© 2022 European Federation for Medical Informatics (EFMI) and IOS Press.

This article is published online with Open Access by IOS Press and distributed under the terms of the Creative Commons Attribution Non-Commercial License 4.0 (CC BY-NC 4.0).

doi:10.3233/SHT1220616

Deep Learning Methods for Detecting Side Effects of Cancer Chemotherapies Reported in a Remote Monitoring Web Application

Marie-Hélène METZGER^{a,b,1}, Ahmath GADJI^a, Nada HAJ SALAH^a, Wedji KANE^a and François BOUE^b

^a Equipe soins primaires et prévention, INSERM U1018, Villejuif, France ^b Service de médecine interne, Hôpital Antoine-Béclère, Assistance Publique Hôpitaux de Paris, Clamart, France

Abstract. The objective of our work was to develop deep learning methods for extracting and normalizing patient-reported free-text side effects in a cancer chemotherapy side effect remote monitoring web application. The F-measure was 0.79 for the medical concept extraction model and 0.85 for the negation extraction model (Bi-LSTM-CRF). The next step was the normalization. Of the 1040 unique concepts in the dataset, 62, 3% scored 1 (corresponding to a perfect match with an UMLS CUI). These methods need to be improved to allow their integration into home telemonitoring devices for automatic notification of the hospital oncologists.

Keywords. Telemedecine, Antineoplastic agents, Drug-related Side Effects and Adverse Reactions, Natural Language Processing, Deep Learning

1. Introduction

Cancer chemotherapies are highly toxic and some of them can cause serious side effects, requiring urgent hospital treatment. In a randomized trial evaluating the use of a remote monitoring web application of cancer chemotherapies, patients reported their side effects daily. The objective of our work was to use deep learning methods for extracting and normalizing side effects reported in free text by patients in the web application.

2. Methods

Study design: Patients were recruited from the Antoine-Béclère hospital located in the southern surburbs of Paris (Assistance Publique – Hôpitaux de Paris). The NEUTROSIS project is a research project that consisted of an evaluation of the impact on hospital management of a daily home monitoring web application for patients undergoing cancer chemotherapy. The study was designed as a randomized controlled trial. One arm used

¹ Corresponding Author, Service de médecine interne, Hôpital Antoine-Béclère, Assistance Publique Hôpitaux de Paris, 157 rue de la porte de Trivaux, Clamart, France; E-mail: metzger.marie-helene@orange.fr.

the web application (n=49) allowing the patient to enter his temperature and symptoms each morning for 14 days following each chemotherapy cycle. The control group (n=51) did the same monitoring using a paper diary. Patients reported several symptoms in structured form (temperature, diarrhea, vomiting, mucositis) but could also report other symptoms in free text. The patients were monitored during a period of six months while undergoing chemotherapy treatment, from 24/02/2017 to 17/05/2019.

Extraction and normalization processing of symptoms related to side effects of cancer chemotherapies: The extraction method was based on deep learning with word embeddings using bidirectional long short-term memory network-conditional random field (Bi-LSTM-CRF) [1]. One model was developed for medical concepts extraction and one model for negation extraction. The two models were applied in series. The performance of the models was evaluated by calculating F-measure of the extraction models against a referential (manual annotation of NEUTROSIS text data by a physician).

After extraction, the next step was to standardize the medical concepts using the Unified Medical Language System (UMLS). The first normalization step consisted in searching the medical concepts in the French version using the SimString tool to match the medical concepts with the UMLS [2]. The second step consisted of the use of the UMLSBertALL model [3]. Standardization was assessed manually by medical review of the medical concept and its CUI correspondence. A score of 1 was assigned if there was a perfect match, allowing a computation of the recall.

3. Results

On the 12,665 annotated tokens, the F-measure was 0.79 for the medical concept extraction model and 0.85 for the negation extraction model. Of the 1,040 unique concepts of the set, applying a similarity threshold of 0.9 for the first step and a threshold of 0.4 for the second step of normalization, 62, 3% of the concepts obtained a score of 1 (recall).

4. Discussion and Conclusions

The performance of applied methods for extracting and normalizing chemotherapy side effects from patients is not high enough to allow their application in remote monitoring devices. The next step will be to apply active learning methods to re-train the models.

References

- [1] Habibi M, Weber L, Neves M, Wiegandt DL, Leser U. Deep learning with word embeddings improves biomedical named entity recognition. Bioinformatics (Oxford, England). 2017;33:i37–48.
- [2] Okazaki N, Tsujii J. Simple and Efficient Algorithm for Approximate Dictionary Matching. In: Proceedings of the 23rd International Conference on Computational Linguistics (Coling 2010). Beijing, China: Coling 2010 Organizing Committee; 2010. p. 851–9
- [3] Yuan Z, Zhao Z, Sun H, Li J, Wang F, Yu S. CODER: Knowledge-infused cross-lingual medical term embedding for term normalization. J Biomed Inform. 2022;126:103983.