Using Natural Language Generation to Support Patients

Ehud Reiter ehudreiter.com

Who is Ehud?

- Professor of Computing at Aberdeen University
 - » Formerly Chief Scientist of Arria NLG
- Working on NLG, esp evaluation, since the late 1980s
 - » Many health-oriented projects

Supporting Patients

- Use NLG/Al to help patients, eg
 - » Encourage healthier behaviour
 - » Help patients manage chronic illness
 - » Support informed decision making
- Help patients to look after themselves
 - » Key goal of NHS and other health services
- Focus on patients, not clinicians

Content

- Why important
- Example projects at Aberdeen
- Challenges and discussion

NHS Priorities

- Move from analogue to digital
- Shift care from hospitals to communities.
- Pivot to (focus) on prevention instead of treating illness.

Prime Minister Starmer, 11 Sep 2024

NHS Priorities

- Move from analogue to digital.
 - » Wont discuss further
- Shift care from hospitals to communities
 - » Home, GP, health centre (Call the Midwife)
 - » Better for patient, cheaper
- Pivot to prevention instead of treatment
 - » Better for patient, cheaper

Two possibilities

- Now: People ignore health issues (esp if poor), get sick, go to hospital, get treated
- Vision: People (including poor) look after their health and manage illness supported by GPs and community health. Hospitals used sparingly.

How can AI help?

- Patient-focused apps to encourage healthy behaviour, manage chronic conditions, detect problems, etc
 - » Focus of this talk
- Empower GPs and community health centres to do more, be more efficient
 - » Clinical, eg diagnosis
 - » Admin, eg letter writing, logistics
 - Probably priority at moment…

Side note

- Al/Medicine community largely focuses on improving diagnosis in hospitals
 » Of course exceptions!
- More real-world impact if focus on helping patients at home?
- https://ehudreiter.com/2024/09/23/howai-can-help-reform-uk-nhs/

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Themes

- Behaviour change: smoking cessation, dietary struggles
- Manage chronic illness: melanoma
- Information and decision-making: patient records, outcome likelihood

Focus on problems as well as solutions

Behaviour Change: Smoking

- Old project
- Smokers filled out questionnaire
- Received NLG-generated letter to encourage smoking cessation
 - » Based on Stages of Change theory

E Reiter et al (2003). Lessons from a Failure: Generating Tailored Smoking Cessation Letters. *Artificial Intelligence* 144:41-58.

Questionnaire (extract)

SMOKING QUESTIONNAIRE

Please answer by marking the most appropriate box for each question like this:

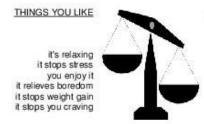
Q1 Have you smoked a cigarette in the last week, even a puff? YES ⊠ NO □		
Please complete the following questions		Please return the questionnaire unanswered in the envelope provided. Thank you.
Please read the questions carefully. If you are not sure how to answer, just give the best answer you can.		
Q2	Home situation: Live	Live with Live with Other adults children
Q3 Number of children under 16 living at home boys boys		
Q4 Does anyone else in your household smoke? (If so, please mark all boxes which apply) husband/wife/partner other family member others		
Q5 How long have you smoked for?10 years Tick here if you have smoked for less than a year		

Letter (extract)

Smoking Information for Heather Stewart

You have good reasons to stop...

People stop smoking when they really want to stop. It is encouraging that you have many good reasons for stopping. The scales show the good and bad things about smoking for you. They are tipped in your favour.



THINGS YOU DISLIKE it makes you less fit it's a bad example for kids you're addicted it's unpleasant for others other people disapprove it's a smelly habit it's bad for you it's expensive it's bad for others' health

You could do it...

Most people who really want to stop eventually succeed. In fact, 10 million people in Britain have stopped smoking - and stayed stopped - in the last 15 years. Many of them found it much easier than they expected.

Although you don't feel confident that you would be able to stop if you were to try, you have several things in your favour.

- You have stopped before for more than a month.
- You have good reasons for stopping smoking.
- You expect support from your family, your friends, and your workmates.

We know that all of these make it more likely that you will be able to stop. Most people who stop smoking for good have more than one attempt.

Overcoming your barriers to stopping...

You said in your questionnaire that you might find it difficult to stop because smoking helps you cope with *stress*. Many people think that cigarettes help them cope with stress. However, taking a cigarette only makes you feel better for a short while. Most ex-smokers feel calmer and more in control than they did when they were smoking. There are some ideas about coping with stress on the back page of this leaflet.

You also said that you might find it difficult to stop because you would put on weight. A few people do put on some weight. If you did stop smoking, your appetite would improve and you would taste your food much better. Because of this it would be wise to plan in advance so that you're not reaching for the biscuit tin all the time. Remember that putting on weight is an overeating problem, not a no-smoking one. You can tackle it later with diet and exercise.

And finally...

We hope this letter will help you feel more confident about giving up cigarettes. If you have a go, you have a real chance of succeeding.

With best wishes.

The Health Centre.

Evaluation

- Full RCT
- 2500 smokers filled out questionnaire
- Received either (A) NLG text, (B) fixed text, (C), simple thank-you letter
- Checked if smoking 6 months later
- Negative result: (B) as good as (or better than) (A)

Support dietary change

- Apps to provide information and guidance to people about nutrition
 - » Frequent interaction (not one-off)
 - » Support change, don't argue with people
 - » Use LLMs

Evaluation of ChatGPT advice

- Experiment: assess whether GPT3.5 can respond to dietary struggles
 - » eg "I eat too much when stressed"
- Ask GPT to respond to 2448 struggles
- Nutrition experts evaluated responses
- Lots of inappropriate responses

S Balloccu et al (2024). Ask the experts: sourcing a high-quality nutrition counseling dataset through Human-Al collaboration. *Findings of EMNLP*

Example

User: When I am stressed out, I am more likely to consume foods and drinks I know aren't good for me because eating it makes me feel better.

chatGPT: Starting from tomorrow you could make a conscious effort to make healthier choices when it comes to food and drinks.

Experts: Not helpful, could make person feel worse

True but unsafe

- 15% of responses not appropriate and/or not safe
- Rare to get factually wrong responses.
- Problem was responses that were not helpful, made user feel worse, etc
- See similar problems in GPT4

Solutions?

- Prompt engineering, fine-tuning, safety assessment metrics?
- Tried to get funding, not successful

Behaviour Change

- Difficult, especially on long-term basis.
 - » Impossible if people don't want to change
- Include in Al assistant/chatbot?
 - » Frequent interaction
 - » Personalise to individual
- Cannot use LLM "off shelf" ...
 - » inappropriate, unsafe output
 - » Need to ensure safety

Prehabilitation?

- Behaviour change before surgery
 - » Diet, exercise to make surgery more succ
 - » Limited time-frame
 - » Clear objective
 - » More successful?
- Would love to explore this

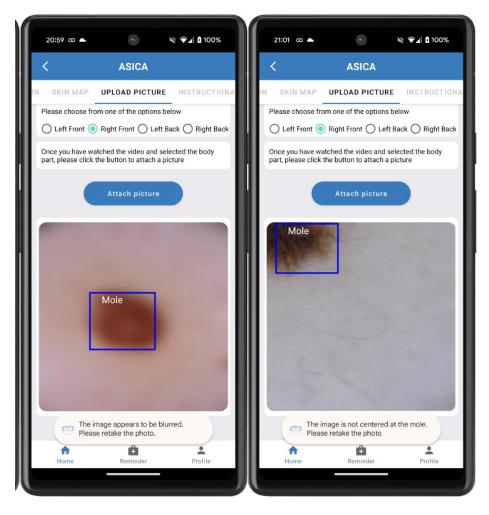
Managing Melanoma

- People who have skin cancer (melanoma) should regularly check skin
 - » At home as well as in hospital
- Many people don't, can app help?
- New project (ASICA)
 - » Create app to support this
 - » Clinicians, health psych, NLP, vision

ASICA

- App to support skin self-checking
- Patient takes picture of potential prob
 - » App checks image quality, then sends to clin
- Chatbot gives help on self-checking
 - » Also general information on melanoma
- Project just started

Example



Evaluation

- Plan is to evaluate with 50 patients and 10 clinicians
 - » Adherence (do people do skin exams)
 - » User satisfaction
 - » Image quality and utility (rated by clinicians)
 - » Not full RCT (this would be a later stage)

Managing chronic illness

- New area to me, but I think there is a lot of potential
- Supporting and encouraging people to act appropriately, including contacting clinicians
 - » For years (decades?), not months

Explaining information

- Explain patient record
 - » Explain information about sick baby to its parents
 - » Explain cancer MDT report to patients
- Explain model
 - » IVF success likelihood
- Goal: support decisions, reduce stress

Info about sick babies

- Analyse patient record about baby in neonatal ICU, summarise for parent
- Deployed in Edinburgh hospital for a few years, parents mostly positive
 - » Hospital would not allow reports on web
- Negative info delivered in person

S Mahamood and E Reiter (2011). Generating Affective Natural Language for Parents of Neonatal Infants. In Proceedings of ENLG

BT-Family text (extract)

Yesterday, John was on a ventilator. The mode of ventilation is Bilevel Positive Airway Pressure (BiPAP) Ventilation. This machine helps to provide the support that enables him to breathe more comfortably. Since last week, his inspired Oxygen (FiO2) was lowered from 56% to 21% (which is the same as normal air). This is a positive development for your child.

During the day, Nurse Johnson looked after your baby. Nurse Stevens cared for your baby during the night.

MDT Info

- Ask GPT4 to summarise information from a Multidisciplinary Team meeting
- Many problems
 - » Wrong lab results, Americanisms, spam URLs, not personalised, depressing...
 - » Patients do not trust
- Work in progress
 - » Improve model? Adjust use case?

M Sun et al (2024). Effectiveness of ChatGPT in explaining complex medical reports to patients. Arxiv

Dr. Ehud Reiter, Computing Science, University of Aberdeen

Example (wrong lab result)

MDT: (clinical history)

PSA 6.2, cT2a (Right lobe)... Post-op. PSA 0.033, rising to 0.050 (11 weeks post-op.) ...

GPT:

Your current PSA level is 6.2, which is elevated.

Example (depressing)

GPT:

It may be helpful to get your affairs in order, including any legal and financial planning, which can provide peace of mind for you and your family

 Don't say this to someone who is sick but not dying!

Explaining model

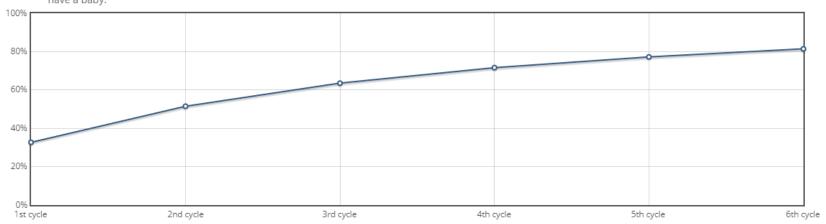
- Explain prediction from AI model, to help user decide on action to take
- Focus on success prediction for IVF
 - » "How likely am I to have a baby if I do IVF"
 - » Help use decide whether to do IVF
- Work in progress

A Sivaprasad and E Reiter (2024). Linguistically Communicating Uncertainty in Patient-Facing Risk Prediction Models. Proc of EACL workshop on Uncertainty-Aware NLP.

OPIS tool

* A complete cycle includes all fresh and frozen-thawed embryo transfers resulting from one egg collection.

**Your chance of having your first baby after 1 complete cycle of treatment is: 32.71%. This means that out of 100 couples having 1 cycle, approximately 33 would have a baby.



^{**}Disclaimer: Using the information that you entered above, this tool allows you to estimate your chance of having a live birth using in vitro fertilization (IVF)—the most common type of Assisted Reproductive Technology (ART). This information is calculated based on the experiences of women and couples with similar characteristics. The estimates are based on the data we have available and may not be representative of your specific experience. Because fewer patients are available in the upper age group, please interpret the results with caution in conjunction with counsel by your doctor. Please speak with your doctor about your specific treatment plan and potential for success.

Explaining OPIS

- Work with users, find out what they want
 - » User: Model ignored my BMI, and I have read that high BMI reduces chance of success. Can I believe the model?
 - Many such questions
 - » Hard to understand time-series of prob
- Work in progress: address above issues

Communicate/explain info

- Better information can support decision making, and also reduce stress
- Caution needed with LLMs
 - » Rule-based NLG (babies) can work
 - » LLMs have great potential, need to reduce mistakes and other problems
- Understand what patients want to know!

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Challenge: Patient Diversity

- Circumstances
 - » I have a screaming toddler, Im not coping
- Skills and expertise
 - » I struggle with numbers
- Personality
- Finances
- Etc, etc

Challenge: long-term

- Support long-term
 - » Behaviour change
 - » Managing chronic condition
 - » Years of IVF attempts
- How keep people engaged and motivated?
- How evaluate long-term usage?

Challenge: Data

- Data quality: missing, incorrect, inconsistency between providers
- Data sets: hard to get, esp for representative data
 - » Good coverage of deprived communities with worst health

Challenge: LLMs

- LLMs have great potential!
 - » Interactive, can respond to many questions
 - » Potential to personalise for user
- But too many mistake and unsafe text
 - » Dont tell stressed person "make a conscious effort"
 - » Cannot give incorrect PSA
- Can this be fixed?

Challenge: Evaluation

- Evaluating success is hard
 - » Metric on test set not useful
- Ideally measure clear outcomes in RCT
 - » Smoking cessation, dietary change
 - » Expensive and time-consuming
- "Soft" outcomes important
 - » Quality of life, pain, etc

Challenge: Deployment

- Difficult to deploy AI in NHS, esp clinical
 - » Scot: no new AI apps approved since 2022
 - » Research success (inc RCT) not translated into deployed app
- Why?
 - » Lack of RCT showing clinical benefits
 - » Lot of hassle, cost for limited benefit (ROI)
 - » Doctors not pushing for this

Success would be great!

- Success in patient-focused AI would have huge benefits
 - » Much better health outcomes
 - » Significantly reduced costs
- Help NHS (etc) deliver high quality care to an increasingly elderly population.

Discussion