**INSIGNEO-Oncology Studentship**  
**PhD Studentships Project Proposal Form**  
**October 2014 entry**

<table>
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<th>Supervisor and Research Group Details:</th>
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<tr>
<td><strong>Oncology Supervisor</strong></td>
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<td><strong>Department</strong></td>
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<td><strong>INSIGNEO Supervisor</strong></td>
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<td><strong>Department</strong></td>
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<td><strong>Other supervisors</strong></td>
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(The student must have at least 2 supervisors)  
To join INSIGNEO please email – Lesley Statham l.statham@sheffield.ac.uk

**Proposed Title of Project:**
Development of a decision support system to facilitate prediction of risk and prognosis in thyroid cancer and aid decision making in management.

**Abstract describing the project that can be used as part of the project advertisement and can be made available on publicly accessible websites and other media (250 words max)**

Thyroid cancer is a common endocrine cancer and is increasing in incidence. A variety of treatment options are available and prognosis is in general very good. However, uncertainty in diagnosis often necessitates a diagnostic procedure. In addition, the availability of diagnostic and treatment options that vary in effectiveness and the risks involved makes decision making difficult for both patients and clinicians. Published literature does not provide precise estimates of risk that can be directly applied to an individual patient.

The aim of this project is to develop a decision support system that collects and integrates information from both literature and local experience in an ongoing, iterative manner to provide individualised estimates of risk that are applicable to a specific patient.

A detailed systematic review of available literature and local experience on predictive (risk) factors in thyroid cancer will be conducted. A decision support system will be developed that will retrieve appropriate information from literature and patient records, enable machine learning in an iterative fashion and present the information in a user friendly manner. The predictive value of the decision support system that uses both published and ‘local’ information will be compared to the predictive value of published evidence alone. A qualitative study of patients and healthcare professionals will also be done to evaluate the utility of this electronic tool.
Outline of the proposed Studentship Project: include a background to and need for the specific project, hypothesis, aims and objectives, brief research plan, expected deliverables for each year and contingency plans. Also include key publications from supervisors to support this (not more than 2 sides of A4, Arial point 11 – or equivalent size font).

Project description

• Describe why computational / modelling approaches are needed
• Describe the importance of the problem in Oncology

Risk of thyroid cancer: Thyroid cancer is a common endocrine malignancy and its incidence has increased by up to three fold in the last thirty years. Thyroid nodules are a very common occurrence; prevalence is reported to be up to 30% in the general population. However, the vast majority of nodules are benign. Patients with thyroid nodules often need several diagnostic investigations to secure a benign diagnosis. A number of patient related and nodule related factors, imaging and cytology findings may help in the diagnosis of thyroid cancer; but the predictive value of these factors is dependent on the population of interest and locally available imaging and expertise. Many patients still need an operation under a general anaesthetic to remove part of the thyroid to exclude malignancy. For example, in patients with thyroid nodules where fine needle aspiration cytology shows indeterminate features, up to 80% of those undergoing a ‘hemi-thyroidectomy’ have benign pathology.

Decision support systems in cancer: There is an increasing demand from patients and clinicians for diagnostic and prognostic information to be as accurate and up to date as possible and for this information to be consistent with local experience. Decision support systems have been developed to aid the provision of such information to support decision making.

The sarcoma nomogram (http://www.mskcc.org/mskcc/html/6181.cfm) was developed in the Memorial Sloan Kettering Cancer centre to predict the risk of local recurrence and death of patients who have had surgical excision of sarcoma. This is available online for general use and helps clinicians and patients in determining the need for further adjuvant treatment. The limitations of this tool are that it is based on published experience of a large tertiary centre in United States (limiting its generalizability) and is not updated. ‘Adjuvant online’ (https://www.adjuvantonline.com/index.jsp) is another online tool that provides prognostic information on breast, colon and lung cancer based on an extensive literature base. It also enables a degree of interactivity by allowing the user to select from a list of adjuvant treatment options. Other tools in common use include an ‘outcome calculator’ (https://www.cancermath.net) that provides information on melanoma, breast, colon, head and neck and renal cancer based on the US SEER dataset; and a tool that provides information on survival from lung, rectum, head and neck cancer (https://www.predictcancer.org). A general limitation of these tools is that local information and experience is not taken into account. Also, there are no similar tools to aid the prediction of thyroid cancer in patients presenting with thyroid nodules.

Published literature on thyroid cancer diagnosis can be critically appraised and subject to a systematic review and meta-analysis to obtain estimates of risk attributable to individual risk factors. However, a ‘data mining’ approach to the problem may enable a comprehensive search and identification of all predictors of risk. Computer based modelling of the predictors involved has the potential to provide better estimates of risk. In addition, the use of these approaches in parallel...
to the retrieval and analysis of information from the local centre may provide further valuable insight into risk specific to the local population; enable comparisons of local and published data; and identify areas for improvement that are applicable to the local community.

Machine learning within a Bayesian framework will permit the continual updating of the model and the integration of both local (e.g. patient record) and global (e.g. population or more stratified risk factors) information. This will ensure the model remains fully up-to-date and has the ability to track changes in the statistical make-up of the local catchment. Furthermore a baseline model could be tuned over time to other settings through routine use.

**Hypothesis. (or if work is hypothesis-free or hypothesis-generating, please justify)**

Where relevant, describe data available or to be sourced or used for modelling

The development of decision support systems based on data mining and computational modelling of available medical literature and hospital patient records will improve prediction of risk in patients with thyroid cancer.

**Aims.**

To develop a decision support system that would enable accurate prediction of risk of thyroid cancer; prognosis from thyroid cancer following surgical treatment; and value of adjuvant treatment options in thyroid cancer.

**Research plan.**

The project will comprise the following objectives:

1. Perform a systematic review of existing literature on predictive factors in thyroid cancer.
2. Perform a retrospective, institutional study of patients in Sheffield Teaching Hospitals NHS foundation trust to examine factors relating to thyroid cancer risk.
3. Develop a predictive tool (decision support system) to estimate cancer risk in patients with thyroid nodules.
4. Validation of the tool against currently used risk criteria such as cytology grading.
5. Evaluate the perceptions of patients and healthcare professionals (clinicians, nurse specialists) on the value of the decision support system

**Deliverables.**

First year – necessary training, conduct of the systematic reviews and institutional audit
Second year – development of a pilot ‘decision support system’
Third year – Comparison of the tool against currently used methods and evaluating its usefulness in the clinical setting

**Contingency plan.**

Progress will be reviewed on a regular basis. Any difficulties with the above mentioned plans will be discussed by all supervisors and an exit strategy will be discussed. This may be the development of a ‘stand alone’ predictive tool similar to existing tools for other cancers (as mentioned in the introduction).

**References (not to be included in the two page limit).**


**Supervisor publications:**


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**Detail the training that the student will receive during the project and outline any training requirement that will be required for the proposed project. Indicate key individuals with whom the student will interact. (200 words max)**

The student will be under the joint supervision of researchers in the departments of Oncology, SCHARR and ‘Automatic Control and Systems Engineering’ at the University of Sheffield and the cancer directorate at Weston Park hospital. The student will need and receive training in the design and conduct of systematic reviews, the principles and modelling of decision support systems and the development of online media to facilitate the clinical use of such systems. The individuals with whom the student will interact include

1. Saba Balasubramanian, Dept of Oncology
2. Robert Harrison, Dept of Automatic Control and Systems Engineering
3. Lesley Uttley, SCHARR
4. Jon Wadsley, Weston Park Hospital

**Describe the supervision arrangements for the proposed student: describe your plans for co-supervision: (250 words max)**

The student will be jointly and primarily supervised by Saba Balasubramanian and Robert Harrison who will oversee the machine learning, data analysis and modelling aspects. Lesley Uttley is a systematic reviewer and will provide input on the design and conduct of the systematic reviews. Jon Wadsley is a clinical oncologist in
Weston Park hospital and an expert in thyroid cancer management. He will provide guidance with the conduct of the review, the institutional audit and the development of the model.

The primary supervisors will jointly meet with the student at least once a month. The secondary supervisors will meet and provide support as and when required (this is expected to be at least once every three months).

**Ethics and Research Governance:** Does the project require Ethics or Research Governance approval at any time during its course? If so, what provisions have been made for this?

Not required currently. Local data on thyroid cancer can be made available as part of audit/service evaluation. When the system is nearing completion and needs to be evaluated by patients and healthcare professionals, appropriate ethical approvals will be obtained.

**Previous review:** If the project has been reviewed previously either internally or externally, please provide details and attach the reviewer’s comments if available.

Not applicable

**Please submit applications to:** [SCRC@sheffield.ac.uk](mailto:SCRC@sheffield.ac.uk)

By completing and submitting the attached form by **5pm on Friday 29th November** you are confirming that:

- the project is available to go to advert (short abstract to be released publicly)

If you have any questions please get in contact ([l.burn@sheffield.ac.uk](mailto:l.burn@sheffield.ac.uk))

The CR-UK/YCR Sheffield Cancer Research Centre Strategy for 2014-2017 can be found at: [http://www.sheffield.ac.uk/sheffield-cancer-research-centre/home/strategy](http://www.sheffield.ac.uk/sheffield-cancer-research-centre/home/strategy)