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A Novel Modelling Method For Estimating Cost Impact of a Non-Prescriptive Digital Intervention in Type 2 Diabetes

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INTRODUCTION

- Digital healthcare presents a growing opportunity to improve diabetes management.
- A number of digital tools are currently in development for patients with diabetes, including interventions to monitor clinical measures, such as blood pressure and glucose levels, and to support lifestyle changes such as weight loss.[1–5]
- However, the impact of digital interventions on patient outcomes and healthcare costs in diabetes and other conditions is poorly understood, partly due to the heterogeneity of assessed interventions.

OBJECTIVE

- To develop a framework for assessing the cost impact of digital interventions in people with type 2 diabetes (PWD2).

METHODS

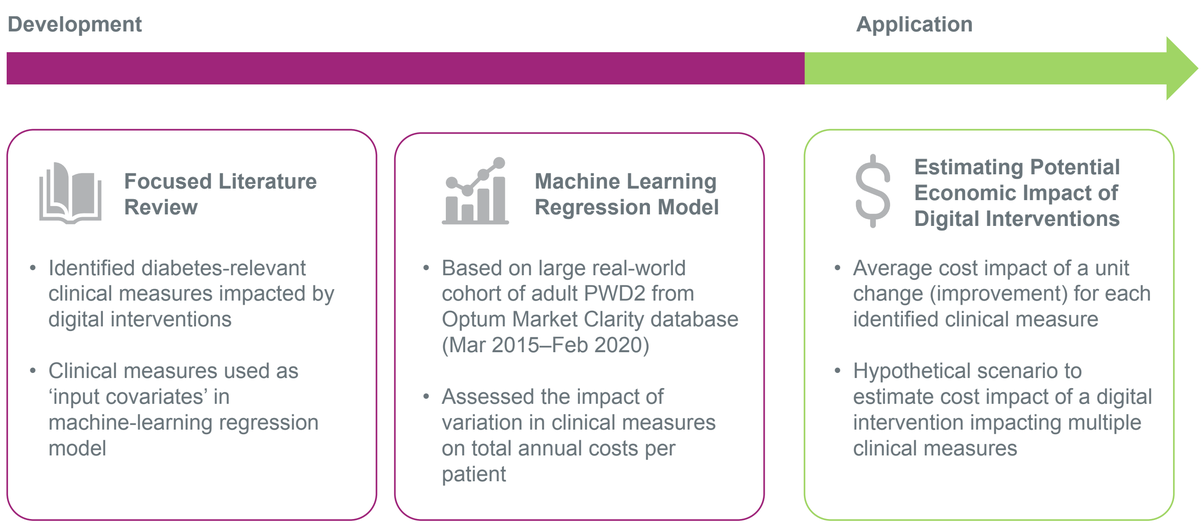
Model framework development

- A model framework was developed to estimate the potential change in total annual costs to the healthcare system for patients receiving digital interventions, based on their predicted effect on diabetes-relevant clinical measures (**Figure 1**).
- The model framework was developed in two key stages:
  - Focused literature review to identify studies assessing the impact of digital interventions on diabetes-relevant clinical measures published between 2011–2021.
  - Machine-learning regression model to assess the impact of variation in identified clinical measures on total annual costs per patient.
- The regression model was based on a large real-world cohort of adult patients with a diagnosis of type 2 diabetes from the Optum® Market Clarity database with 5 years of electronic health record and claims data (March 2015–February 2020).
- Clinical measures identified in the literature review were used as 'input covariates' in the regression model.
- More than 100 covariates were programmed for each patient in the regression model, including input covariates (identified clinical measures) and other potential confounders (eg, age, sex, race, ethnicity).
- For each patient, a central 'index' date was selected; covariates were assessed during the year preindex, and total medical costs during the year postindex.
- The model was used to predict the relationship between input covariates and cost, including relative magnitude of impact per unit change in covariate.

Model framework application

- Estimates for the impact of digital interventions on clinical measures were obtained from the focused literature review and applied to the regression model to estimate the potential economic impact of the interventions.
  - Average cost impact per patient per year was estimated for each intervention type/clinical measure.
  - A hypothetical scenario also was applied to estimate the cost impact of a digital intervention impacting multiple clinical measures.

Figure 1. Model Framework Development and Application



PWD2, patients with type 2 diabetes.

RESULTS

Model framework development

Focused literature review

- Thirty studies were identified that assessed digital interventions and reported a measurable impact on relevant clinical measures.
  - Of these, 11 studies were selected as reporting impacts on relevant quantitative metrics and as being of sufficient methodological quality.[6–16]
- The selected studies addressed 3 main types of digital intervention: health-metric tracking, coaching and education, and telemedicine.
- Five key clinical measures (input covariates) from these studies were selected for inclusion in the final model: glycated hemoglobin (HbA1c), blood glucose, hypoglycemic events, blood pressure, and weight. Associated ranges of impact of digital interventions on these measures are shown in **Table 1**.

Table 1. Covariates and Reported Impact Ranges by Intervention Type

Intervention Type	Selected Covariates	Number of Studies (N=11)[a]	Impact Range Across Studies
Health-metric tracking	HbA1c	2	-0.7% to -8.9% (relative[b])
	Blood glucose	2	-8% to -14%
	Hypoglycemia events	2	-17% to -57%
	Diastolic blood pressure	1	-6.2 mm Hg
Coaching and education	HbA1c	2	-2.3% to -12% (relative[c])
	Weight	2	-7.5%
Telemedicine	HbA1c	1	-2.9%
	Diastolic blood pressure	1	-1.31 mm Hg

[a]Studies are not mutually exclusive (total exceeds 11, as some studies report multiple clinical measures).
[b]Corresponds to ~0.1–0.9% decrease in absolute HbA1c.
[c]Corresponds to ~0.2–1.3% decrease in absolute HbA1c.
HbA1c, glycated hemoglobin.

Machine-learning regression model

- Model coefficients for the effect on total cost of a unit change in each input covariate showed a statistically significant impact for HbA1c, hypoglycemia events, blood glucose, and weight (**Table 2**).
  - For example, for every decrease of 1 unit of HbA1c (%), the model estimated a patient's total annual cost will reduce by 5.02%.
  - Impact of diastolic blood pressure on cost was not statistically significant.

Table 2. Model Coefficients for Input Covariates

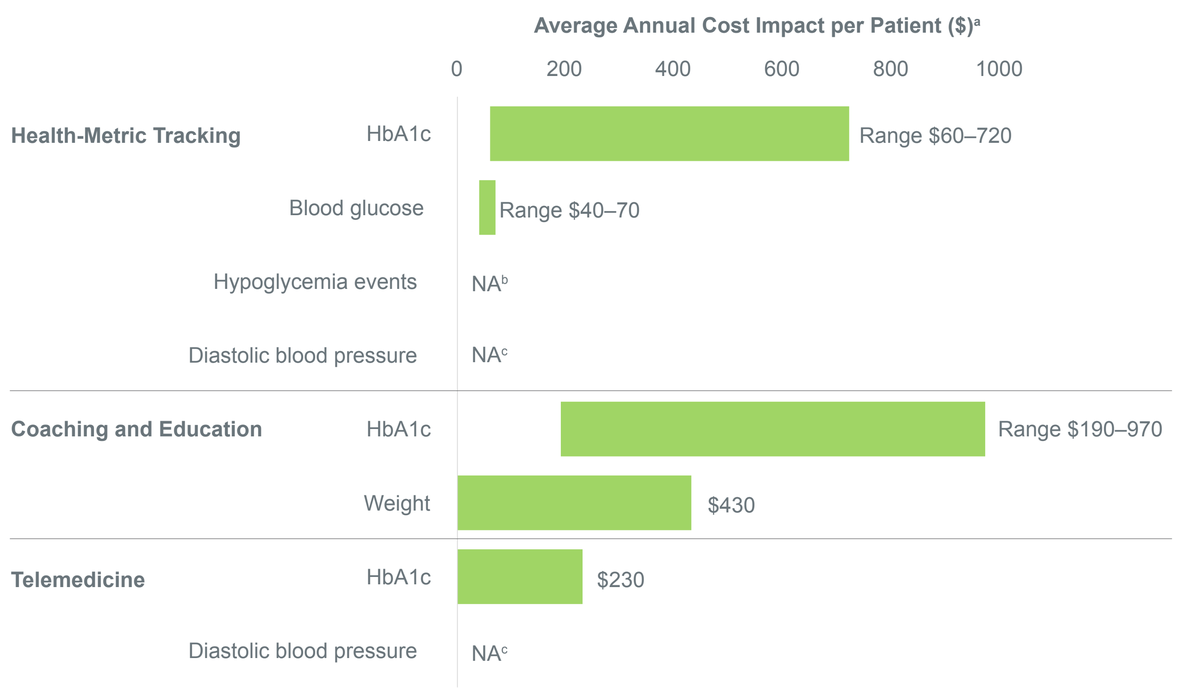
Input Covariate	Unit[a]	Coefficient (Change in Total Annual Cost per Patient, per Change in Covariate Unit), %
HbA1c (%)	%	5.02*
Hypoglycemia events[b]	N	1.01*
Blood glucose	mM/L	0.78*
Weight	kg	0.27*
Diastolic blood pressure	mm Hg	0.04

[a]Model coefficients are applicable to the specified unit for that covariate.
[b]Impact in subpopulation of patients with ≥1 hypoglycemic event.
*$P \leq 0.05$.
HbA1c, glycated hemoglobin.

Model framework application

- Based on impact ranges reported in the literature for each clinical measure (**Table 1**) applied to the regression model, average cost reductions of up to $970 per patient per year were estimated for changes in individual clinical measures (**Figure 2**).

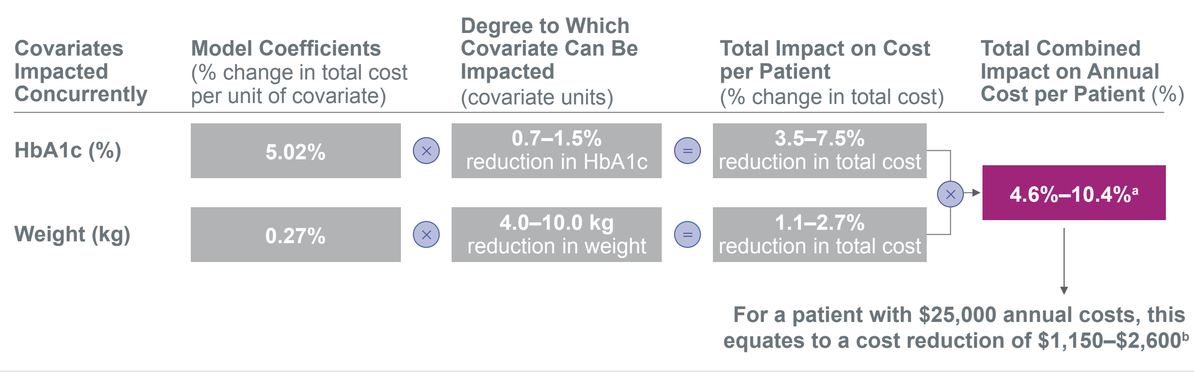
Figure 2. Average Annual Cost Impact per Patient by Intervention Type/Clinical Measure



[a]Average annual cost impact = estimated impact on covariate per literature (eg, 7.5% weight loss) x patient covariate preindex (eg, weight 86 kg) x covariate coefficient (eg, weight 0.27%) x patient total annual cost during postindex period ($).
[b]Values recorded for only subpopulation with ≥1 hypoglycemic events.
[c]Model coefficient was not statistically significant.
HbA1c, glycated hemoglobin; NA, not applicable.

- Combining the impact of multiple covariates in the hypothetical scenario shown in **Figure 3**, estimated cost savings ranged $1,150–$2,600 for a digital intervention that reduced HbA1c by 0.7–1.5% and weight by 4–10 kg, for a patient currently incurring healthcare costs of $25,000 per annum.

Figure 3. Estimated Cost Impact With a Hypothetical Digital Intervention Targeting HbA1c and Weight



Impact estimates were additive without further adjustment for covariance.
[a]Lower bound calculated as 1.035 x 1.011 = 1.046; upper bound calculated as 1.075 x 1.027 = 1.104.
[b]Lower bound calculated as $25,000 x 0.046 = $1,150; upper bound calculated as $25,000 x 0.104 = $2,600.
HbA1c, glycated hemoglobin.

LIMITATIONS

- The regression model was based on real-world data, and misclassified/inaccurate data entries are possible; generalisability may be limited to populations represented in the database, and causality cannot be conclusively inferred.
- Owing to heterogeneity in the identified studies, the estimates of cost impact of clinical measure variation are relatively wide.
- The clinical measure variation estimates are applied uniformly across the cohort; real-world variation is likely to change within subgroups or depending on the baseline clinical measure value.
- Furthermore, model estimates did not account for changes in treatments received during ongoing digital interventions, which could have influenced the observed effect.

CONCLUSIONS

- Our model framework provides guidance on linking clinical impacts of digital interventions to real-world healthcare costs.
- Initial analyses suggested that selected interventions have the potential to drive meaningful change in patient costs.
- This proof-of-concept model framework is modifiable and can be further developed for a more clinically robust and accurate cost assessment of digital intervention in diabetes patients, with potential application in other disease areas.

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DISCLOSURES
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