

# Cost Effectiveness Analysis of Colorectal Cancer Screening Cessation in a Population of Patients with Chronic Illnesses

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# The optimal stop age for colon cancer depends on many factors

- Some colorectal cancer (CRC) screening guidelines recommend a fixed age to stop screening, while others recommend assessment of health status to determine if continuing screening would be beneficial.
- Ideally, the stop age for screening would be based on careful consideration of multiple factors: an individual's risk of CRC morbidity and mortality, life expectancy, likelihood of adverse events from screening, and past screening results.
  - This is especially difficult for patients with chronic conditions such as diabetes and cardiovascular disease.

**Cost-effectiveness analysis can be used to determine optimal colorectal cancer screening strategies in populations with chronic illnesses.**

# Relationships between colorectal cancer and chronic illnesses are complex

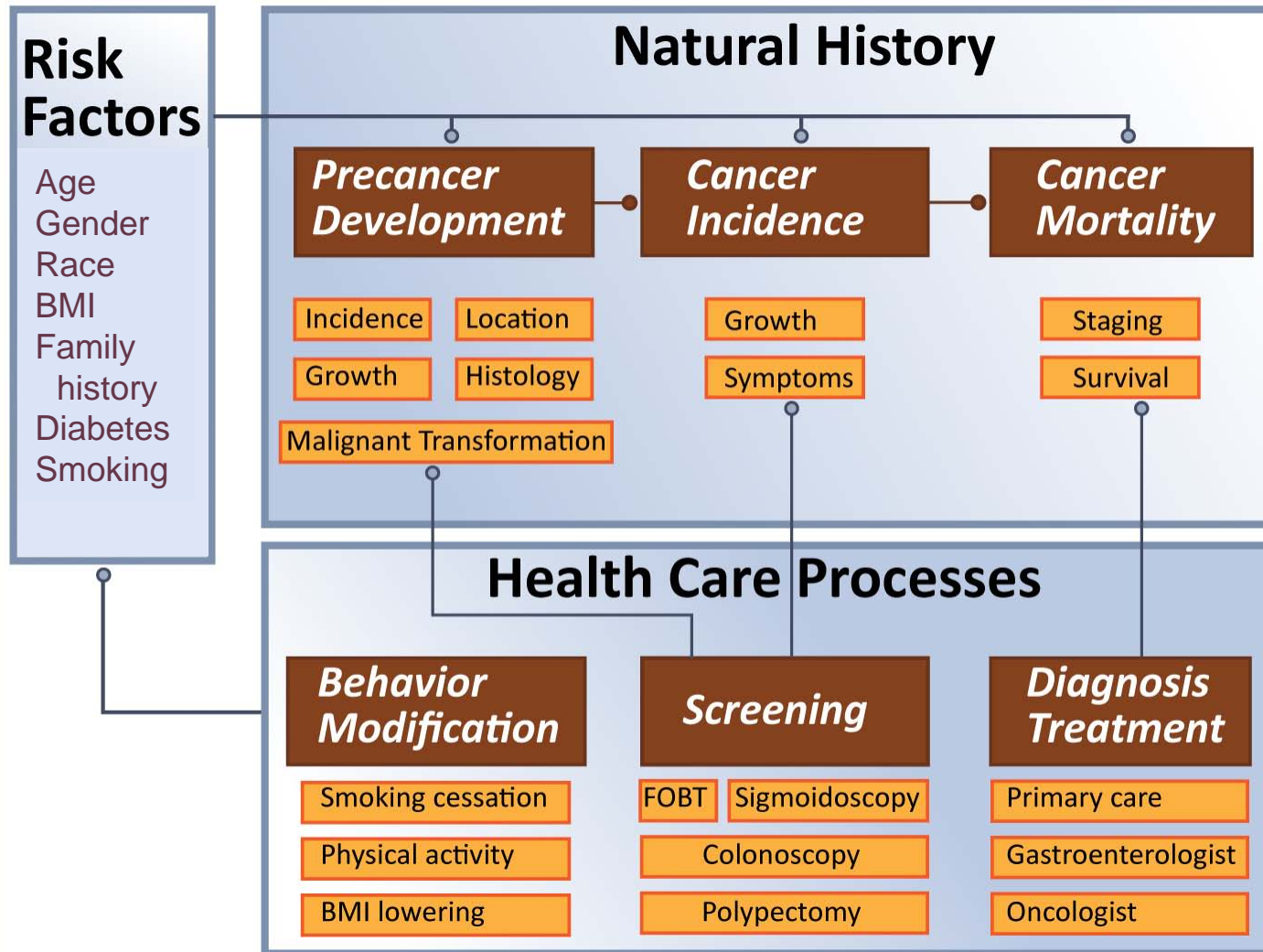
- Chronic illnesses and CRC share many common risk factors
  - Including age, gender, race/ethnicity, obesity, diet, smoking, and others.
- Diabetic patients are at increased risk of developing colorectal adenoma (Elwing *et al.*, 2006) and being diagnosed with colorectal cancer (Coughlin *et al.*, 2004; Larsson *et al.*, 2005; Will *et al.*, 1998).
- A person who has diabetes and/or cardiovascular disease may not only have a shorter life expectancy but may also have a higher risk of colorectal cancer.
- Advanced age and the presence of chronic illnesses increase the risk of adverse events related to screening by colonoscopy (Gatto *et al.*, 2003; Warren *et al.*, 2009).

**Therefore, a screening recommendation using life expectancy and cancer risk estimates for the general population is not accurate.**

# Methods

- We used the Archimedes Model to analyze the cost-effectiveness of different stop ages for CRC screening in people with and without diabetes or cardiovascular diseases.
- The Archimedes Model is a large-scale simulation of human physiology, diseases, interventions, and health care systems. The Model includes descriptions of diabetes, congestive heart failure, coronary artery disease, stroke, hypertension, obesity, in addition to breast, lung, and colorectal cancers.
- The colorectal cancer component of the Archimedes Model was developed in collaboration with the American Cancer Society and was built from large scale databases such as CORI and SEER, as well as meta-analyses of the literature. The model has been validated against a large number of studies including Cancer Prevention Study II.

# Structure of Colorectal Cancer Model



# Population in the study

- A cross-section of the US population, aged 50 years old at the start of the simulation.
- Subpopulations (at the start of the simulation):
  1. Individuals without diabetes
  2. Individuals with diabetes, without hypertension
  3. Individuals with diabetes and hypertension

# Screening strategies

1. **No screening**
2. **Stop age 50:** screened by colonoscopy once, at age 50
3. **Stop age 60:** screened by colonoscopy twice, at ages 50 and 60
4. **Stop age 70:** screened by colonoscopy at 10-year intervals, starting at age 50, and stopping after age 70
5. **Stop age 80:** screened by colonoscopy at 10-year intervals, starting at age 50, and stopping after age 80
6. **No stop age:** screened by colonoscopy starting at age 50, at 10-year intervals, until death

In this study, we only considered screening by colonoscopy.

# Outcomes measured

Category	Outcome variable
<i>Disease-specific measures</i>	Colorectal cancer incidence
	Colorectal cancer death
	Number of colonoscopies
<i>Global outcome measures</i>	Deaths
	Life years
	Quality-adjusted life years (QALYs)
	Costs of CRC screening and surveillance
	Costs of CRC treatment
	Costs related to CRC (screening, surveillance, and treatment)
	Other costs (e.g. diabetes, CVD)
	Total medical costs
	Cost per QALY saved

*All costs and QALYs are discounted 3% annually*



# Colonoscopy screening reduces the incidence of CRC and increases life expectancy in diabetics

Patients diagnosed with diabetes at age 50 and without hypertension

<b>Screening Strategy</b>	<b>Reduction in CRC compared to no screening (%)</b>	<b>Life years saved compared to no screening</b>
<i>No Screening</i>	0	0
<i>Stop at age 50</i>	51	0.145
<i>60</i>	67	0.178
<i>70</i>	76	0.192
<i>80</i>	79	0.195
<i>No stop age</i>	80	0.196

# Colonoscopy screening potentially reduces costs related to CRC

Patients diagnosed with diabetes at age 50 and without hypertension

Screening Strategy	Cost of CRC Treatment	Cost of CRC Screening	Total Cost associated with CRC	Difference in total cost associated with CRC, compared to no screening
<i>No Screening</i>	\$ 2437	0	\$ 2437	0
<i>Stop age: 50 (once at age 50)</i>	\$ 1170	\$ 1167	\$ 2337	\$ -99
<i>Stop age: 80</i>	\$ 715	\$ 2076	\$ 2791	\$ 354

Patients without diabetes at age 50

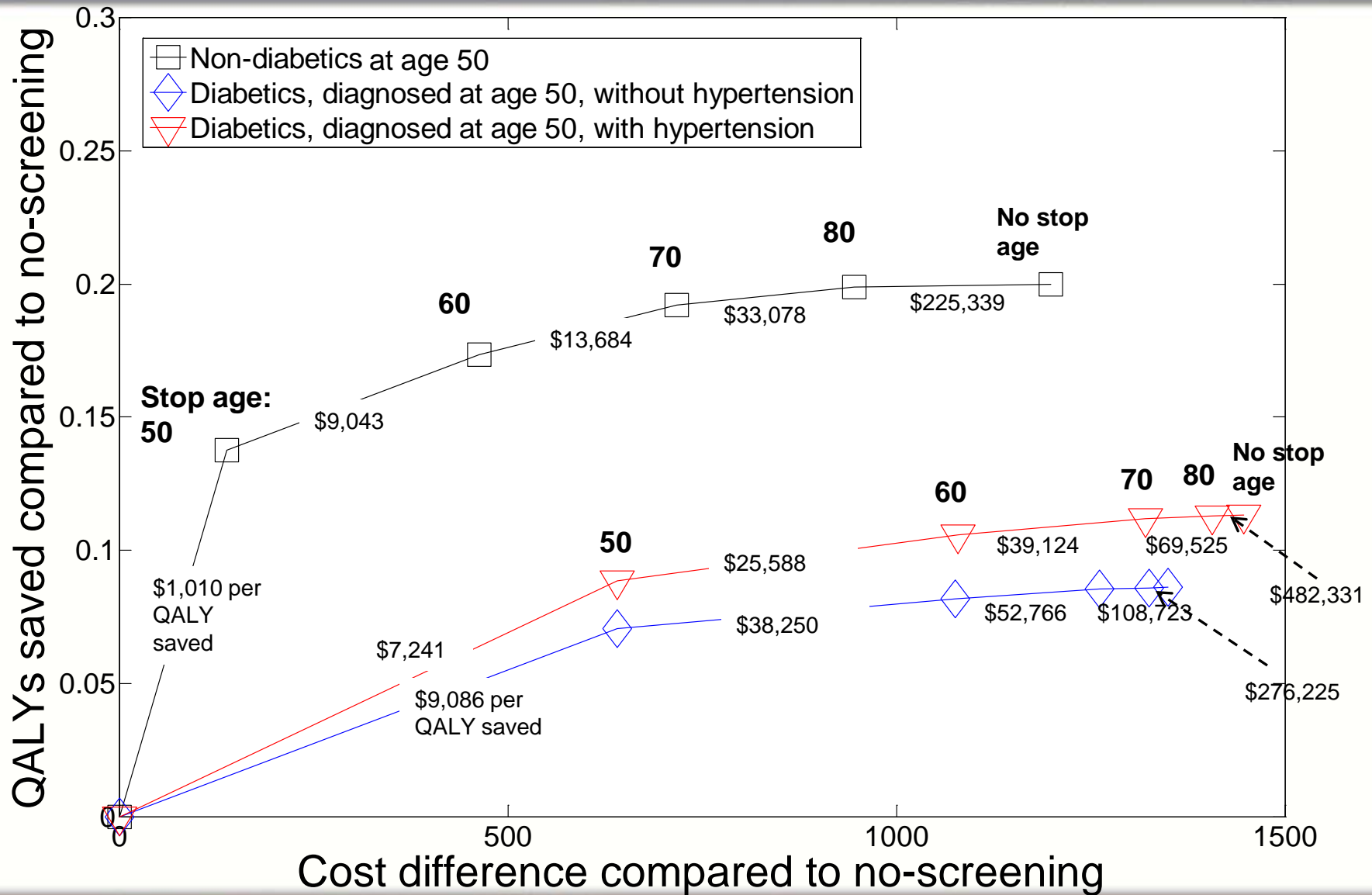
Screening Strategy	Difference in total cost associated with CRC, compared to no screening
<i>Stop age: 50 (once at age 50)</i>	\$ -511
<i>Stop age: 80</i>	\$ -93

# Older stop ages increase total medical costs

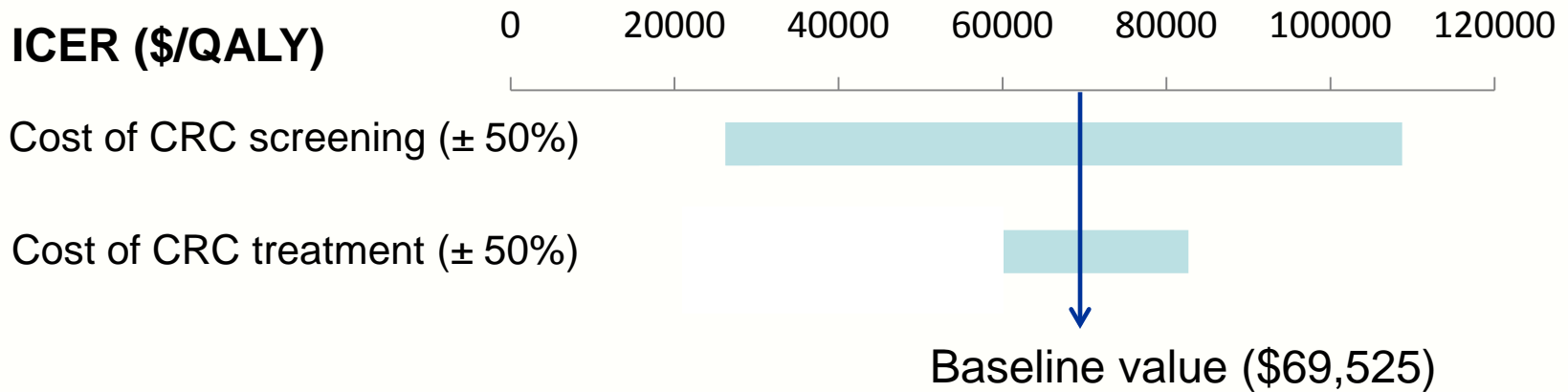
Patients diagnosed with diabetes at age 50 and without hypertension

Screening Strategy	Total cost associated with CRC	Total cost associated with other diseases (mostly CVD and diabetes)	Total medical cost	Difference in total medical cost compared to no screening
<b>No Screening</b>	\$ 2437	\$ 130410	\$ 132847	<b>0</b>
<b>Stop age: 50</b> (screened once at age 50)	\$ 2337	\$ 131151	\$ 133488	<b>\$ 641</b>
<b>Stop age : 80</b>	\$ 2791	\$ 131462	\$ 134253	<b>\$ 1406</b>

# QALY vs. Cost



# Incremental cost-effectiveness ratio is sensitive to costs of CRC screening and costs of CRC treatment



## ICER for stop age 80

Population: patients diagnosed with diabetes at age 50, without hypertension

# Conclusion

- Using \$50,000 per QALY as the threshold for cost-effectiveness
  - It is cost-effective to screen patients without **diabetes at age 50** for colorectal cancer using colonoscopy, starting at age 50 at 10-year intervals **up to age 80**.
  - It is cost-effective to screen patients **diagnosed with diabetes at age 50, without hypertension, up to age 70**.
  - It is borderline cost-effective to screen patients **diagnosed with diabetes at age 50, and with hypertension up to age 70**.

# Implications: In the future, colorectal cancer screening recommendations can be individualized

- Consider patient A
  - age 78, male, no family history of CRC
  - BMI = 25, normal blood pressure, no diabetes
  - at ages 52 and 67, he had two colonoscopies which found no adenoma

Screening Option	Reduction in risk of developing CRC compared to do nothing	Life years saved compared to do nothing	Risk of adverse events due to screening	ICER (\$ per QALY saved) compared with no screening
<i>Do nothing (no more screening)</i>	0	0	0	<b>0</b>
<i>Screened once more at age 78</i>	49%	0.0681	0.0028	<b>\$ 7,319</b>

# Implications: In the future, colorectal cancer screening recommendations can be individualized

- Consider patient B
  - age 70, male, no family history of CRC
  - BMI = 34, diagnosed with diabetes at age 42, with hypertension
  - at 59, he had a colonoscopy which found no adenoma.

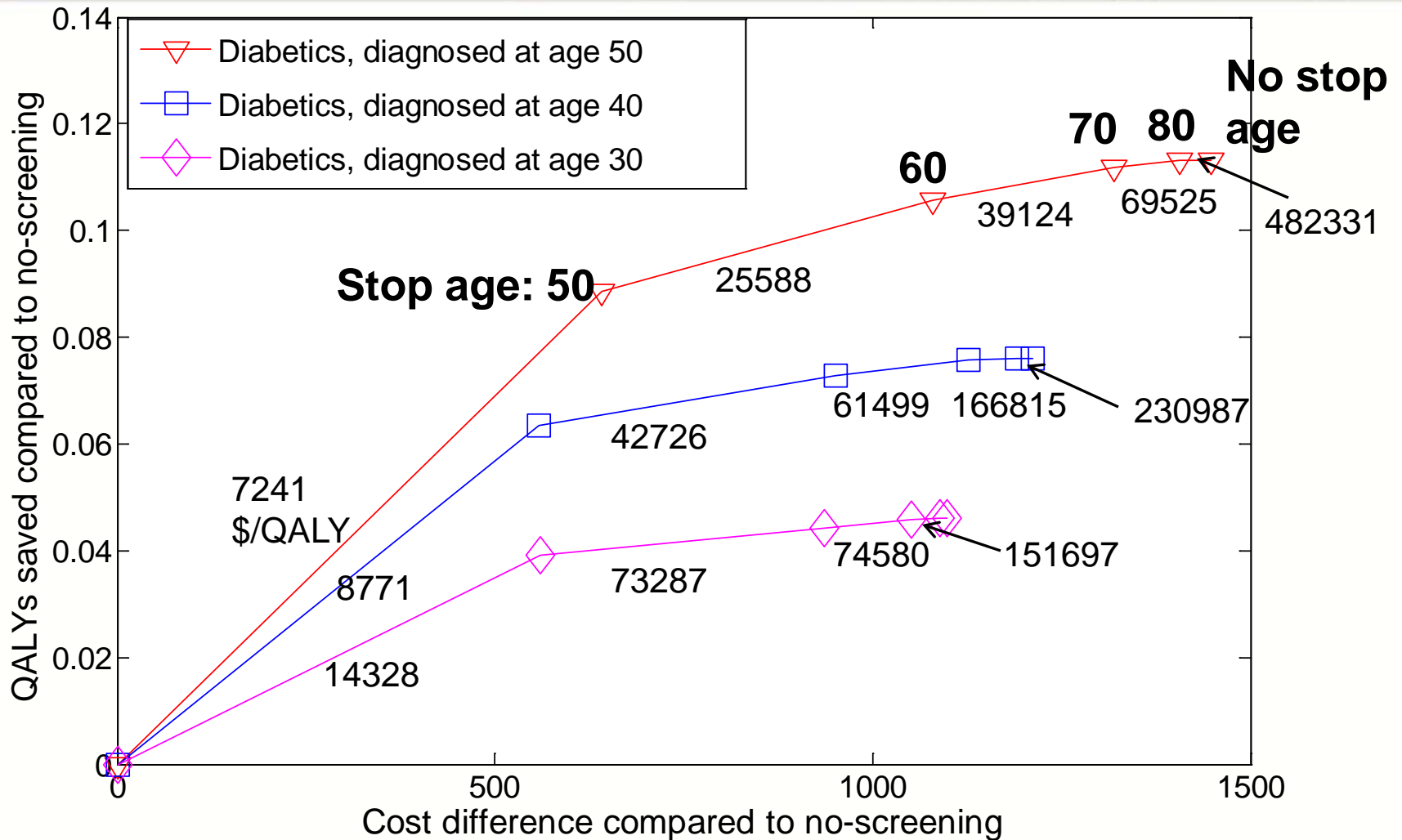
Screening Option	Reduction in risk of developing CRC compared to do nothing	Life years saved compared to do nothing	Risk of adverse events due to screening	ICER (\$ per QALY saved) compared with no screening
<i>Do nothing (no more screening)</i>	0	0	0	<b>0</b>
<i>Screened once more at age 70</i>	24%	0.0066	0.0015	<b>\$ 115,979</b>



# References

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# Cost vs. QALYs for diabetic populations of different durations of diabetes



Incremental cost effectiveness ratio (ICER) for CRC screening up to age 70 in diabetic populations is < \$50,000 per QALY