

Health Card Retrieval for Consumer Health Search

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Consumer Health Search (CHS)

- CHS: **people searching for health advice online.**
 - 59% of U.S. adults has searched online for health information [Fox & Duggan, 2013].
 - 7% of Google searches are health related ~ 70,000 health queries/minute [Murphy, 2019].
- Search results strongly **bias people's** health decisions [Pogacar, 2017; White, 2009].
- People **struggle to understand** health search results and **fail to make correct health decisions** [Alpay, 2009; Kobayashi & Ishizaki, 2019].
- 59% of self-diagnosers decided **NOT to confirm their condition with a health professional** [Fox & Duggan, 2013].

Benefits of Health Card for CHS

- Entity cards have been used by commercial search engines to present **coherent, easy to understand and trustworthy** information

(Radlinski, 2015).

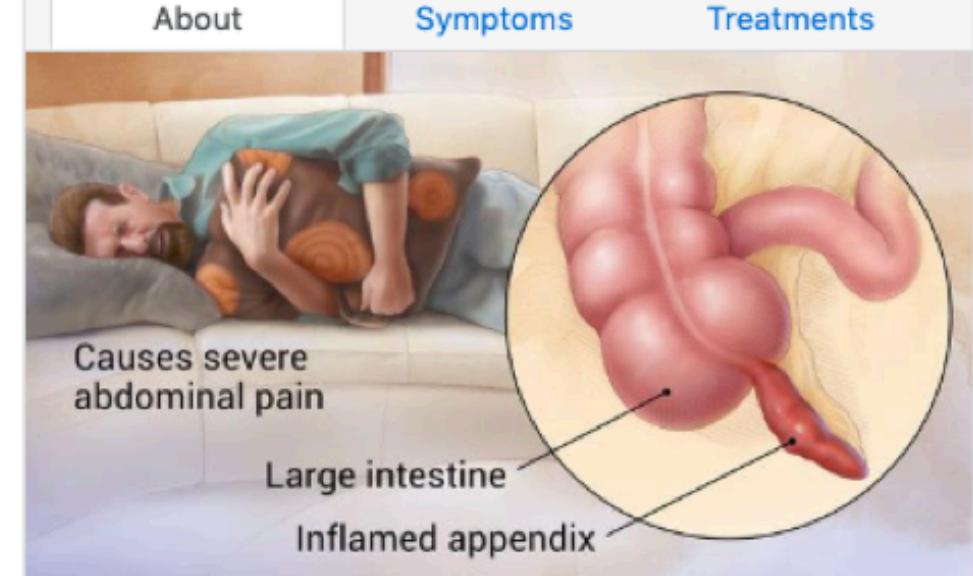
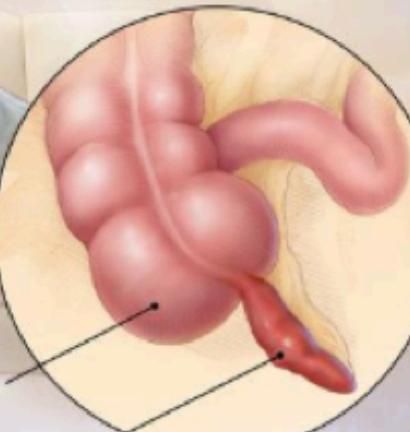
- The appearance of a health card is triggered by queries **that contain a health condition name or its aliases.**

- Health cards** significantly **increases** the number of **correct diagnosis** [Jimmy et al., 2019].

A screenshot of a search results page from a web browser. The search query is "child stomach ache vomiting diarrhea temperature". The results show several cards for different health conditions:

- Why Is My Child Throwing Up With No Fever? Nausea and ...**
About 1,750,000 results
<https://www.webmd.com/children/guide/child-throw-up-no-fever>
Usually, your child will also have nausea, watery diarrhea, and stomach pain. It's possible for food poisoning to cause fever, but it's common for it to cause throwing up with no fever, too.
- Diarrhea, Fever, Nausea or vomiting and Stomach cramps ...**
<https://symptomchecker.webmd.com/multiple-symptoms?symptoms=diarrhea%7Cfever%7Cnausea-or-vomiting%7Cstomach-cramps>
Diarrhea, Fever, Nausea or vomiting and Stomach cramps. WebMD Symptom Checker helps you find the most common medical conditions indicated by the symptoms diarrhea, fever, nausea or vomiting and stomach cramps including Gastroenteritis, Food poisoning, and Irritable bowel syndrome.
- What are the Causes of Stomach Ache and Fever?**
<https://www.wisegeek.com/what-are-the-causes-of-stomach-ache-and-fever.htm>
When a person has a stomach ache and fever, one of the most likely causes of his symptoms is a stomach flu. Despite the misleading name, this condition is not related to influenza, but is caused by a virus that leads to such symptoms as pain, fever, diarrhea, nausea, and vomiting.
- Viral Gastroenteritis (Stomach Flu): Symptoms and Treatment**
<https://www.healthline.com/health/viral-gastroenteritis>
Symptoms can last from 1 to 10 days, including diarrhea, vomiting, and fever. Here are some self-care tips and home remedies for relief. Viral gastroenteritis, also known as the stomach flu, is an ...
- Norovirus | Symptoms | CDC**
<https://www.cdc.gov/norovirus/about/symptoms.html>
It's probably norovirus, a common virus that is not related to the flu. Norovirus is the most common cause of foodborne diarrhea and vomiting. Norovirus causes inflammation of the stomach or intestines. This is called acute gastroenteritis. A person usually develops symptoms 12 to 48 hours after ...
- Child Vomiting | Ask Dr Sears**
<https://www.askdrsears.com/topics/health-concerns/childhood-illnesses/vomiting>
This is a virus that causes sudden onset of vomiting, high fever and stomach pain. Diarrhea usually begins during the first or second day. The length of vomiting varies from the "12 hour flu" to the dreaded "72 hour flu." There is no blood or stool test to diagnose this.
- Diarrhea, Fever and Stomach cramps: Common Related ... - WebMD**
<https://symptomchecker.webmd.com/multiple-symptoms?symptoms=diarrhea%7Cfever%7Cstomach-cramps&sympto...>
Food poisoning can cause abdominal pain, diarrhea, nausea, vomiting, fever, chills, and weakness. Traveler's diarrhea. Traveler's diarrhea causes watery diarrhea and cramps, sometimes with a low-grade fever. Diverticulosis. Diverticulosis is a condition of the colon and causes pain, cramping, infection, bleeding, and other symptoms. Drug overdose

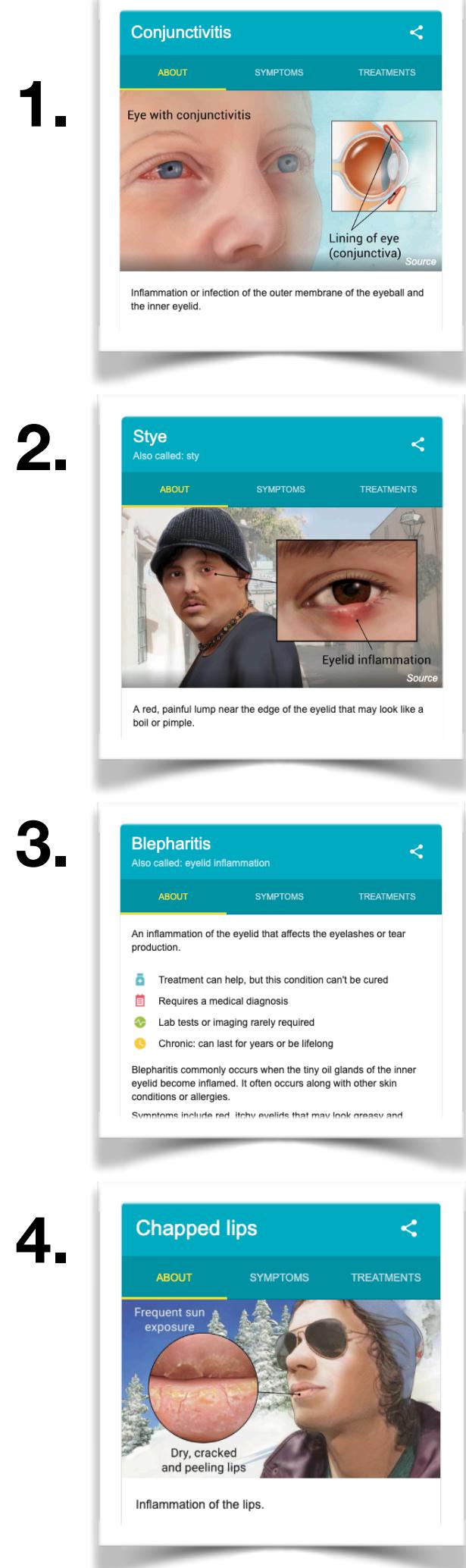
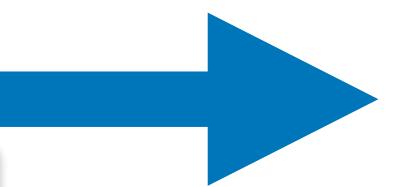
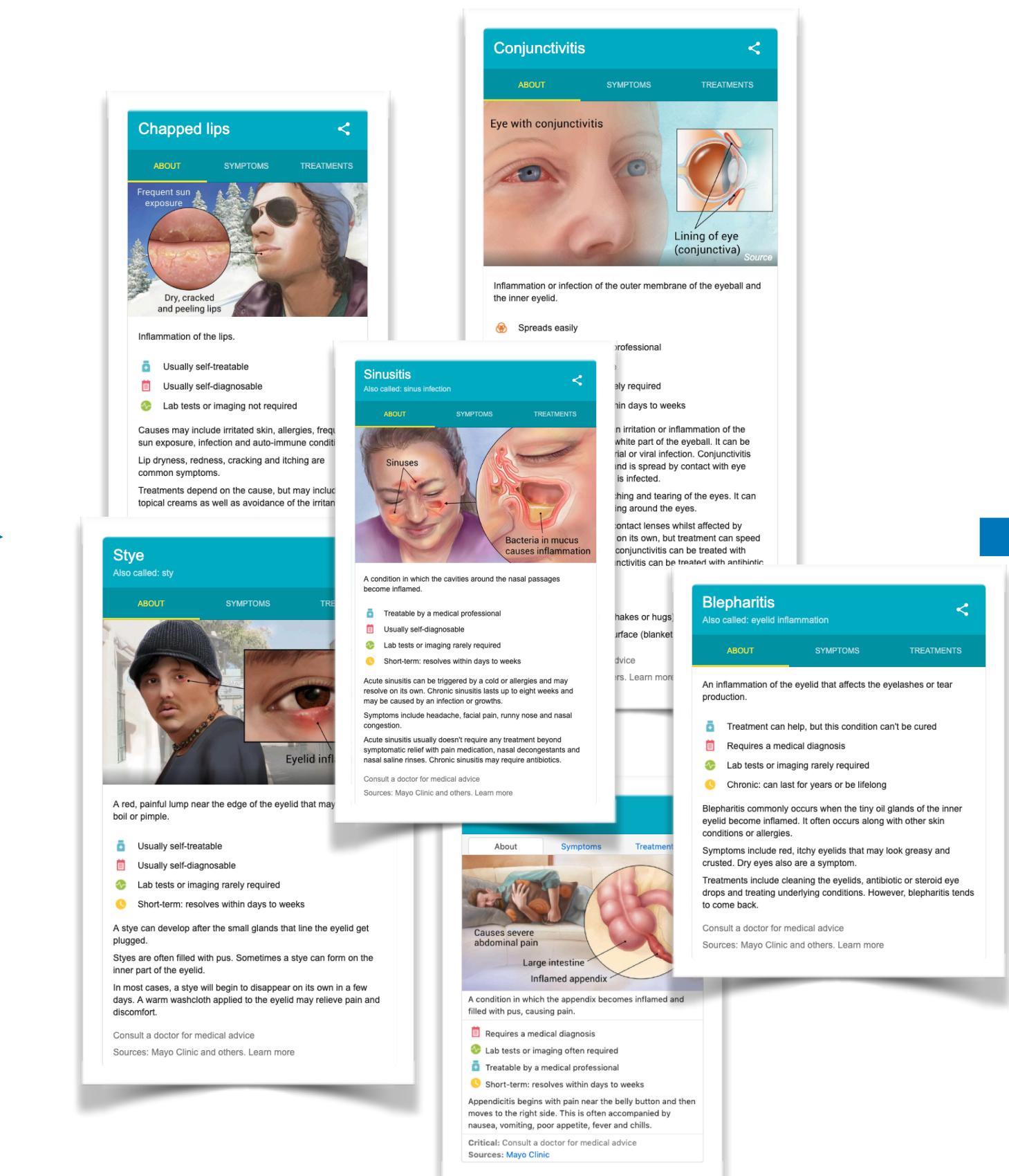
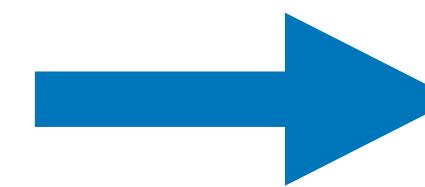
A screenshot of a detailed health card for Appendicitis. The card includes:

- Appendicitis** (Section title)
- About**, **Symptoms**, **Treatments** (Navigation tabs)
- 
- Causes severe abdominal pain** (Text)
- 
- Large intestine** (Label)
- Inflamed appendix** (Label)
- A condition in which the appendix becomes inflamed and filled with pus, causing pain.** (Text)
- Requires a medical diagnosis** (Icon)
- Lab tests or imaging often required** (Icon)
- Treatable by a medical professional** (Icon)
- Short-term: resolves within days to weeks** (Icon)
- Appendicitis begins with pain near the belly button and then moves to the right side. This is often accompanied by nausea, vomiting, poor appetite, fever and chills.** (Text)
- Critical: Consult a doctor for medical advice** (Text)
- Sources: Mayo Clinic** (Text)

Research Question

How effective are current retrieval models in ranking health cards based on their relevance to a person's health query?

swollen tender pink eye 



Current Practice in Health Entity Retrieval

Current commercial search engines present health entity cards for '**navigational queries**' that **target a specific health condition**.

The diagram illustrates the current practice of health entity retrieval. On the left, a search bar contains the query "Meningitis". A red arrow points from this search bar to a detailed health entity card on the right. The card has a teal header with the title "Meningitis" and three tabs: "ABOUT", "SYMPTOMS", and "TREATMENTS". The "ABOUT" tab is selected. It features a central image of a human head showing the brain and spinal cord, with labels for "Brain", "Spinal cord", and "Skull". An inset image shows a cross-section of the brain and spinal cord membranes. Below the image, the definition of meningitis is provided: "Inflammation of brain and spinal cord membranes, typically caused by an infection." A list of characteristics follows: Some types preventable by vaccine, Treatable by a medical professional, Spreads by airborne droplets, Requires a medical diagnosis, Lab tests or imaging always required, Short-term: resolves within days to weeks, and Critical: needs emergency care. Further details include: Meningitis is usually caused by a viral infection but can also be bacterial or fungal. Vaccines can prevent some forms of meningitis. Symptoms include headache, fever and stiff neck. Depending on the cause, meningitis may get better on its own or it can be life-threatening, requiring urgent antibiotic treatment. The section "How it spreads" notes that it spreads by airborne respiratory droplets (coughs or sneezes). A call to action "Consult a doctor for medical advice" and a source note "Sources: Mayo Clinic and others. Learn more" are at the bottom.

Symptoms Based Retrieval

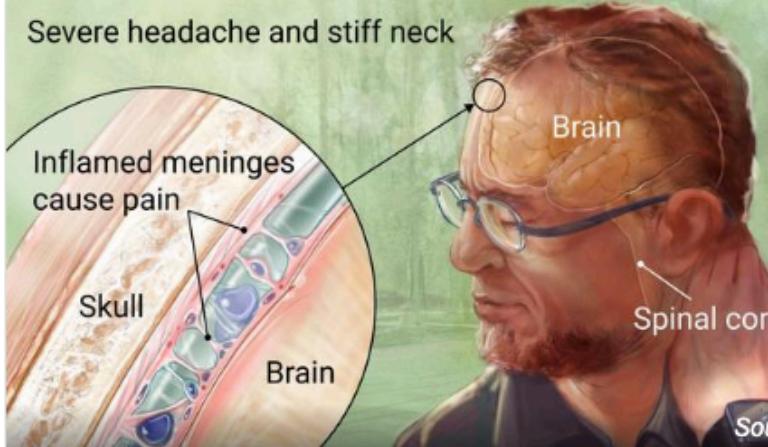
We are **the first to consider** methods in retrieving health entities given a **symptom based query**.

headache fever light sensitivity neck stiffness 



Meningitis

ABOUT SYMPTOMS TREATMENTS



Severe headache and stiff neck

Inflamed meninges cause pain

Brain

Skull

Brain

Spinal cord

Source

Inflammation of brain and spinal cord membranes, typically caused by an infection.

- Some types preventable by vaccine
- Treatable by a medical professional
- Spreads by airborne droplets
- Requires a medical diagnosis
- Lab tests or imaging always required
- Short-term: resolves within days to weeks
- Critical: needs emergency care

Meningitis is usually caused by a viral infection but can also be bacterial or fungal. Vaccines can prevent some forms of meningitis.

Symptoms include headache, fever and stiff neck.

Depending on the cause, meningitis may get better on its own or it can be life-threatening, requiring urgent antibiotic treatment.

How it spreads

By airborne respiratory droplets (coughs or sneezes).

Consult a doctor for medical advice

Sources: Mayo Clinic and others. Learn more

Evaluated Retrieval Methods

We empirically evaluate four general entity retrieval methods adapted to the problem of ranking health cards:

- BM25F
- Fielded Sequential Dependence Model (FSDM)
- Mixture Language Model (MLM)
- Learning to Rank (LeToR)

Methodology

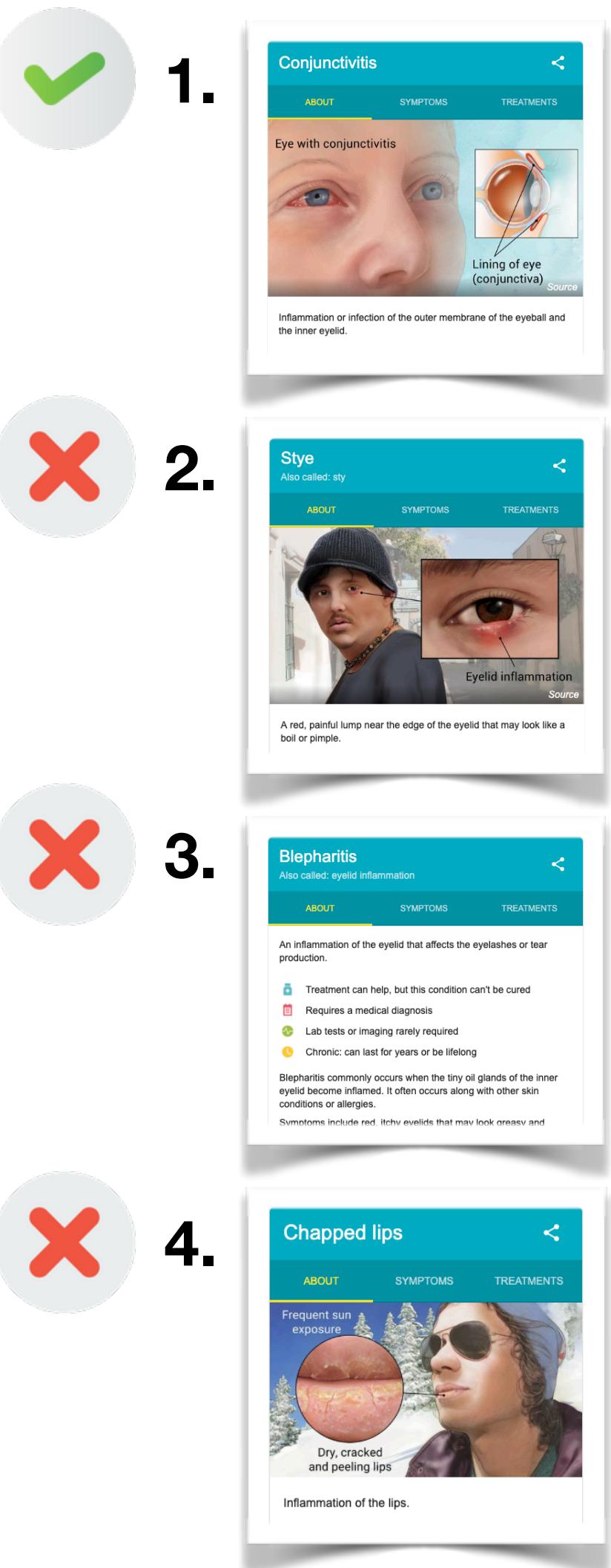
- **Health scenarios**
 - We use **41 self-diagnostic health scenarios** [Semigran et al., 2015].
- **Queries**
 - We **collect queries from Amazon Mechanical Turk** workers by asking them to search to make self-diagnosis for a health scenario.
 - For **quality control**, we pay \$0.2 (USD) for completing a task with a **bonus** of \$0.5 for a correct diagnosis.
 - Worker selection: released 12 tasks to select **good workers** to work on the remaining tasks.

Methodology: Health Card Collection

- We **crawl** pages within the “Diseases and Conditions” sections from **Mayo Clinic**.
- We **collect 1,142 health cards**. We found this is **comparable to Bing’s** health cards count: 1,330 health cards.
- Each **health card contains fielded information**, including: name, aliases, overview, symptoms, and treatments.
- We make our topic, queries and health card **collection publicly available** for other researchers to use.

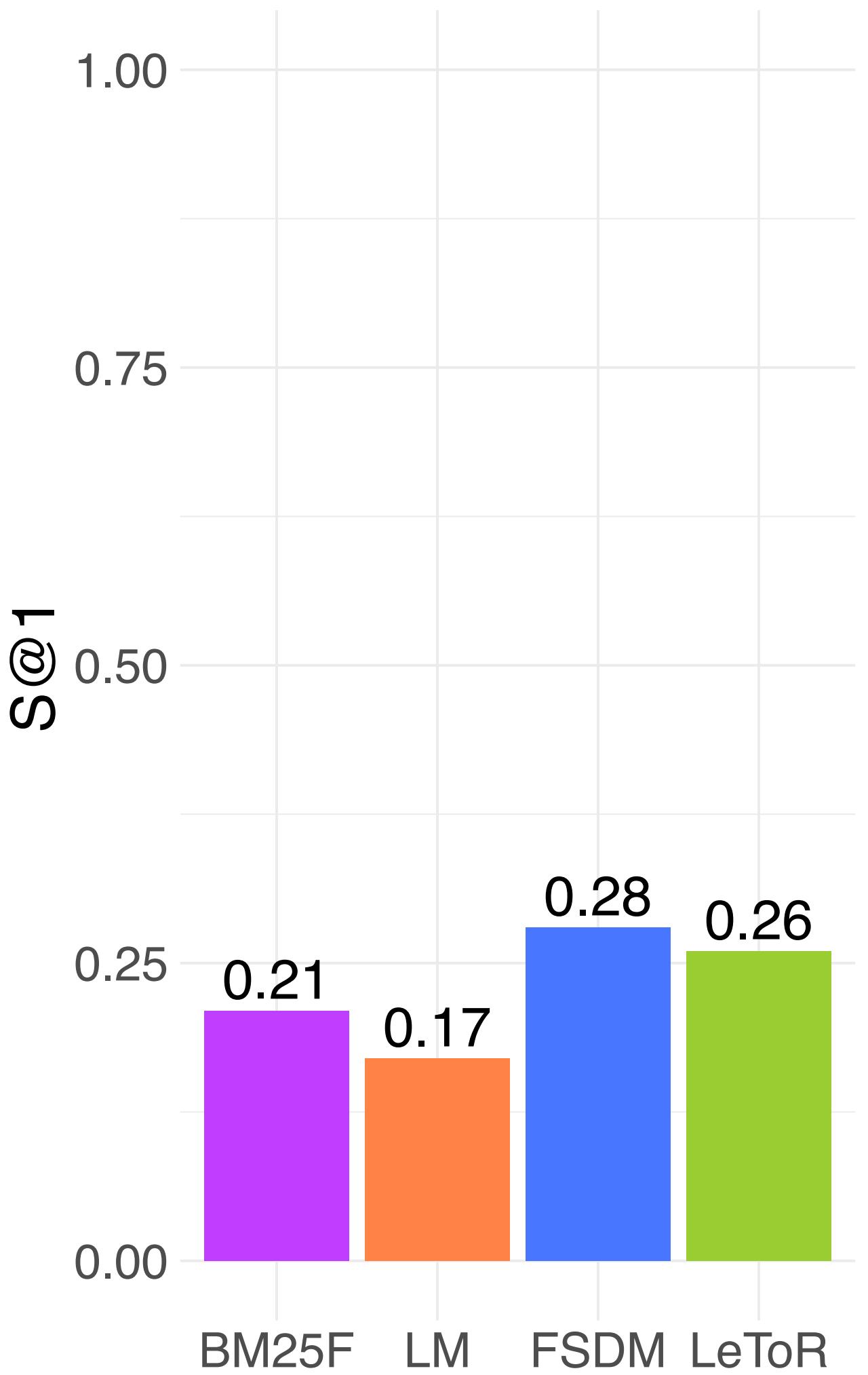
Evaluation

- One correct health card for each task.
- Success at rank 1 (S@1): how many times the correct health card is retrieved at rank 1?



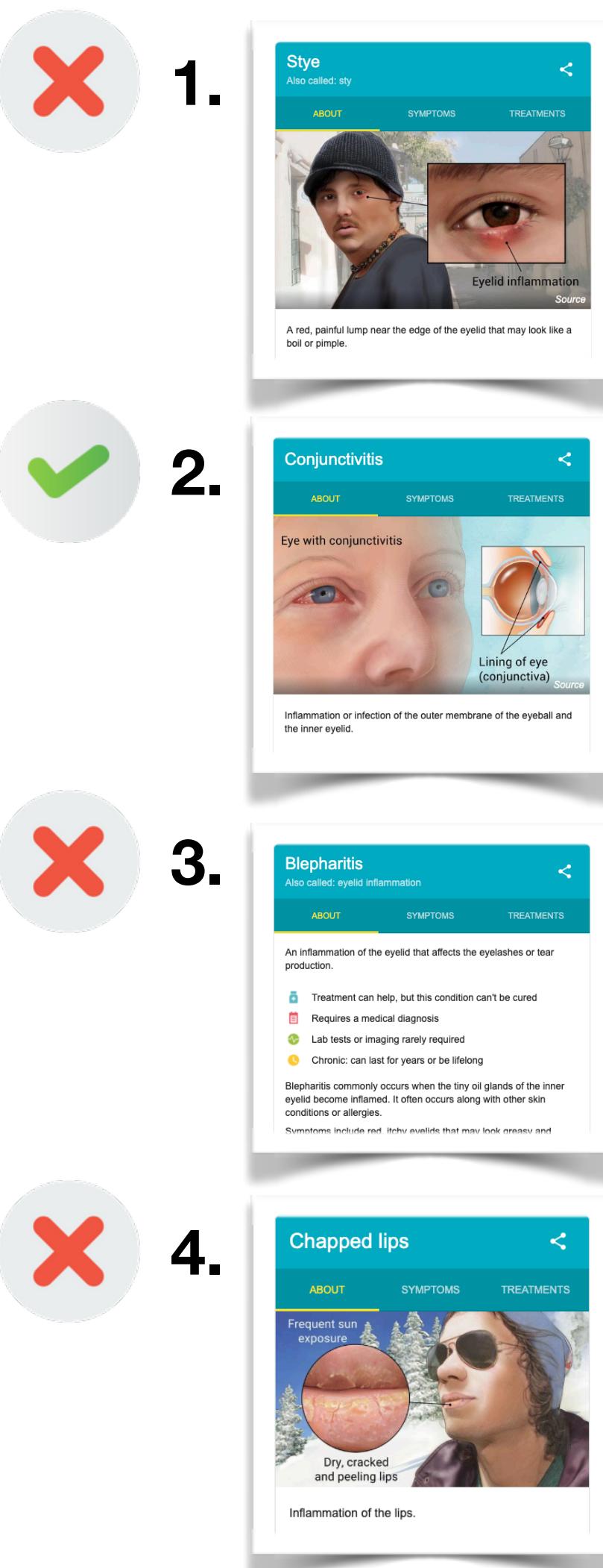
Success @ 1 (n= 584 queries)

- All four methods that we investigated are **not effective** for self-diagnostic, often under-specified queries.
- FSDM (the best) only successfully retrieve the correct health card at rank 1 for 28% of the 584 queries.



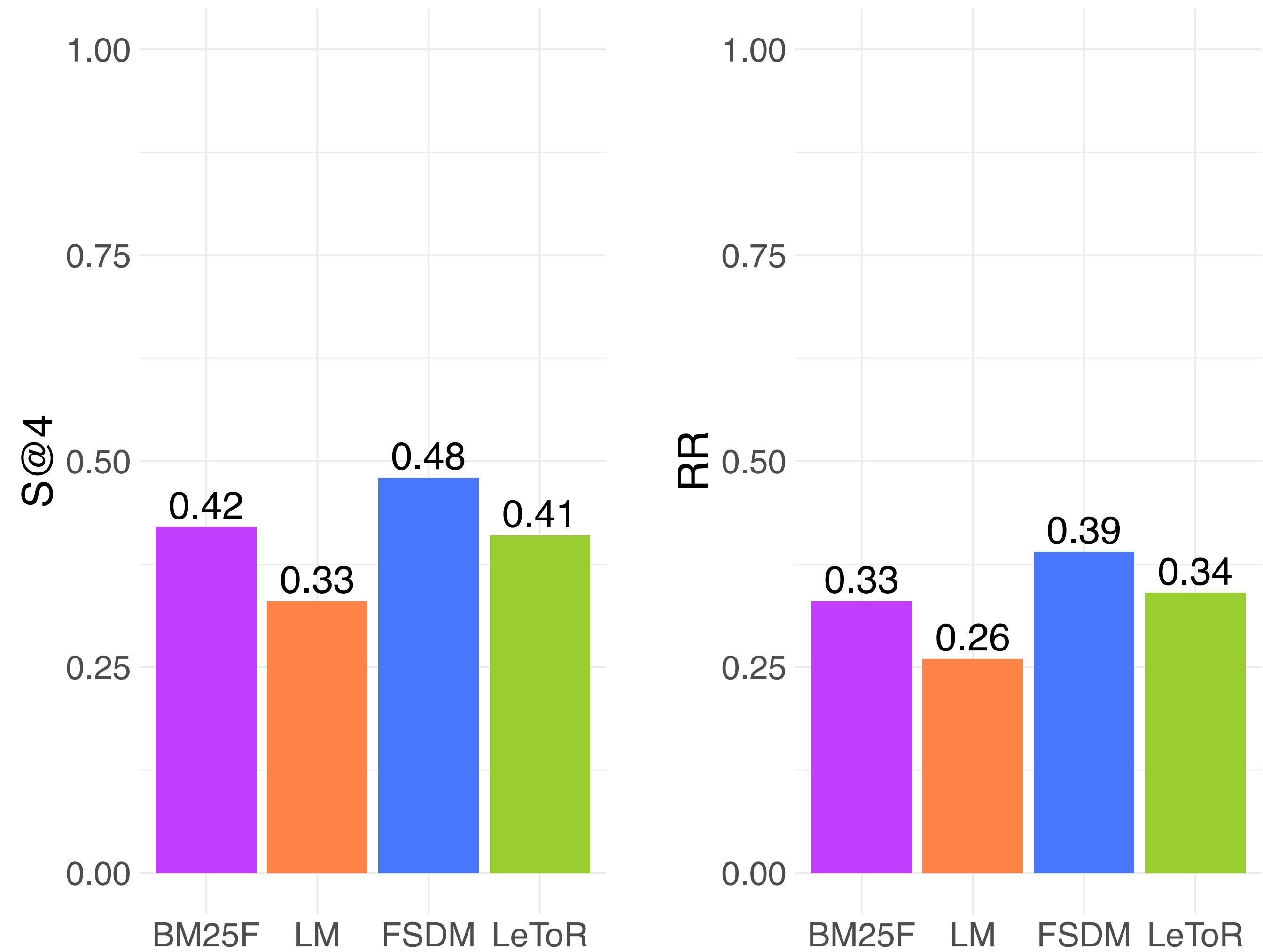
Effectiveness Beyond S@1

- Success at rank 4 (S@4): how many times the correct health card is retrieved at rank 4?
- Reciprocal Rank (RR): consider the rank of the correct health card.



Effectiveness Beyond S@1

- **More probability** in presenting the correct health card **within top 4**.
- FSDM (the best) successfully retrieve the correct health card at top 4 for 48% of the 584 queries.
- On average, the **correct health cards** are found between **rank 2 to 3**.

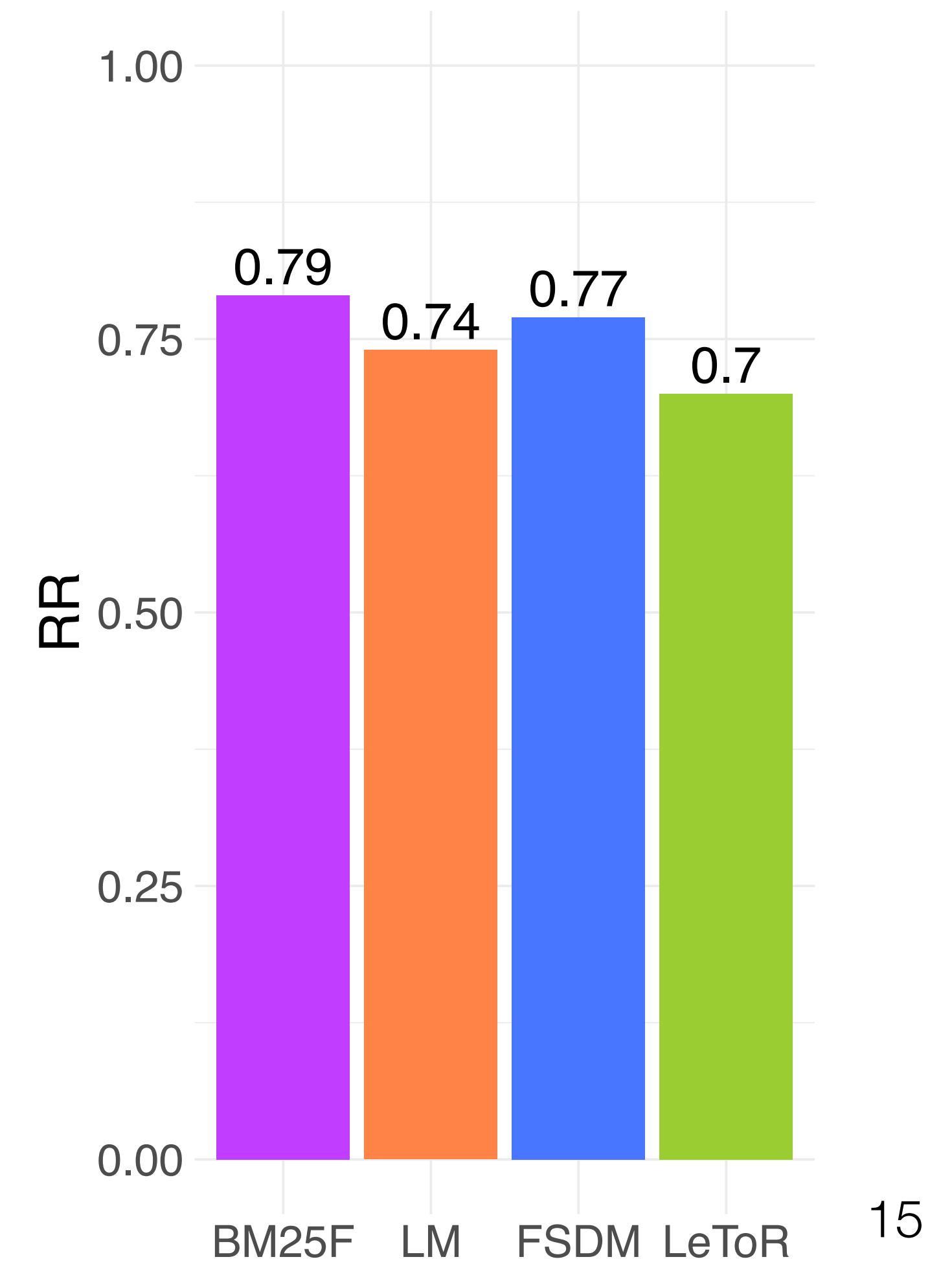
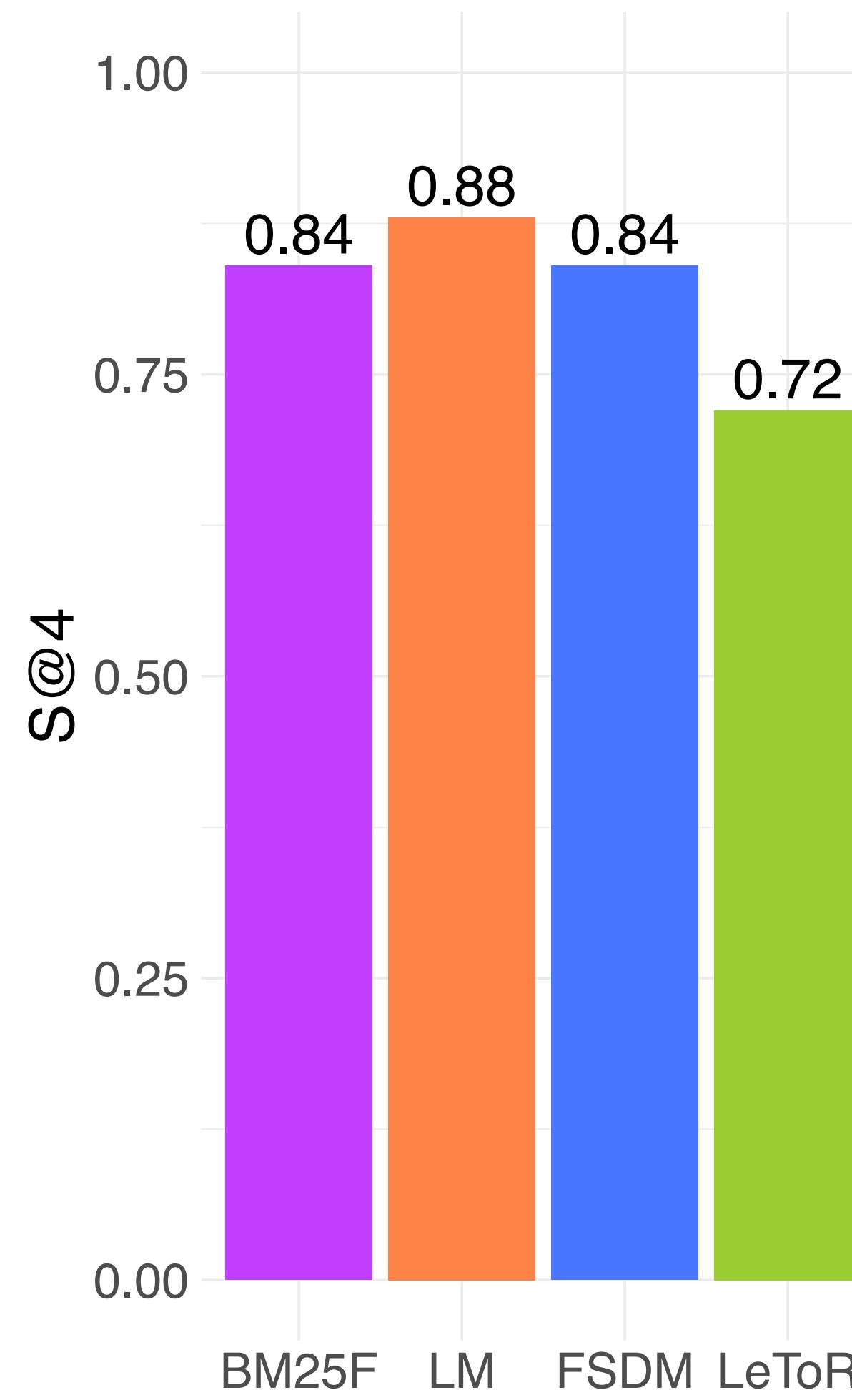
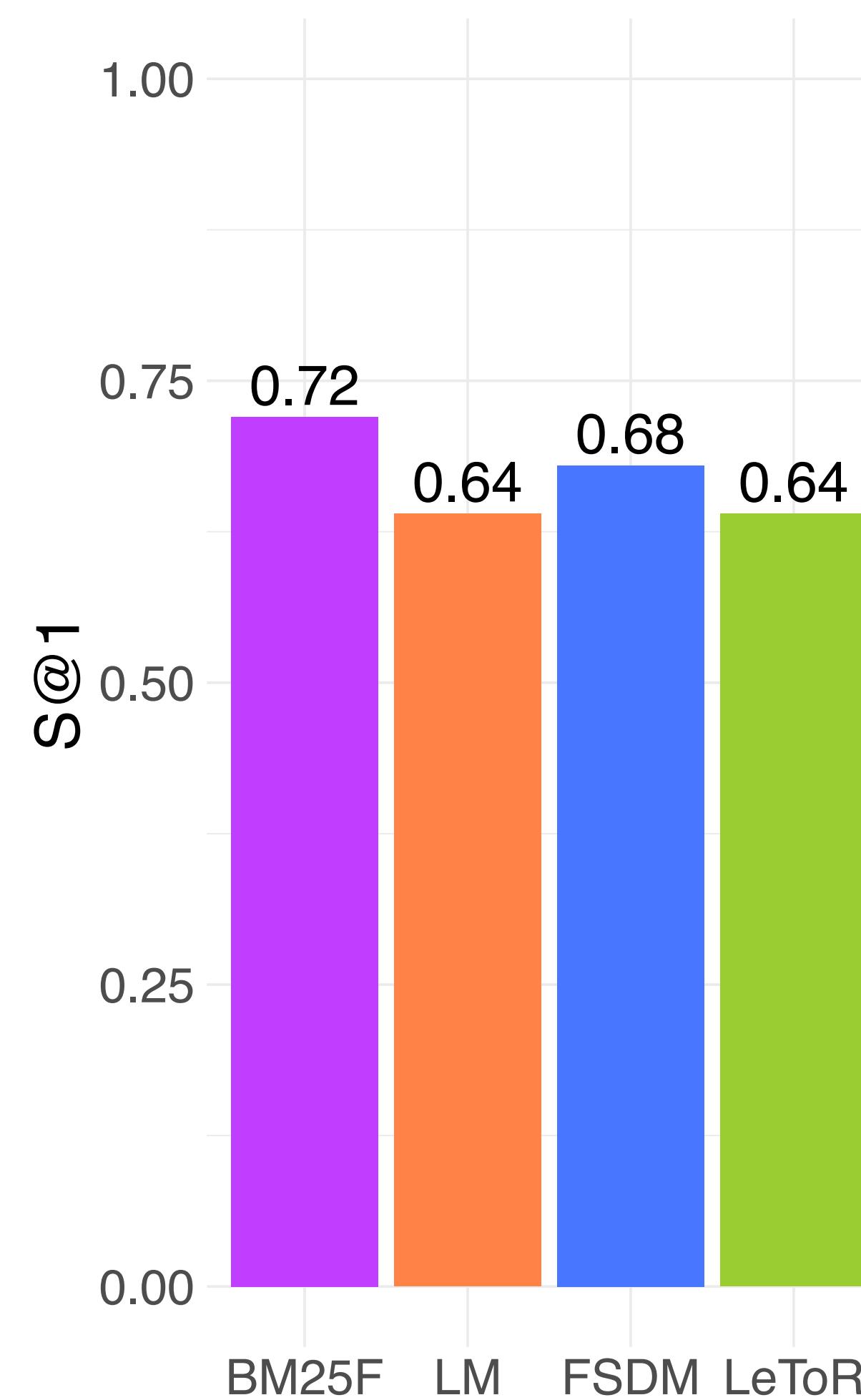


Queries with Navigational Intent

- Navigational Queries **target a specific health condition.**
- Some navigational queries are **a part of the user strategy** to identify the correct diagnosis.
- For example, people search for ‘migraine’ when they attempt to self-diagnose the symptoms of ‘meningitis’.

Effectiveness for Navigational Queries (n=25)

The four retrieval models are more effective for the majority of navigational queries.



Contributions

- We investigated methods to **retrieve health cards based on observation of symptoms for self-diagnosis.**
- We **introduced LeToR features specific to health cards** that statistically increase the effectiveness LeToR.
- We **assembled and released** the first **test collection of health cards** containing information for 1,142 health conditions, and 584 query variations for 41 self-diagnosis search tasks.

Questions?



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