Medical image informatics in e-Health: Towards quantitative radiology

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Challenges for medical imaging

How to make expensive diagnostic technology more cost effective?

Employ innovative, cloud-based medical image informatics to better harness the wealth of information about pathology on medical images.

-> Provide quantitative clinical reports / clinical decision support tools to improve patient management and hospital workflows.
Medical informatics research programs at AeHRC

Detecting liver pathologies

Quantitative clinical reports - neuro

Quantitative clinical reports - MSK

Aneurysm detection

MRI lung function assessment

Image-guided therapy for brain cancer

Improving prostate treatment toxicity

Improved radiation treatment planning using MRI
Quantitative clinical reports for MRI and PET imaging

- Ageing and dementia: the tsunami to hit the health system
  - 342,800 Australians living with dementia costing the health care system ($5b in 2009/10)
  - Within 2 decades, dementia will become the third greatest source of health expenditure
  - Without effective treatment, 900,000 Australians are predicted to have dementia by 2050

- The need for quantitative radiology!
  - To improve the accuracy of diagnosis of dementia (AD, FTD, vascular dementia, DLB, CJD, Korsakoff, HIV-related cognitive decline, MCI)
  - Identify individuals at high risk of developing dementia for early lifestyle interventions and commencement of new therapeutics
  - Identify patients that will respond to cognitive enhancing drugs (cost >$100M per year to the PBS)
Quantitative clinical reports for MRI and PET imaging

Imaging the pathological features of dementia

Cost of amyloid and tau PET scans $3000 - $8000 highlights the need for quantitative reporting of medical images
Quantitative clinical reports for MRI and PET imaging

- Need for quantitative reporting of amyloid burden

Florbetapir amyloid PET tracer (rebate in the US)
Quantitative clinical reports for MRI and PET imaging

- Need for quantitative reporting of amyloid burden

Florbetapir amyloid PET tracer (rebate in the US)
CapAIBL: cloud-based Computational Analysis of PET from AIBL
CurAIBL: cloud-based Computational quantification of MRI from AIBL

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Vincent Doré
Jurgen Fripp
Olivier Salvado
Chris Rowe
Victor Villemagne
Cloud-based clinical decision support tools

**iAssessCP**: neuroimaging Assessment e-toolbox for Cerebral Palsy

- Novel tablet based platform for quantitative characterisation of brain injury for planning and monitoring of rehabilitation therapy
Cloud-based clinical decision support tools for CP

- CP is an early brain injury (~70% in the 3rd trimester)
- The most common cause of physical disability in children ~38,000
- Cost on the Australian health budget is $1.5b per year
- While early injury is static, functional problems are progressive, although physical disability can be alleviated by appropriate choice of rehabilitation
- Early diagnosis is important for increasing the window of opportunity for intervention
- The American Academy of Neurology recommends that a brain MRI should form part of the diagnosis of CP at 2 years of age
- Currently there are no automated clinical reporting methods for the quantification of brain injury for CP
- Measures of brain injury must correlate with physical ability (motor function)
iAssessCP: neuroimaging Assessment e-toolbox for Cerebral Palsy

Semi-quantitative scale for the classification of brain injury
-> pencil and paper approach

Disadvantages:
• Time consuming and requires an expert child neurologist
• Uses a single score to describe complex brain injury

Fiori et al., DMCN 2014
iAssessCP: neuroimaging Assessment e-toolbox for Cerebral Palsy

Technical challenge for automated assessment of brain injury for CP

- Injury is heterogeneous
- Can range from minor to severe in some cases
- Injury is anatomically complex; can affect multiple brain regions

![Mild PWM](image1)
![Severe PWM](image2)
![CDGM](image3)

mild PWM  severe PWM  CDGM
**iAssessCP**: neuroimaging **Assessment** e-toolbox for **Cerebral Palsy**

- Quantification of periventricular white matter injury (PWM)
  - Developed the concept of using ventricular volume and shape to describe the extent of injury to WM and important deep GM structures which control motor function.

**AeHRC Colloquium 2015**

Nick Dowson
Alex Pagnozzi
James Doecke
Roslyn Boyd
iAssessCP: neuroimaging Assessment e-toolbox for Cerebral Palsy

- Ventricular shape model for quantitation of PWM injury
  - compare ventricular shape of the patient to a large database of normative control data

- Change in ventricular shape (distance from healthy) is significantly correlated with motor, executive function and vision and communication skills

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**iAssessCP**: neuroimaging *Assessment* e-toolbox for Cerebral Palsy

- Quantification of cortical and deep grey matter (CDGM)

  - Developing automated methods for segmentation of the cortical mantle to fully characterise the extent of cortical injury

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iAssessCP: neuroimaging Assessment e-toolbox for Cerebral Palsy

- Quantification of cortical and deep grey matter (CDGM)

- Automatically generate quantitative markers of cortical injury (sulcal curvature, sulcal depth and cortical thickness) to fully characterise the extent of cortical injury

WORK IN PROGRESS

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Alex Pagnozzi
James Doecke
Roslyn Boyd
Summary

- How to make expensive diagnostic technology more cost effective?

- Need to better harness the opportunity afforded by new imaging technology for capturing exquisite information about injury and disease by moving towards a model of quantitative reporting of MRI and PET images.
  -> provides more information to the clinician to improve diagnosis, patient management and workflows.
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19 |