Designing Change: Accelerating Automated Insulin Delivery Systems in Practice Using Multifactorial Design

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Background

- Automated insulin delivery (AID) systems offer significant benefits for individuals with T1D, yet their adoption remains suboptimal, especially in vulnerable populations.
- Enhancing AID system uptake involves multiple factors and often necessitates both singular and complex, multi-component interventions.
- Understanding which single or combined interventions best accelerate AID uptake is key to expanding successful approaches across diverse healthcare systems.
- Multifactorial design simultaneously evaluates the effect of >1 independent variable on a single dependent variable. In addition, interactions between independent variables can be explored.

Objective

To employ multifactorial design to identify and evaluate the most effective intervention bundles which successfully improve AID uptake in vulnerable populations.

Methods

A multifactorial design was used to evaluate the impact of single and combined interventions on AID uptake Interventions included no tech list, pump options and care coordination (Fig 1). Uptake rates were compared across intervention groups to identify the most effective strategies and synergistic combinations.

Interventions to Increase AID Uptake – 3 Components utilized for MFD

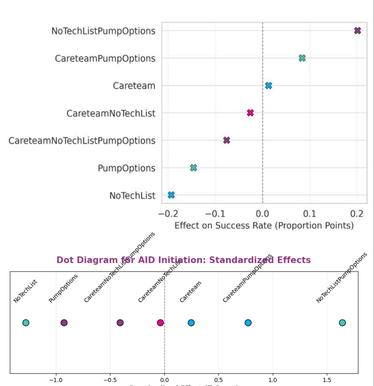
1	2	3	4	5	6
CGM At Diagnosis	CGM Trial Program	AID Video	Pump Options Class	No Tech List	Care Coordination Teams
			☑	☑	☑
Update and standardize diabetes education curriculum to incorporate CGM at new onset	Reduce barriers so it's easier for patients to "try before you buy." Zero cost trial kits of CGMs available for patients in clinic	Connect patients to each other and care options by sharing patient stories	Increase access to classes that review diabetes technology in group or individual setting	EHR driven report of patients not on technology with an upcoming appointment	RN care coordinators skilled at identifying and intervening for patients not on technology (previsit planning)

2^3 Factorial Design Data Table

Care Team	No Tech List	Pump Options	N Patients	AID Initiated	Success Rate
—	—	—	90	41	45.6%
—	—	✓	9	0	0.0%
—	✓	—	35	4	11.4%
✓	—	—	24	13	54.2%
✓	—	✓	1	0	0.0%
✓	✓	—	11	0	0.0%

Factorial Dot Diagram

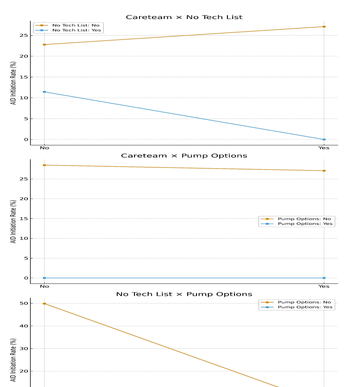
These show how much each factor or combination changes the AID initiation rate



These put all effects on a common scale (mean = 0, SD = 1), useful for comparing relative magnitudes

Factorial Response Plots

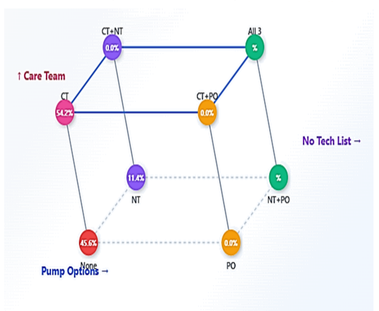
These are interaction plots showing how AID initiation changes depending on the combination of two interventions at a time



Factorial Design Cube$^{(2^3)}$

3D representation showing all 8 treatment combinations. Each vertex shows the AID initiation rate for that combination.

CT = Care Team, NT = No Tech List, PO = Pump Options



Each corner represents 1 treatment combination.
The % shown is the AID initiation rate.
Green indicates highest rates, red indicates lowest.
The 3 dimensions represent the 3 interventions

Traditional Statistical Results

- At baseline, 34% of patients with T1D from 9/1/2024-12/31/2024 (n = 170) initiated AID.
- Statistical analysis using Pearson's correlation and t-tests revealed both the **No Tech** list (r = 0.327, $p < 0.005$) and **Pump Options** (r = 0.270, $p = 0.0004$) were **significantly** associated with increased AID initiation.
- When analyzed independently, pump options alone (r = 0.180, $p = 0.019$) and the No Tech list alone (r = 0.244, p = 0.0014) remained significant predictors.
- Combined interventions, pump options + No Tech list, demonstrated a positive impact (r = 0.189, $p = 0.013$).
- Notably, care team involvement, while essential to patient support, did not yield statistically significant results in isolation

Multifactorial Design Interpretation

- **DOT DIAGRAM** → The strongest *positive* effect came from **No Tech × Pump Options** interaction — suggesting that when both were applied, success rates increased substantially.
- **RESPONSE PLOTS** → **Care team** involvement substantially increases AID initiation. No Tech List alone has limited influence.
- **DESIGN CUBE** → **Care team alone** is the most effective intervention.

Limitations

- Individual-level analysis (n=170) shows strong correlations, while group-level analysis (n=8 combinations) reveals interaction patterns.
- When averaging across groups, you lose individual patient-level variation