Extractive Evidence Based Medicine Summarisation Based on Sentence-Specific Statistics

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Contents

Contents

Background
●○○

Method
○○○○○
○○○○○○○

Evaluation
○○○○

Contents

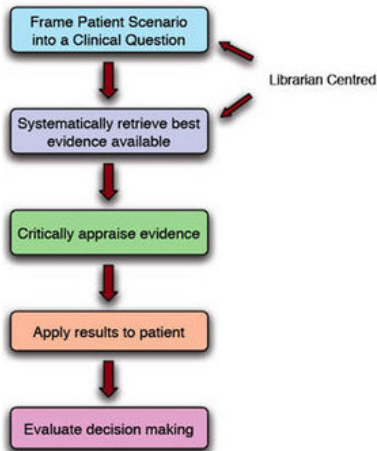# Evidence Based Medicine

http://laikaspoetnik.wordpress.com/2009/04/04/evidence-based-medicine-the-facebook-of-medicine/

Background
○○●

Method
○○○○○
○○○○○○○

Evaluation
○○○○

EBM and Natural Language Processing

http://hlwiki.slais.ubc.ca/index.php?title=Five_steps_of_EBM

NLP tasks

- ▶ Question analysis and classification
- ▶ Information Retrieval
- ▶ Classification and re-ranking
- ▶ Information extraction
- ▶ Question answering
- ▶ Summarisation

Background
000

Method
00000
0000000

Evaluation
0000

Contents

Background
○○○

Method
○○○○○
○○○○○○○

Evaluation
○○○○

General Approach

In a Nutshell

1. Gather statistics from the best 3-sentence extracts.
   - Exhaustive search to find these best extracts.
2. Build three classifiers, one per sentence in the final extract.
   - Classifier 1 based on statistics from best 1st sentence.
   - Classifier 2 based on statistics from best 2nd sentence.
   - Classifier 3 based on statistics from best 3rd sentence.

Contents

Background
○○○

Method
○●○○○○
○○○○○○

Evaluation
○○○○

Journal of Family Practice's "Clinical Inquiries"

Which treatments work best for hemorrhoids?

Evidence-based answer

Excision is the most effective treatment for thrombosed external hemorrhoids (strength of recommendation [SOR]: **B**, retrospective studies). For prolapsed internal hemorrhoids, the best definitive treatment is traditional hemorrhoidectomy (SOR: **A**, systematic reviews). Of nonoperative techniques, rubber band ligation produces the lowest rate of recurrence (SOR: **A**, systematic reviews).

▌Evidence summary

External hemorrhoids originate below the dentate line and become acutely painful with thrombosis. They can cause perianal pruritus and excoriation because of interference with perianal hygiene. Internal hemorrhoids become symptomatic when they bleed or prolapse (**TABLE**).

For thrombosed external hemorrhoids, surgery works best

Few studies have evaluated the best treatment for thrombosed external hemorrhoids. A retrospective study of 231 patients treated conservatively or surgically found that the 48.5% of patients treated surgically had a lower recurrence rate than the conservative group (number needed to treat [NNT]=2 for recurrence at mean follow-up of 7.6 months) and earlier resolution of symptoms (average 3.9 days compared with 24 days for conservative treatment).[1]

Another retrospective analysis of 340 patients who underwent outpatient excision of thrombosed external hemorrhoids under local anesthesia reported a low recurrence rate of 6.5% at a mean follow-up of 17.3 months.[2]

A prospective, randomized controlled trial (RCT) of 98 patients treated nonsurgically found improved pain relief with a combination of topical nifedipine 0.3% and lidocaine 1.5% compared with lidocaine alone. The NNT for complete pain relief at 7 days was 3.[3]

Conventional hemorrhoidectomy beats stapling

Many studies have evaluated the best treatment for prolapsed hemorrhoids. A Cochrane systematic review of 12 RCTs that compared conventional hemorrhoidectomy with stapled hemorrhoidectomy in patients with grades I to III hemorrhoids found a lower rate of recurrence (follow-up ranged from 6 to 39 months) in patients who had conventional hemorrhoidectomy (NNT=14).[4] Conventional hemorrhoidectomy showed a nonsignificant trend in decreased bleeding and decreased incontinence.

A second systematic review of 25 studies, including some that were of lower quality, showed a higher recurrence rate at 1 year with stapled hemorrhoidectomy than with conventional surgery.[5]

Nonoperative techniques? Consider rubber band ligation

A systematic review of 3 poor-quality trials comparing rubber band ligation with excisional hemorrhoidectomy in patients with grade III hemorrhoids found that excisional hemorrhoidectomy produced better long-term symptom control but more immediate postoperative complications of anal stenosis and hemorrhage.[6] Rubber band ligation had the lowest recurrence rate at 12 months compared with the other nonoperative techniques of sclerotherapy and infrared coagulation.[7]

Fiber supplements help relieve symptoms

A Cochrane systematic review of 7 RCTs enrolling a total of 378 patients with grade I to III hemorrhoids evaluated the effect of fiber supplements on pain, itching, and bleeding. Persistent hemorrhoid symptoms decreased by 53% in the group receiving fiber.[8]

When surgical hemorrhoidectomy is recommended

The American Society of Colon and Rectal Surgeons recommends adequate fluid and fiber intake for all patients with symptomatic hemorrhoids. For grade I to III hemorrhoids, the society states that banding is usually most effective. When office treatments fail, the society recommends surgical hemorrhoidectomy (SOR: **B**).

The society recommends excision of thrombosed hemorrhoids less than 72 hours old and expectant treatment with hemorrhoids that present early. Surgical hemorrhoidectomy should be reserved for when conservative treatment fails and for patients with symptomatic grade III and IV hemorrhoids.[10] ■

TABLE 1

Classification of sympto internal hemorrhoid
GRADE	**DESCRIPTION**
I	Hemorrhoids do not protr
II	Hemorrhoids protrude wit reduce spontaneously
III	Hemorrhoids protrude and by hand
IV	Hemorrhoids are permane

Source: Madoff RD, et al. Gastroenterology. 2004.[10]

References

1. Greenspon J, Williams SB, Young HA, et al. Thrombosed external hemorrhoids: outcome after conservative or surgical management. Dis Colon Rectum. 2004;47:1493-1498.

2. Jongen J, Bach S, Stubinger SH, et al. Excision of thrombosed external hemorrhoids under local anesthesia: a retrospective evaluation of 340 patients. Dis Colon Rectum. 2003;46:1226-1231.

3. Perrotti P, Antropoli C, Molino D, et al. Conservative treatment of acute thrombosed external hemorrhoids with topical nifedipine. Dis Colon Rectum. 2001;44:405-409.

4. Jayaraman S, Colquhoun PH, Malthaner RA. Stapled versus conventional surgery for hemorrhoids. Cochrane Database Syst Rev. 2006;(4):CD005393.

5. Tjandra JJ, Chan MK. Systematic review on the procedure for prolapse and hemorrhoids (stapled hemorrhoidopexy). Dis Colon Rectum. 2007;50:878-892.

6. Shanmugam V, Thaha MA, Rabindranath KS, et al. Systematic review of randomized trials comparing rubber band ligation with excisional hemorrhoidectomy. Br J Surg. 2005;92:1481-1487.

7. Johanson JF, Rimm A. Optimal nonsurgical treatment of hemorrhoids: a comparative analysis of infrared coagulation, rubber band ligation, and injection sclerotherapy. Am J Gastroenterol. 1992;87:1600-1606.

8. Alonso-Coello P, Guyatt G, Heels-Ansdell D, et al. Laxatives for the treatment of hemorrhoids. Cochrane Database Syst Rev. 2005;(4):CD004649.

MACQUARIE UNIVERSITY

The XML Contents I

```xml
<record id="7843">
<url>http://www.jfponline.com/Pages.asp?AID=7843&amp;issue=September_2009&amp;UID=</url>
<question>Which treatments work best for hemorrhoids?</question>
<answer>
  <snip id="1">
    <sniptext>Excision is the most effective treatment for thrombosed
external hemorrhoids.</sniptext>
    <sor type="B">retrospective studies</sor>
    <long id="1_1">
      <longtext>A retrospective study of 231 patients treated
      conservatively or surgically found that the 48.5% of patients
      treated surgically had a lower recurrence rate than the
      conservative group (number needed to treat [NNT]=2 for
      recurrence at mean follow-up of 7.6 months) and earlier
      resolution of symptoms (average 3.9 days compared with 24 days
      for conservative treatment).</longtext>
      <ref id="15486746" abstract="Abstracts/15486746.xml">Greenspon
      J, Williams SB, Young HA, et al. Thrombosed external
      hemorrhoids: outcome after conservative or surgical
      management. Dis Colon Rectum. 2004; 47: 1493-1498.</ref>
    </long>
    <long id="1_2">
      <longtext>A retrospective analysis of 340 patients who underwent
      outpatient excision of thrombosed external hemorrhoids under
      local anesthesia reported a low recurrence rate of 6.5% at a
      mean follow-up of 17.3 months.</longtext>
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Background
000

Method
00●00
0000000

Evaluation
0000

The XML Contents II

```
    <ref id="12972967" abstract="Abstracts/12972967.xml">Jongen J,
    Bach S, Stubinger SH ,et al. Excision of thrombosed external
    hemorrhoids under local anesthesia: a retrospective evaluation
    of 340 patients. Dis Colon Rectum. 2003; 46: 1226−1231.</ref>
  </long>
  <long id="1.3">
    <longtext>A prospective, randomized controlled trial (RCT) of 98
    patients treated nonsurgically found improved pain relief with a
    combination of topical nifedipine 0.3% and lidocaine 1.5% compared
    with lidocaine alone. The NNT for complete pain relief at 7 days was
    3.</longtext>
    <ref id="11289288" abstract="Abstracts/11289288.xml">Perrotti P,
    Antropoli C, Molino D ,et al. Conservative treatment of acute
    thrombosed external hemorrhoids with topical nifedipine. Dis
    Colon Rectum. 2001; 44: 405−409.</ref>
  </long>
  </snip>
  </answer>
  </record>
```

Background
ooo

Method
ooooo
ooooooo

Evaluation
oooo

Corpus Statistics

Size

- ► 456 questions ("records").
- ► Over 1,100 distinct answers ("snips").
- ► 3,036 text explanations ("longs").
- ► 2,707 references.

Background
ooo

Method
ooooo
ooooooo

Evaluation
oooo

Summarisation Using This Corpus

Input

- ▶ Question.
- ▶ Document Abstract.

Output

- ▶ Extractive summary that answers the question.
- ▶ Target summary is the annotated evidence text ("long").
- ▶ Evaluated using ROUGE-L.

Background
ooo

Method
ooooo
●ooooooo

Evaluation
oooo

Contents

Background
000

Method
00000
0●00000

Evaluation
0000

The Statistics Gathered

1. Source sentence position.
2. Sentence length.
3. Sentence similarity.
4. Sentence type.

Background
000

Method
00000
0000000

Evaluation
0000

1. Source Sentence Position

- ▶ Compute relative positions.
- ▶ Create normalised frequency histograms $f_1, f_2, \ldots, f_{10}$.
- ▶ Score all relative positions of bin i with its bin frequency: $S_{pos}(i) = f_{bin(i)}$.

Background
ooo

Method
ooooo
oooo●ooo

Evaluation
oooo
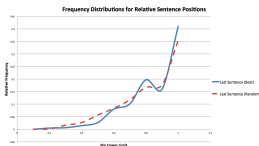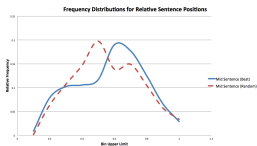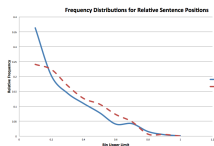
2. Sentence Length

Reward larger sentences and penalise shorter sentences:

Normalised sentence length

$$S_{len}(i) = \frac{l_s - l_{avg}}{l_d}$$

l_s: sentence length

l_{avg}: average sentence length in the corpus

l_d: document length

Background
000

Method
00000
0000●00

Evaluation
0000

3. Sentence Similarity

Sentence Similarity
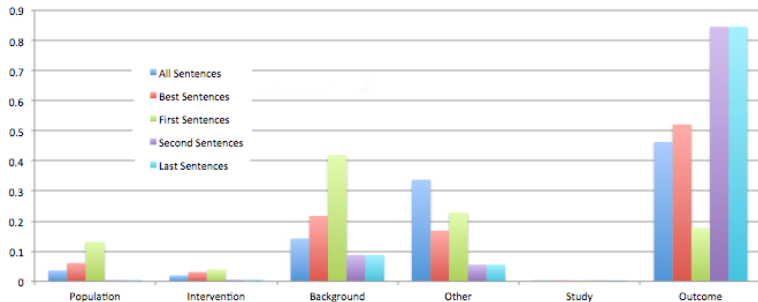
- Lowercase, stem, remove stop words.
- Build vector of $tf.idf$ with remaining words and UMLS semantic types.
- $CosSim(X, Y) = \frac{X.Y}{|X||Y|}$

Maximal Marginal Relevance (Carbonell & Goldstein, 1998)

Reward sentences similar to the query and penalise those similar to other summary sentences.

$$MMR = \lambda(CosSim(S_i, Q)) \\ -(1 - \lambda)max_{S_j \epsilon S}(CosSim(S_i, S_j))$$

Background
○○○

Method
○○○○○
○○○○○●○

Evaluation
○○○○

4. PIBOSO (Kim et al. 2011) I

1. Classify all sentences into PIBOSO types (a variant of PICO).
2. Generate normalised frequency histograms of resulting PIBOSO types.

Background
000

Method
00000
0000●●0

Evaluation
0000

4. PIBOSO (Kim et al. 2011) II

Position independent

$$S_{PIPS}(i) = \frac{P_{best}}{P_{all}}$$

Position dependent

$$S_{PDPS}(i) = \frac{P_{pos}}{P_{best}}$$

P_{best}:   proportion of this PIBOSO type among all best summary sentences.

P_{all}:   proportion of this PIBOSO type among all sentences.

P_{pos}:   proportion of this PIBOSO type among at best summary sentences at this position.

Background
000

Method
00000
000000●

Evaluation
0000

Classification

Edmunsonian Formula

$$S_{S_i} = \alpha S_{rpos_i} + \beta S_{len_i} + \gamma S_{PIPS_i} \\ + \delta S_{PDPS_i} + \epsilon S_{MMR_i}$$

- ► MMR is replaced with cosine similarity for first sentence.
- ► In case of ties, the sentence with greatest length is chosen.
- ► Parameters are fine-tuned through exhaustive search using training set.

$\alpha = 1.0$, $\beta = 0.8$, $\gamma = 0.1$, $\delta = 0.8$, $\epsilon = 0.1$, $\lambda = 0.1$.

Background
000

Method
00000
0000000

Evaluation
0000

# Contents

Background
○○○

Method
○○○○○
○○○○○○○

Evaluation
●○○○

Percentile-based Evaluation (Ceylan et al. 2010) I

We compare against all possible 3-sentence extracts in the test set.

1. Bin all possible three-sentence combinations of each abstract.
   - 1,000 bins.
2. Normalise the resulting histograms.
3. Combine all histograms.
   - convolution.
4. The result approximates the probability density distribution of all three-sentence summaries in all abstracts.

Background
000

Method
00000
0000000

Evaluation
●000

Percentile-based Evaluation (Ceylan et al. 2010) II
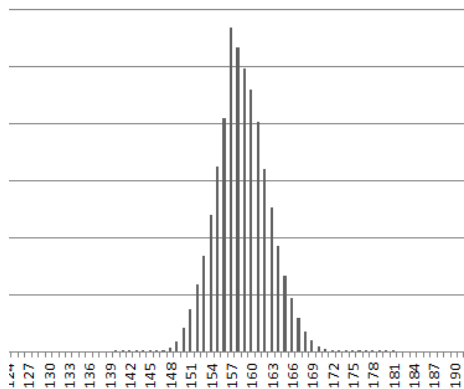
Systems

L3 Last three sentences.

O3 Last three PIBOSO outcome sentences.

R Random.

O All outcome sentences.

PI Sentence position independent.

PD Sentence position dependent (our proposal).

Background
○○○

Method
○○○○○
○○○○○○○

Evaluation
○○●○

Results

System	F-Score	95% CI	Percentile (%)
L3	0.159	0.155–0.163	60.3
O3	0.161	0.158–0.165	77.5
R	0.158	0.154–0.161	50.3
O	0.159	0.155–0.164	60.3
PI	0.160	0.157–0.164	69.4
PD	**0.166**	**0.162–0.170**	**97.3**

Background
ooo

Method
ooooo
ooooooo

Evaluation
oooo

Questions?

Background
    Evidence Based Medicine

Method
    Corpus
    Generation of Statistics

Evaluation

Further Information

`http://web.science.mq.edu.au/~diego/medicalnlp/`