PREDICTING DAY-TO-DAY SYMPTOM DETORIATION DURING CHEMOTHERAPY USING DEEP LEARNING

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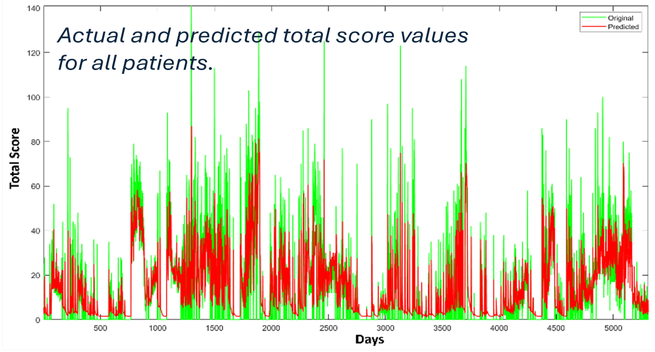
BACKGROUND

Advances in symptom management have been aided by frequent monitoring of symptoms through electronic patient-reported symptom monitoring (ePROs) digital tools that can identify symptom escalations requiring further treatment. Complex computational approaches utilizing artificial intelligence (AI) offers the prospect of further advancement through the predication of symptom deterioration before it is evident, allowing even earlier clinical intervention. AI deep learning methodologies have the potential to identify serial data patterns that are characteristic of impending symptom deterioration. The goal of this study was to explore deep learning approaches that could predict different facets of symptom deterioration from serial ePRO data during cancer chemotherapy.



METHOD

- 10 common symptoms were assessed daily for presence, severity and distress (0-10 rating): nausea/vomiting, diarrhea, mucositis, pain, fever, fatigue, sleep, numbness/tingling, trouble concentrating/thinking, concern about physical changes
- We utilized regression and classification approaches through recurrent neural network, Long Short Term Memory (LSTM) which is well-suited for sequence prediction tasks
- The classification model labels tomorrow's symptom total score as "no significant increase" or "significant increase" (at least a 20% increase).
- The regression model was utilized to predict tomorrow's symptoms total score based on today's symptoms severity and distress.
- Models were trained on 75% of the data and tested on 25%.

Results of testing the developed ML algorithms based on an analysis incorporating 4 days of prior symptom data.

Classifier	Class I predictive value	Recall	F1-Score	AUC	Accuracy
RUSBoost	0.65	0.91	0.69	0.64	57.8
Wide Neural Network	0.34	0.87	0.79	0.49	68.3
Medium Neural Network	0.34	0.87	0.79	0.5	68.8
Fine KNN	0.33	0.87	0.81	0.55	70.3
Trilayered Neural Network	0.32	0.87	0.81	0.53	70.4
Quadratic Discriminant	0.41	0.88	0.8	0.64	70.5
Gaussian Naive Bayes	0.37	0.88	0.82	0.63	71.6
Bilayered Neural Networks	0.34	0.87	0.81	0.55	71.8
Narrow Neural Network	0.31	0.87	0.83	0.57	73.8

RESULTS

- Daily ePRO reports from 339 patients receiving chemotherapy provided 26,537 data points.
- The regression prediction of next day symptoms showed a good fit between predicted and actual scores, with R-squared of 0.53, a highly significant p-value (<0.001) and a F-statistic showing a strong overall fit (1.19e+04) in forecasting next day symptom scores.
- For the classification model, the accuracy for correctly detecting no increase or a significant increase were both 62%.

CONCLUSIONS

We demonstrated that deep learning predictive techniques show promise for embedding personalized decision support into cancer symptom digital tools that could lead to proactive and tailored symptom care. Further refinement is needed to improve predictive application for clinical use.

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