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## HealthMap: A visual platform for patient suicide risk review

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### SUMMARY

Misjudging suicide risk can be fatal. Risk assessment is complicated by multiplicity of risk factors, none of which individually can reliably predict risk. This paper addresses the need for better clinical support, visualising risk factors scattered in raw electronic medical records. HealthMap is a visual tool that helps clinicians effectively examine patient histories during a suicide risk assessment. We characterise the information visualisation problems accompanying suicide risk assessments. A design driven by visualisation principles was implemented. The prototype was evaluated by clinicians and accepted into daily clinical work-flow.

### INTRODUCTION

“More British soldiers commit suicide than die in battle.” “Suicide: Leading cause of Death among middle age Americans surpass car accidents, says CDC report”. These are some recent headlines showing the severity of suicide in our modern society. Although most people have sought clinical help before committing suicide<sup>1</sup>, the help they received is often insufficient. Intensive intervention, no matter how costly, is needed for the right people at the right time. To identify patients at risk, mental health practitioners rely on assessment organised through a list of questions covering major risk factors such as suicide attempts, suicide ideation, family history and sense of hopelessness<sup>2</sup>. Answers to the questions are based on interviews with the patient or the family members in combination with patient history. But the task of collecting relevant patient information is so complex that it is a “source of apprehension for clinicians”<sup>3</sup>. This complexity reflects the Variety dimension of big data. The bottle neck of retrieving patient information is, to a large degree, due to badly designed user interface. We need a computer tool for clinicians to quickly understand the psychosocial context and life experience of each patient<sup>4</sup>. In this talk, we present HealthMap, a visual tool supporting suicide risk assessment. We chart our journey from concept to acceptance of HealthMap in a large Australian hospital.

### METHODS

HealthMap (see Figure 1) exploits the routine information from Electronic Medical Records (EMR) to reconstruct a comprehensive picture of patients’ mental history. By organising information around the patient, we facilitate optimal information retrieval. Coupled with machine learning predictions, the system presents data that address- “Is this patient is at risk?” and “Why?”

#### *Development and implementation*

HealthMap aims to present two types of information: the raw patient records and the summarised patient suicide risk based on machine prediction, which is generated through a data mining system previously validated and published in<sup>5</sup>. The design follows Sedlmair et al’s 9-stage framework<sup>6</sup>. Tasks involved identification and subsequent filtering of Electronic Medical Records and other specialised databases to extract factors critical to suicide risk, prioritising to visually discriminate moderate and high risk elements, and finally presentation of that information during a risk assessment. We describe the interaction, feedback and evolution of the visualisation, conducted in 3 phases, with final adoption into clinical practice. Feedback collection is through presentation of the prototype at clinician meetings and following questionnaires.

In the final design, we organise raw patient data by their relevance to suicide risk. We borrow several ideas from<sup>5</sup>. They considered a wide range of variables that can be extracted from electronic medical records and found the most predictive variables are recent ED visits, recent admissions, and certain demographic information. We classify each patient event into three risk levels, in part through the ICD-10 codes generated from each event.

To achieve click-free navigation, we classified patient information into two tiers: event dates and risk categories are on the top tier; detailed diagnoses and clinical notes are on the bottom tier. Two tiers were mapped to two views: the left view shows temporal overview and enables event selection; the right view displays contextual information for the selected event. The layout/navigation design and visual encoding in HealthMap center around a two-tier information hierarchy that align with the mantra of “overview first; details on demand”.



FIGURE 1. HealthMap, a visual tool for interactive overview of patient mental health history. Easter Bunny is a hypothetical patient. Machine prediction uses the same colour scheme as (clinician) risk assessment.

## RESULTS

HealthMap has been deployed in an Australian tertiary hospital after initial positive response from mental health clinicians. The main scientific contributions of this work include:

1. Characterisation of the information visualisation needs for suicide risk assessment, a daily task in mental healthcare. The social significance of improved suicide risk assessment is immense, as errors can be fatal.
2. Implementation of a visual tool to assist suicide risk assessment, iteratively refining the visualisation to fit the needs of clinicians.
3. Validation of the visual tool through clinical interactions and acceptance into clinical practice at a large Australian hospital. These factors are used as the basis to “gather a comprehensive picture of each individual patient”<sup>7</sup>.

## CONCLUSIONS

We describe the visual design challenges in producing HealthMap, a supporting tool for suicide risk assessment. We present the journey from problem identification to specification and visual design, and finally, iterative refinement of prototypes. Our final prototype was accepted for adoption in clinical practice. Our experience yields interesting lessons for utilising EMR more effectively, and for introducing machine predictions into clinical practice.

<sup>1</sup>The Telegraph, 14/07/2013.

<sup>2</sup>International Business Times, 06/05/2013.

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