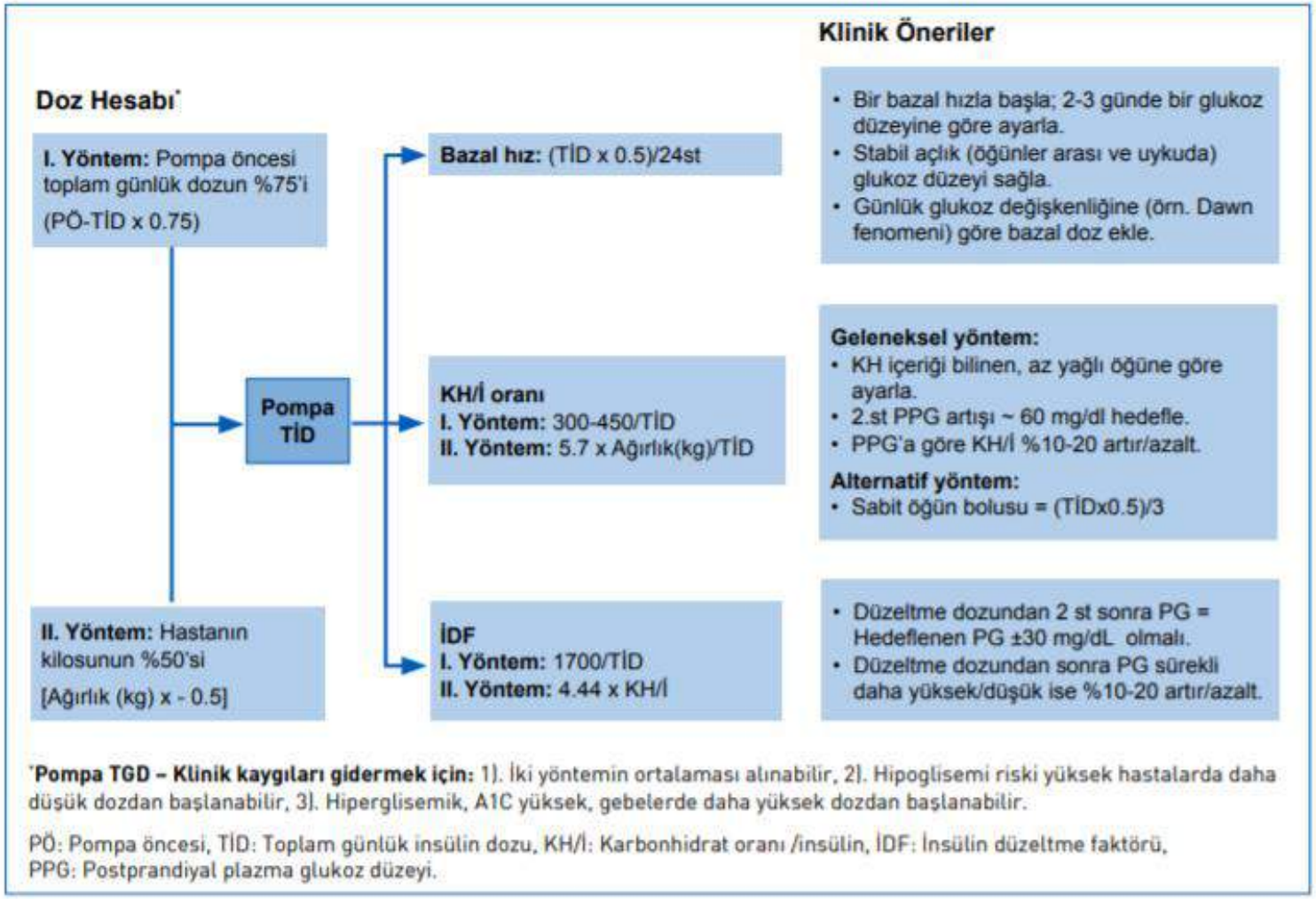
Sürekli Cilt Altı İnsülin İnfüzyonu (SCİİ; İnsülin Pompası) Endikasyonları:

- **SCİİS'i hangi koşullar altında kullanılması gerekir?**
  - ✓ Tekrarlayan şiddetli hipoglisemi
  - ✓ HbA1c'den bağımsız olarak kan şekeri seviyelerinde geniş dalgalanmalar
  - ✓ Uygun olmayan glisemik kontrol (HbA1c'nin hedef dışında olması)
  - ✓ Mikrovasküler kommplikasyonlar ve/veya makrovasküler komplikasyon riski taşıyanlar
  - ✓ İyi bir metabolik kontrol ancak insülin rejimi ile uyuşmayan yaşam tarzı- esnek yaşam tarzı isteği
  - ✓ 7 yaş altındaki olgular

- **SCİİS'in yararlı olabileceği durumlar**
  - ✓ Küçük çocuklar ve özellikle bebekler/yenidoğanlar
  - ✓ Belirgin şafak fenomeni olan çocuklar ve ergenler
  - ✓ Enjeksiyon/iğne fobili çocuklar
  - ✓ Hamile ergenler, prekonsepsiyonel dönem
  - ✓ Ketoz eğilimli bireyler
  - ✓ Yarışmacı/profesyonel sporcular

Sherr JL, Tauschmann M, Battelino T, et al. ISPAD Clinical Practice Consensus Guidelines 2018: Diabetes technologies. Pediatric Diabetes. 2018 Oct;19 Suppl 27:302-325. DOI: 10.1111/pedi.12731.

Sürekli İnsülin İnfüzyon Tedavisinde Bazal ve Bolus Dozlarının Hesaplanması



(Grunberger G, et al. AACE/ACE Consensus Statement on Insulin Pump Management. Endocrine Practice 2014;20:464-89'dan modifiye edilmiştir.)

Nisan 2021 Minimed 780 G Gelişmiş Hibrit Kapalı Devre Sistem İnsülin Pompası tedavisine geçildi

KH/İ oranı:	5
İDF:	20
Aktif insulin:	2 saat
Hedef :	100 mg/dl

İNSÜLİN İNFÜZYON POMPA TEKNOLOJİSİ

Closed loop

Minimed 780G
Advanced hybrid closed loop

MiniMed™ 670G system*
SmartGuard™ hybrid closed loop tech

2017
US only

MiniMed™ 640G system
SmartGuard™ Suspend before low technology

2015

MiniMed™ Veo
SmartGuard™ Suspend on low technology

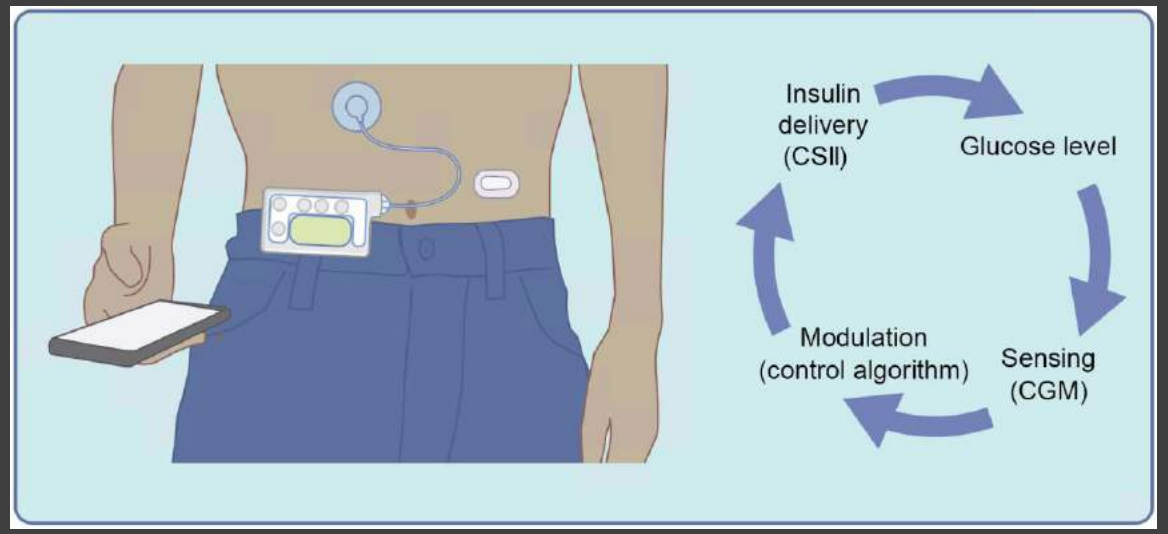
2009

Diabetologia (2021) 64:1007–1015
https://doi.org/10.1007/s00125-021-05391-w

REVIEW

New closed-loop insulin systems

Charlotte K. Boughton[1] · Roman Hovorka[1]



Kapalı devre insülin sistemlerinin şematik görünümü

Glukoz İzleminde Yeni Kavramlar Ve Sürekli Glikoz Ölçüm Raporunu Değerlendirme

Table 2—Standardized CGM metrics for clinical care: 2019

1. Number of days CGM worn (recommend 14 days) (42,43)		
2. Percentage of time CGM is active (recommend 70% of data from 14 days) (41,42)		
3. Mean glucose		
4. Glucose management indicator (GMI) (75)	Glukoz yönetim göstergesi	
5. Glycemic variability (%CV) target ≤36% (90)*	Glisemik değişkenlik	
6. Time above range (TAR): % of readings and time >250 mg/dL (>13.9 mmol/L)	Hedefin üzerinde geçirilen zaman	
7. Time above range (TAR): % of readings and time 181–250 mg/dL (10.1–13.9 mmol/L)		Level 1
8. Time in range (TIR): % of readings and time 70–180 mg/dL (3.9–10.0 mmol/L)	Hedefte geçirilen zaman	In range
9. Time below range (TBR): % of readings and time 54–69 mg/dL (3.0–3.8 mmol/L)	Hedefin altında geçirilen zaman	Level 1
10. Time below range (TBR): % of readings and time <54 mg/dL (<3.0 mmol/L)		Level 2

Use of Ambulatory Glucose Profile (AGP) for CGM report

CV, coefficient of variation. *Some studies suggest that lower %CV targets (<33%) provide additional protection against hypoglycemia for those receiving insulin or sulfonylureas (45,90,91).

Battelino T, Danne T, Bergenstal RM, et al. Clinical Targets for Continuous Glucose Monitoring Data Interpretation: Recommendations From the International Consensus on Time in Range. *Diabetes Care*. 2019;42(8):1593-1603. doi:10.2337/dci19-0028

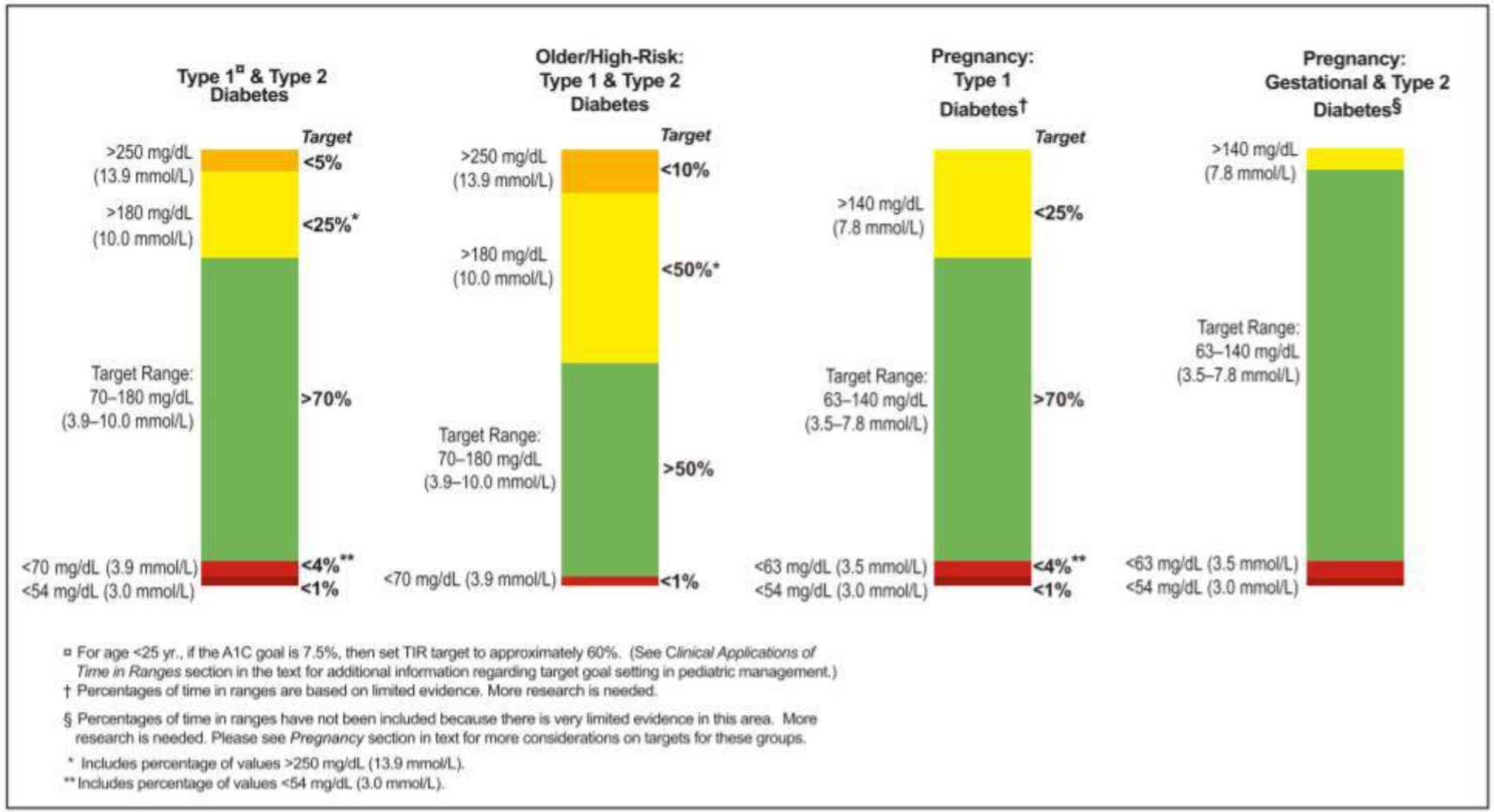


Figure 1—CGM-based targets for different diabetes populations.

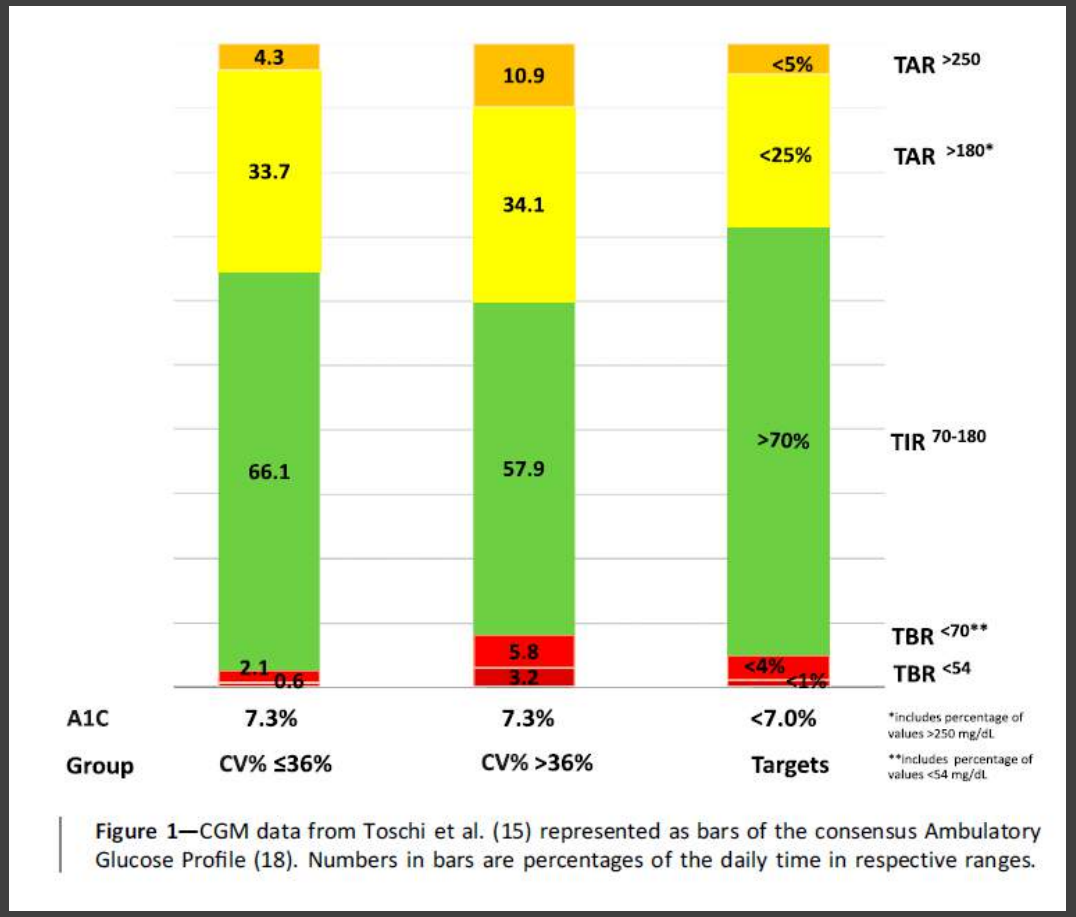


Figure 1—CGM data from Toschi et al. (15) represented as bars of the consensus Ambulatory Glucose Profile (18). Numbers in bars are percentages of the daily time in respective ranges.

Continuous Glucose Monitoring–Derived Data Reported Simply a Better Management Tool, Tadej Battelino and Richard M. Bergenstal. Diabetes Care 2020;43:2327–2329 | https://doi.org/10.2337/dci20-0032

Table 1 Commercially available hybrid closed-loop systems

Component	Medtronic 670G	Medtronic 780G	CamAPS FX	Control-IQ
Algorithm	PID with insulin feedback	PID with insulin feedback	Treat to target adaptive MPC (Cambridge algorithm)	Treat to range predictive algorithm
Insulin pump	670G	780G	Dana RS, Dana-i	Tandem t:slim X2
CGM system	Guardian 3 (requires ~4–6 fingersticks/day)	Guardian 3 (requires ~4 fingersticks/day)	Dexcom G6 (factory calibrated, optional calibration)	Dexcom G6 (factory calibrated, optional calibration)
Target glucose	Fixed target: 6.7 mmol/l Optional activity target	Target: 5.6 mmol/l (default) or 6.7 mmol/l Optional activity target	Target: 5.8 mmol/l (default); customisable between 4.4 mmol/l and 11 mmol/l Optional activity target	Fixed target range: 6.2–8.9 mmol/l Night mode: 6.2–6.7 mmol/l Optional activity target
Algorithm learning	Based on TDD	Based on TDD	Adapts to prandial and diurnal patterns	None
Compatible downloading software	Carelink; manual downloading of pump required	Carelink; automated app compatibility	Diasend; automated download	Clarity: sensor data Diasend/Glooko; manual downloading of pump required

TDD, total daily dose

Medtronic 780G

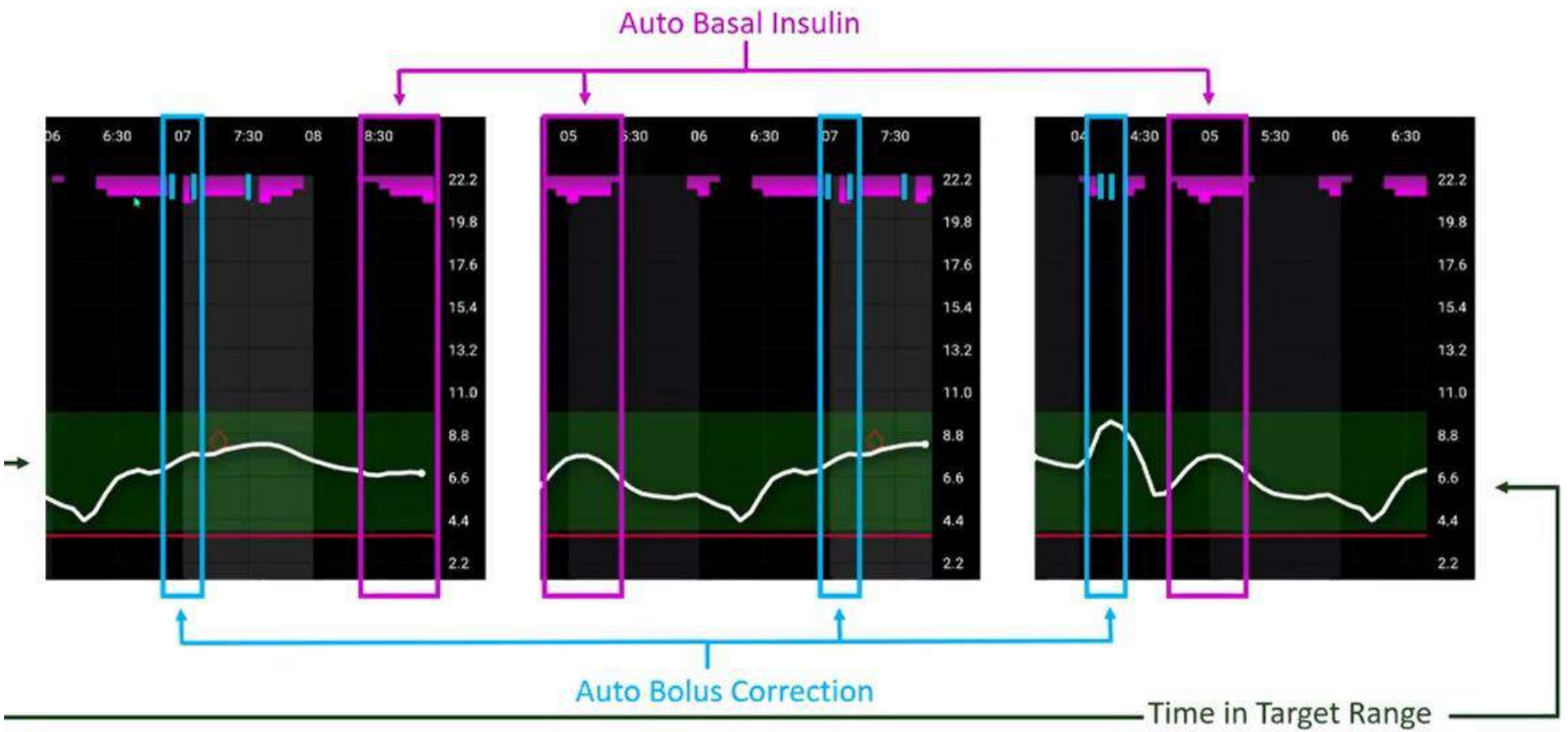
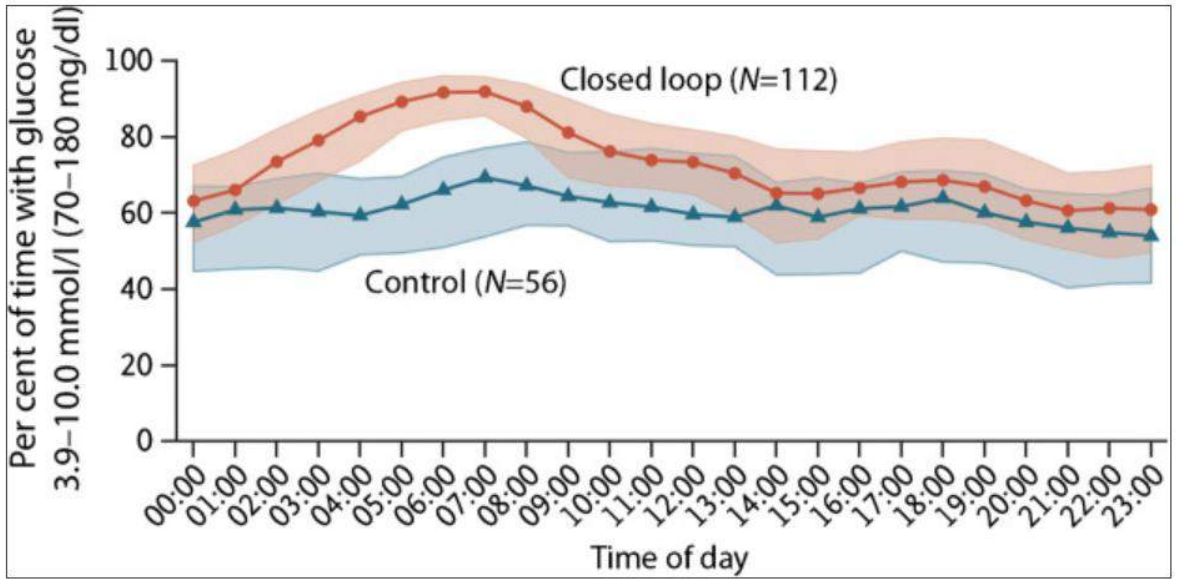


Table 2 Key clinical studies for commercially available hybrid closed-loop systems

Closed-loop device [study reference]	Study design	Study duration	Population	Baseline HbA_{1c}	Glucose outcomes
Medtronic 670G [9]	Non-randomised before-and-after single-arm study	3 months	*n* =30 adolescents, ≥14 years old; *n* =94 adults	Adolescents: 7.7% (61 mmol/mol); adults: 7.3% (56 mmol/mol)	Adolescents: • TIR ↑ from 60% (baseline) to 67% • TBR ↓ from 4.3% (baseline) to 2.8% Adults: • TIR ↑ from 69% (baseline) to 74% • TBR ↓ from 6.4% (baseline) to 3.4%
Medtronic 670G [10]	Non-randomised before-and-after single-arm study	3 months	*n* =105 children (7–13 years old)	7.9% (63 mmol/mol)	• TIR ↑ from 56% (baseline) to 65% • TBR ↓ from 4.7% (baseline) to 3.0%
Medtronic 780G (AHCL) [11]	Randomised crossover study comparing Medtronic AHCL with 670G	3 months	*n* =113 adolescents and young adults (14–29 years old)	7.9% (63 mmol/mol)	AHCL vs 670G: • TIR ↑: 67% vs 63% • TBR ↔: 2.1% vs 2.1%
Control-IQ [12]	Randomised parallel study comparing Control-IQ with SAP	6 months	*n* =168 adults and adolescents ≥14 years old	7.4% (57 mmol/mol)	Control-IQ vs SAP: • TIR ↑: 71% vs 59% • TBR ↓: 1.6% vs 2.3%
Control-IQ [13]	Randomised parallel study comparing Control-IQ with SAP	4 months	*n* =101 children (6–13 years old)	7.6–7.9% (60–63 mmol/mol)	Control-IQ vs SAP: • TIR ↑: 67% vs 55% • TBR ↔: 1.6% vs 1.8%
Cambridge closed-loop [16]	Randomised parallel study comparing closed loop with SAP	3 months	*n* =86 children and adults with sub-optimal	7.8–8.0% (62–64 mmol/mol)	Closed loop vs SAP: • TIR ↑: 65% vs 54% • TBR ↓: 2.6% vs 3.9%



New closed-loop insulin systems
Diabetologia. 2021; 64(5): 1007–1015.

Fig. 4

Median percentage time with sensor glucose in target range during closed-loop insulin delivery (red line) and sensor-augmented pump therapy (blue line) in adults and adolescents ≥14 years of age, using the Tandem Control-IQ closed-loop ...

Yapay zeka&Doktor

Insulin dose optimization using an automated artificial intelligence-based decision support system in youths with type 1 diabetes

Revital Nimri[1], Tadej Battelino[2], Lori M. Laffel[3], Robert H. Slover[4], Desmond Schatz[5], Stuart A. Weinzimer[6], Klemen Dovc[2], Thomas Danne[7], Moshe Phillip[1,8] ✉ and NextDREAM Consortium*

Outcome*	AI-DSS Arm (n=54)	Physician Arm (n=54)	P value
Mean Glucose (mg/dl)	182 ± 21	180 ± 22	0.87§
SD of glucose (mg/dl)	62 ± 9.9	61 ± 10.7	0.36§
Coefficient of variation in glucose level (%)	35.0 ± 4.0	34.2 ± 4.3	0.31§
Time spent in sensor glucose measurements (%)			
Mean < 50mg/dl	0.9 ± 1.0	0.7 ± 0.7	0.23ǂ
Mean < 70mg/dl	3.9 ± 2.7	3.4 ± 2.2	0.37ǂ
Mean >180 mg/dl	45.9 ± 11.4	44.9 ± 12.0	0.67§
Mean >240 mg/dl	21.4 ± 9.6	20.4 ± 10.5	0.76§
Mean total insulin dose (U)¥	56.9 ± 19.8	52.4 ± 10.7	0.14ǂ
Basal insulin dose (U)¥	26.5 ± 11	25.9 ± 7.7	0.74ǂ
Bolus insulin dose (U)¥	29.6 ± 9.7	26.6 ± 8.3	0.03ǂ

Yapay zeka&Doktor

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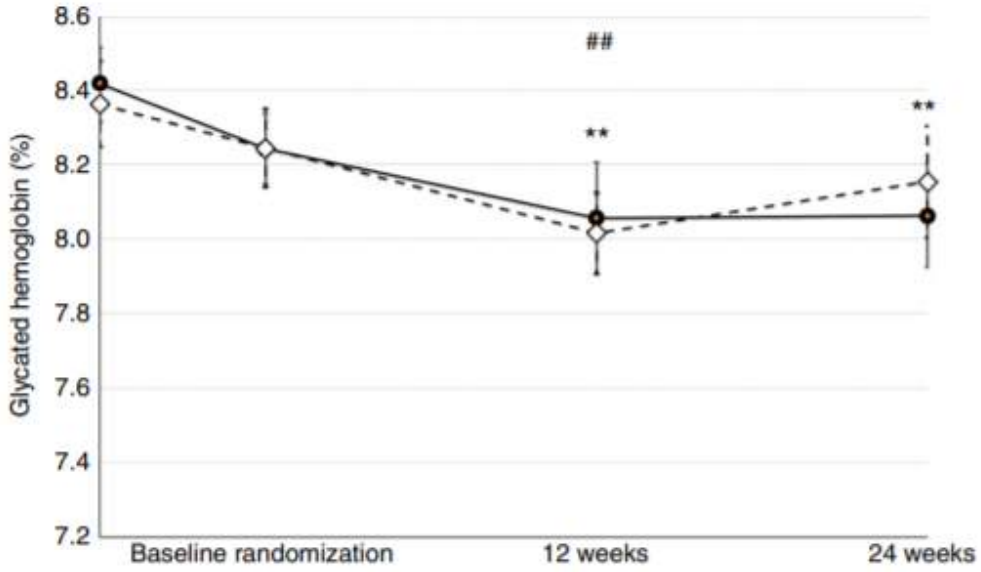


Fig. 2 | Glycated hemoglobin levels at baseline, randomization, 12 weeks and 24 weeks for the intent to treat ($n = 53$ per arm) cohort. Values are

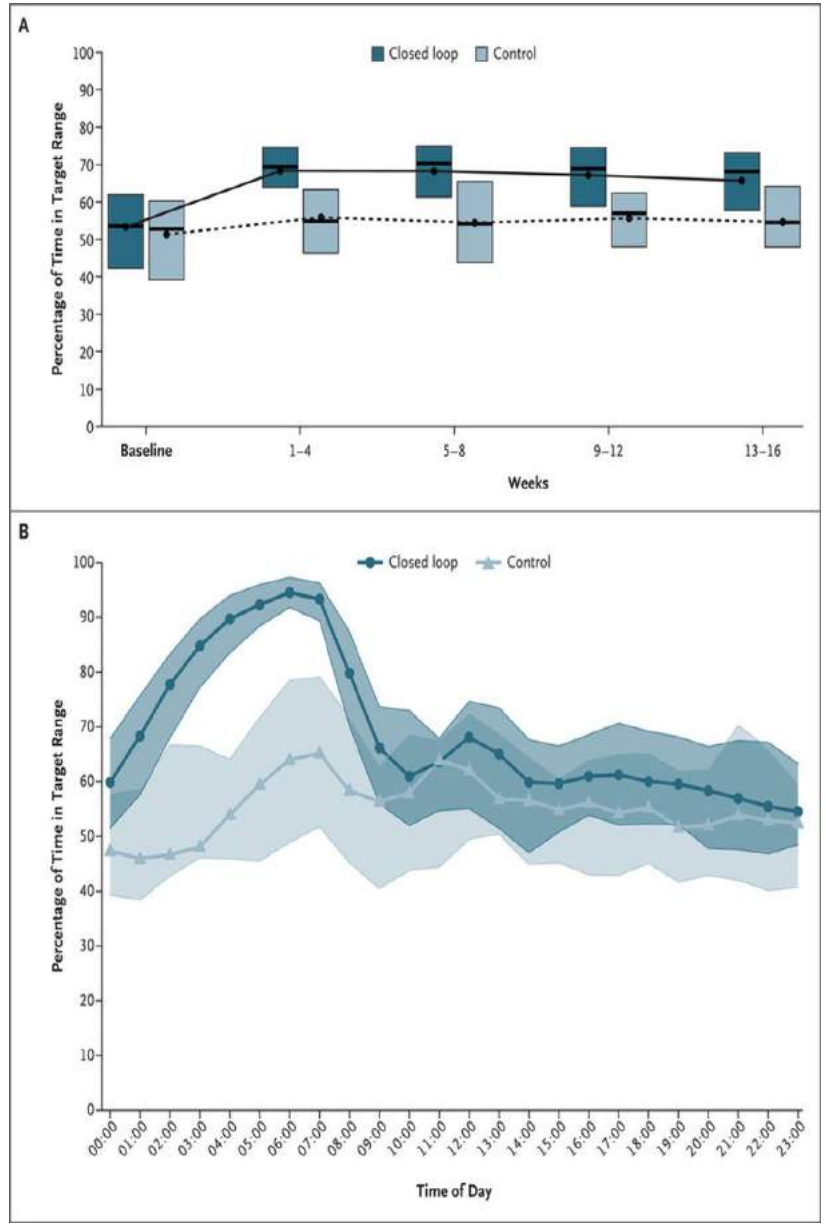
ORIGINAL ARTICLE

A Randomized Trial of Closed-Loop Control in Children with Type 1 Diabetes

Marc D. Breton, Ph.D., Lauren G. Kanapka, M.Sc., Roy W. Beck, M.D., Ph.D., Laya Ekhlaspour, M.D., Gregory P. Forlenza, M.D., Eda Cengiz, M.D., Melissa Schoelwer, M.D., Katrina J. Ruedy, M.S.P.H., Emily Jost, M.P.H., R.D., C.D.E., Lori Carria, M.S., Emma Emory, R.N., Liana J. Hsu, B.S., et al., for the iDCL Trial Research Group*

Table 2. Primary and Secondary Hierarchical Efficacy Outcomes.*

Outcome	Baseline†		16-Wk Trial Period‡			
	Closed Loop (N=77)	Control (N=23)	Closed Loop (N=78)	Control (N=22)	Risk-Adjusted Difference (95% CI)§	P Value
Hours of sensor data	306±33	311±23	2637±134	2609±128		
Primary outcome: glucose level in range of 70 to 180 mg/dl — % of time	53±17	51±16	67±10	55±13	11 (7 to 14)	<0.001
Secondary hierarchical outcomes in prespecified order¶						
Glucose level >180 mg/dl — % of time	45±18	47±17	31±10	43±14	−10 (−14 to −6)	<0.001
Glucose level — mg/dl	183±34	189±34	162±18	179±26	−13 (−20 to −7)	<0.001
Glycated hemoglobin level — %‖	7.6±1.0	7.9±0.9	7.0±0.8	7.6±0.9	−0.4 (−0.9 to 0.1)	0.08
Glucose level <70 mg/dl — median % of time (IQR)**	1.2 (0.5 to 2.4)	1.0 (0.2 to 2.1)	1.6 (0.8 to 2.4)	1.8 (1.1 to 3.0)	−0.40 (−0.83 to −0.02)	NA
Glucose level <54 mg/dl — median % of time (IQR)**	0.1 (0.0 to 0.4)	0.1 (0.0 to 0.3)	0.2 (0.1 to 0.4)	0.3 (0.1 to 0.6)	−0.07 (−0.19 to 0.02)	NA
Glucose level >250 mg/dl — median % of time (IQR)**	17.2 (8.6 to 27.6)	20.7 (12.4 to 32.6)	7.8 (5.1 to 14.3)	18.4 (9.4 to 24.6)	−5.8 (−8.7 to −3.0)	NA
Coefficient of variation in the sensor glucose measurement — %	38±5	38±4	38±4	39±4	−1.6 (−2.8 to −0.4)	NA

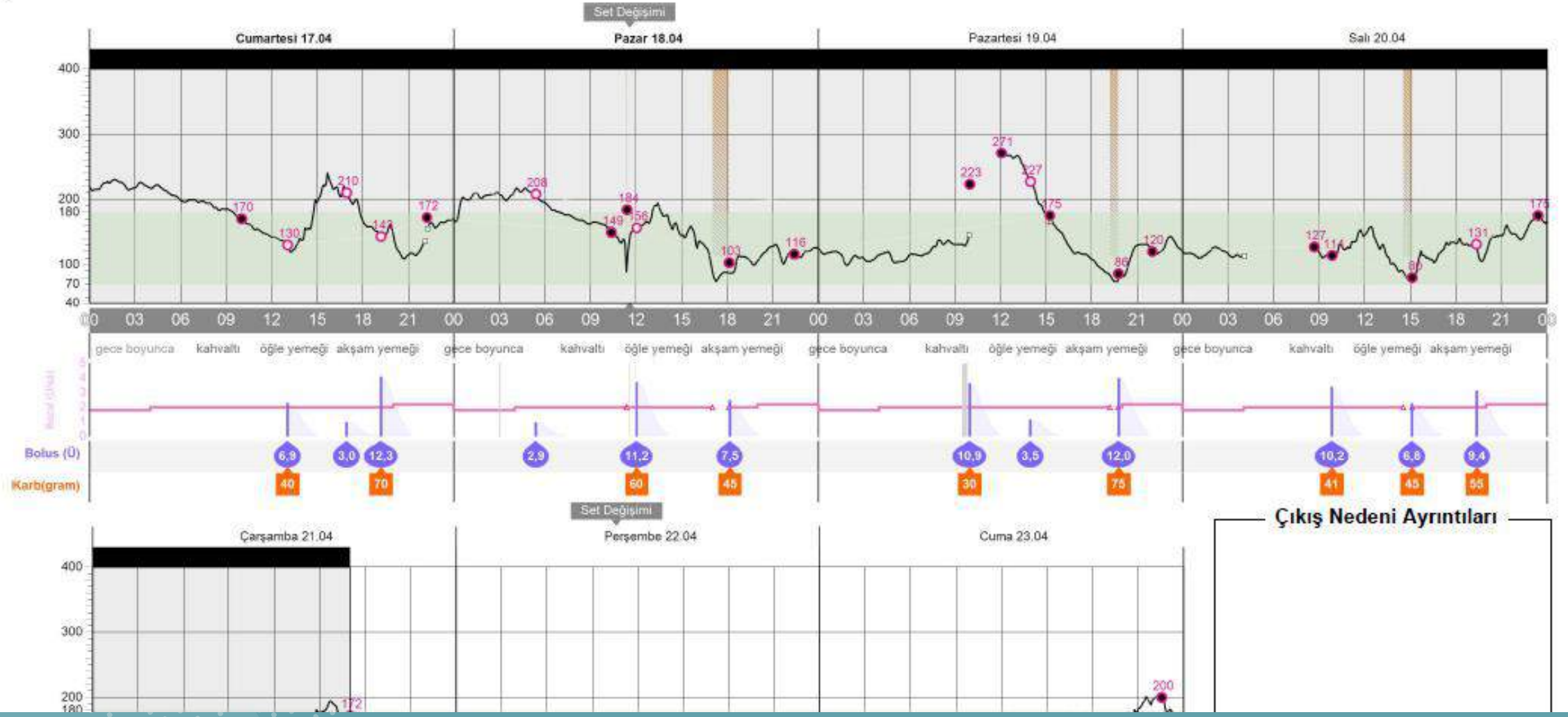


Medtronic

Haftalık Gözden Geçirme (4 / 5)
17.04.2021 - 23.04.2021 (7 Gün)

[redacted]

Oluşturulma Tarihi: 02.05.2021, 15:41 **Sayfa 5 / 22**
Veri Kaynakları: MiniMed 780G, MMT-1886 (N[redacted])



Çıkış Nedeni Ayrıntıları


24.04.2021, 25.04.2021
Cumartesi 24.04
GTD 67Ü
Toplam Bazal %59 | 39,8Ü
Toplam Bolus %41 | 27,2Ü
Bolus %75 | 20,5Ü
Oto Düzeltme %25 | 6,7Ü
Aralık İçindeki Zaman
400
300
Glikoz
(mg/dl)
200
180
100
70
40
90
136
178
100%
00 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17 18 19 20 21 22 23 00
Bolus (Ü)
14,6
5,9
BesinBolus
Düzeltme*
Geçersiz Kıl
Karb(gram)
60
35
Pazar 25.04
GTD -- Ü
Toplam Bazal %-- | -- Ü
Toplam Bolus %-- | 3Ü
Bolus %-- | -- Ü
Oto Düzeltme %-- | 3Ü
Aralık İçindeki Zaman
400
300
Glikoz
(mg/dl)
200
180
100
70
40
100%
00 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17 18 19 20 21 22 23 00

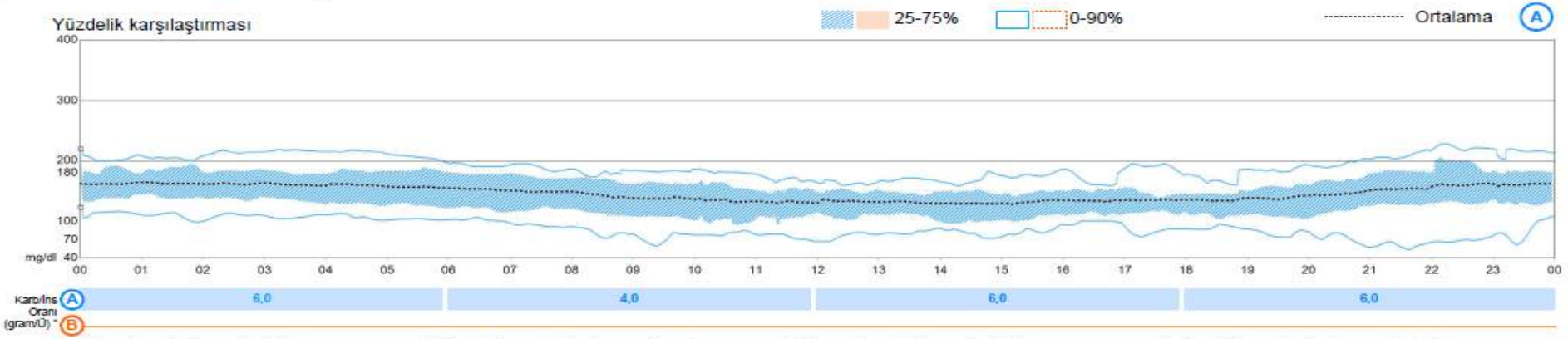
Medtronic

Değerlendirme ve İlerleme
Ⓐ 27.03.2021 - 25.04.2021 (30 Gün)
Ⓑ Mevcut Değil

[redacted]

Oluşturulma Tarihi: 02.05.2021, 15:41 **Sayfa 1 / 22**
Veri Kaynakları: MiniMed 780G, MMT-1886 (NG[redacted])

Yüzdelik karşılaştırması



Karb/İns Oranı (gram/Ü) *	00:00	06:00	12:00	18:00
Ⓐ	6,0	4,0	6,0	6,0
Ⓑ				

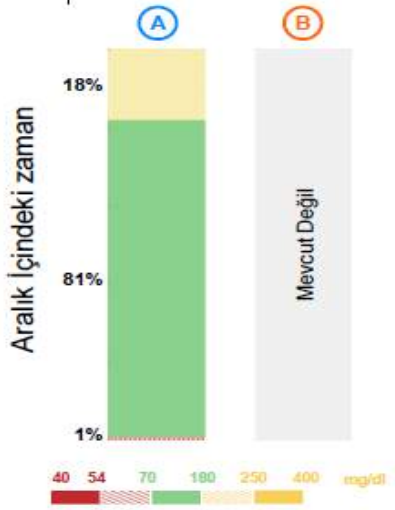
Ⓐ

Hipoglisemi düzenleri (0) — Epizod Sayısı (gün başına): 0

Yok

Hiperglisemi düzenleri (0) — Epizod Sayısı (gün başına): 0,9

Yok



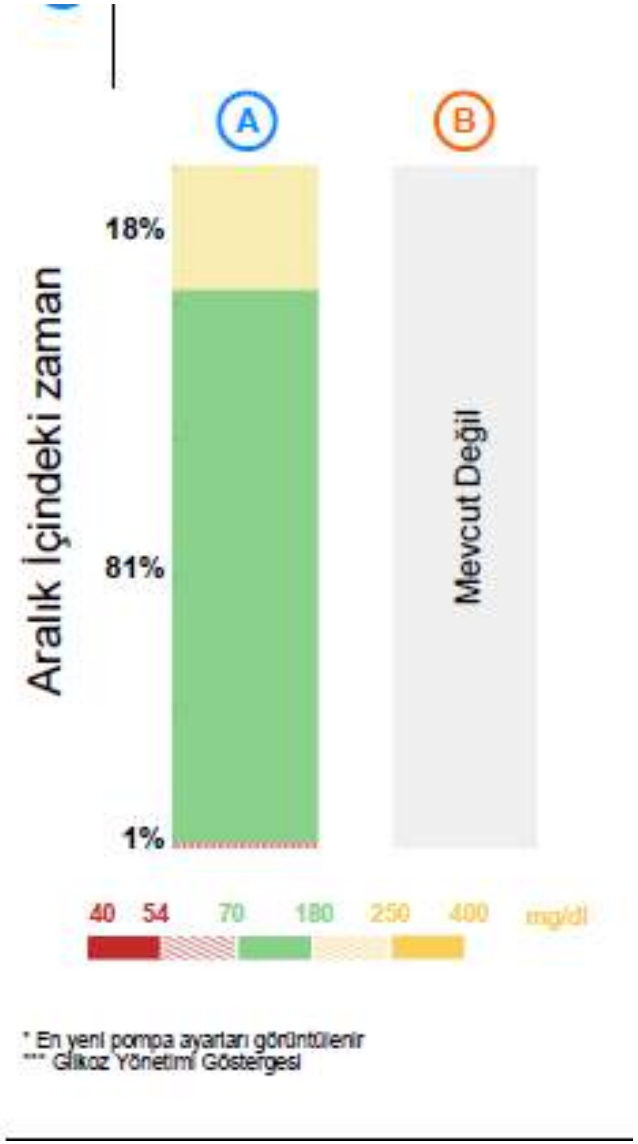
SmartGuard'dan Çıkışlar	Ⓐ	Ⓑ
Kalibrasyon Yok	0	–
SmartGuard maks. iletim	0	–
SmartGuard min. iletim	0	–
SmartGuard için KŞ gerekli	0	–
Sensör Algoritma Değeri Fazla Düşük	0	–
Sensör Güncelleniyor	0	–
SG değeri yok	0	–
Sensör Ömrü Doldu	0	–
SmartGuard Devre Dışı (Kullanıcı Tarafından)	0	–
Uzun Süreli Duraklatma	0	–
SmartGuard Isınması	0	–
Tespit Edilemedi	0	–

İstatistikler	Ⓐ	Ⓑ
SmartGuard (hafta başına)	14% (1g 00sa)	–
Manuel Mod (haftalık)	78% (5g 10sa)	–
Sensör Takma (haftalık)	76% (5g 08sa)	–
Ortalama SG ± SS	146 ± 37 mg/dl	–
GYG***	6,8%	–
Varyasyon Katsayısı (%)	25,6%	–
Düşük/Yüksek SG İkazları	1,1 / 5,1	–
Ortalama KŞ	151 ± 47 mg/dl	–
KŞ / Kalibrasyon (gün başına)	4,0 / 2,5	–
Toplam günlük doz (gün başına)	67,4 ünite	–
Bolus miktarı (gün başına)	23,7Ü (35%)	–
Oto Düzeltme miktarı (günlük)	0,8Ü (3%)	–
Oto Bazal / Bazal miktarı (günlük)	43,7Ü (65%)	–
Set Değişimi	Her 2,6 günde bir	–
Rezervuar Değişimi	Her 2,8 günde bir	–
Yemek (gün başına)	2,0	–
Girilen karb (gün başına)	99 ± 41 gram	–
Aktif İnsülin süresi	2:00 sa	–

* En yeni pompa ayarları görüntülenir
*** Glikoz Yönetimi Göstergesi

Bu rapor, Uluslararası Diyabet Merkezi'nce kullanılan Ayaktan (Ambulatuvar) Glikoz Profili hesaplamaları ile uyumludur.

- VK %25.6 (Hedef <%36)
- GYG %6.8
- Hedefte geçen süre >%70



Zoom meeting, audio only

Zoom meeting with video