Author’s response to reviews

Title: Real-time forecasting of emergency department arrivals using prehospital data

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Reviewer reports:

Thomas Schmidt (Reviewer 1): The authors address the challenge of predicting the inflow of emergency department patients with the objective of reducing the risk of crowding. Based on an existing dataset consisting of ED arrivals at a large Norwegian hospital, the authors propose a set of forecasting models that individually seek to predict arrivals within varying timespans.

Methodologically the paper seems sound. The authors' utilization of a Poisson based regression model is less novel than their focus on various forecasting time windows. Their approach is strengthened through access to a high quality dataset, which includes pre-hospital notification.

With reference to [12] (which describes the dataset), the various prediction functions seem very much in-line with the observed reality. Thus as a reader, I struggle to transfer their results to actual daily clinical use. Consequently, I would appreciate a discussion of the applicability of the proposed algorithm. Although the full model improves the MAPE when compared to the baseline, I question how much better the proposed model is when compared expected arrivals based on historic data. Especially when considering both the increased uncertainty related to shorter time windows, and the high MAPE.

Our response: The baseline-model we use for comparison is essentially expected arrivals based on historical data, and we do demonstrate better performance than this. The question remains
whether there is enough improvement for the method to be applicable. We add text in the discussion to highlight this (see response to next comment).

I assume there is more efficient improvement to be gained by investigating in-house bottlenecks. In other words, how frequent is crowding an effect of unexpected in-flow of patients vs. as happening due to bottlenecks and other throughput issues?

Our response: This is an interesting point, but we consider it outside the scope of this work. To make this more explicit, we have added a paragraph in the discussion to point out that our approach should not be regarded as anything else than a part of an overall strategy to counteract crowding:

“The approach in this study, forecasting arrivals, is only one of many potential approaches to counteracting ED crowding [1, 15]. A well-functioning ED needs to balance input, throughput and output of patients, and forecasting arrivals can be a part of an overall effort to ensure this [16]. We have demonstrated improved accuracy in forecasting over short time horizons. Whether this improved accuracy can make the forecasts good enough to be useful in a clinical setting should be studied further.”

A discussion of the utility added by applying a forecasting model would be an interesting addition to the paper. In general, this is a fine addition to the existing body of literature on forecasting of arrivals in EDs.

Our response: Whether there is added utility in this approach to forecasting is an open question. We hope the response to the above comments also address this comment.

Minor comments:

There are a few typos in the paper, e.g. 'sort' instead of 'short' (Background line 47).

MAPE is an abbreviation for Mean Absolute Percentage Error, not Mean Average Percentage Error. This is a common misunderstanding, but should be corrected nonetheless.

Our response: We have once more read through the manuscript and corrected these and some other typos.
Martin Rohacek (Reviewer 2): Asheim et al developed a model to forecast ED arrivals incorporating data from prehospital services from data from one Hospital over a period of 8 years. This ED has a moderate patient load (20'000 patients per year). They conclude that this approach could be a tool for ED resource management. I have the following comments:

Background: This section might be shortened, and the knowledge gap, and why this model is needed, might be better elaborated.

Our response: We have shortened the section considerably and elaborated on why the model is needed.

Results

Figures: Please add a legend, and explain Figures: e.g. what does Horizon, Baseline etc mean?

Our response: For each figure we have added some extra explanation. We have also improved the figure legends. The terms that are pointed out here, horizon and baseline, have been elaborated on in the text and figure captions. To make less room for misunderstandings, we have rewritten in order to use these terms more consistently throughout the text. Also, we attempt to be more explicit about which methods are used in the comparisons and how they are used.

Discussion:

- Please put your data in context to other research - Please explain how this model might be used in everyday practice, who could use it, and what the consequences would be out of it.

Our response: We have put some more context into the discussion. How the model might be used in everyday practice has been elaborated in the discussion. See also responses to reviewer 1.

- Please explain for what settings this model could be considered, and who would benefit from it.

Our response: We believe this comment is now addressed in the first paragraph of the discussion.