

A pilot course for training-in-context in statistics and research methods: Radiation oncology

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Objectives. Inadequate training of investigators in statistics and research methods in Africa contributes to having limited local evidence and infrastructure to support multi-centre international trials. Methods of teaching junior oncology professionals tend not to emphasise research discovery, or the roles of emotional engagement and social networking in facilitating effective and efficient learning. We developed a strategy for teaching research methods and statistics-in-context, centred on a shared international and practical research project.

Design. An African research network (AFRES) was created and members conducted a pilot clinical registry study to acquire real-time data over a 4-month period in 2011. Following study closure, a proto-course consisting of 7 modules, each orientated to a practical topic in study development, implementation and reporting was administered over 18 weeks to all eight AFRES members. A survey of participants was conducted to evaluate the impact of this training strategy.

Results. This strictly voluntary project had 5 of 8 AFRES members engaged in the process. Within one year, we generated and submitted two manuscripts and two news items for publication. Participants reported an increased understanding of the principles of evidence-based practice, research methods and interest in pursuing future research initiatives.

Conclusion. A novel strategy to build international research infrastructure in Africa, grounded in a practical and relevant project, and which is collaborative and engaging, appears to be efficient and effective.

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Infrastructure in Africa to support multi-centre international trials in radiation oncology is presently limited.¹ Particularly in the sub-Saharan region, challenges include inadequate training of investigators, limited resources, and a lack of socio-political support. This results in few locally derived publications² for evidence fully applicable to the local context. Goals of the International Atomic Energy Agency (IAEA) include increasing capacity in low- and middle-income countries to conduct locally relevant

clinical studies,^{3,4} participate in multi-centre international trials,⁴ and develop evidence-based clinical practices.⁵ Present strategies to build capacity include direct participation in randomised trials within which learning does occur, fellowships and doctorates. Although these are even more limited in number, and training courses in research methods and statistics. Such courses are typically aimed at trainees (undergraduate and postgraduate students) and junior staff.

The IAEA sponsored an African Regional Cooperative Agreement for Research (AFRA) 4-day training course in Ethiopia, in December 2010, on research methods and statistics, and two dozen trainees and staff in radiation medical sciences and oncology disciplines participated.⁶ The course included lectures on research ethics, good research questions, design, data management, basic statistics and end-reporting. A third of the time was applied to a daily laboratory practical for developing and presenting draft protocols for possible randomised trials: three were done, one per small group of students. At the end students provided feedback and expressed concern about math and statistics anxiety, and too few active learning experiences. Statistics anxiety^{7,8} and passive learning^{9,10} are well-recognised problems in the literature. Students also expressed concerns over working at home in relative isolation, with few opportunities for networking and publications, and having few easy-to-do projects for low-resource environments.

Methods to overcome critical barriers to learning and research include improving both emotional engagement and social networking. The concept of emotionally charged learning has been called 'hot-cognition'.¹¹ This implies that thinking, feeling, and acting, together in an educative experience, are synergistic and can change the 'meaning' of the experience.^{9,10} Further, opportunities for networking and sharing projects may allow for peer-to-peer education, for efficiencies through sharing, and for a reduced sense of isolation.¹² For example, the Academic Clinical Oncology and Radiobiology Research Network (ACOORN, UK) has demonstrated the importance of research networks in delivering research through its role in facilitating the work of radiographers.¹² A shared research experience may increase motivation and the number of research products.

Students at the AFRA course also expressed concerns about little-to-no prior training in the principles of evidence-based medicine or evidence-generating research,¹³ understanding medical literature and practice guidelines, and knowing whether such evidence (most being of 'Western' origin) could apply to contexts in Africa. Overcoming emotional, cognitive and social barriers to learning and research productivity is central to increasing the body of local evidence that can inform clinical practice.¹ Despite legitimate student concerns, and advances in pedagogic theory, increasing the capacity for radiation oncology research and evidence-based practice has relied more on conventional approaches. These can fail to leverage the making of 'meaning',^{9,10} working with emotions and establishing social networks,¹⁴ and so can fail to develop skills and transfer knowledge and skills into clinical practice to promote research.⁴ As extensions to conventional teaching approaches, present international initiatives include a virtual university,¹⁵ and very limited technical exercises (e.g. image-guided contouring of organs in the pelvis).¹⁶ These have not yet been evaluated as to their impact. Meanwhile, some locales such as in South Africa and Zimbabwe have introduced one or two compulsory research projects required for qualification to practise in radiation oncology. Such projects are done individually by trainees, and few are within a clear pathway towards sound critical appraisal of literature, or towards participating at national and international levels in research, once qualification to clinical practice has occurred. Under these new requirements, it is unknown how many of today's trainees will pursue a research-orientated career, and whether this will be greater than in the recent past.

In Africa, a strategy to teach junior oncology professionals (trainees and junior staff) in research methods, data management and statistics must be practical for a limited-resource environment. It should provide active learning in relevant context, mimic practice of research, and utilise emotional engagement and social networking. Such training can build research infrastructure and promote learning in the principles and practices of evidence-based medicine. In this paper we report the pilot testing of a strategy using teaching modules aligned with an authentic and potentially publishable research project done by the participants. To mimic the IAEA international trials we used a centralised Data Management Centre, and our research project was trans-national and also relevant to local contexts, resource limitations and participant interests.

Methods

We piloted a strategy of training centred on a practical, shared project, that is relevant to contemporary clinical practice and collaborative international research, and to which we attached sequential, domain-specific learning modules. More akin to an apprenticeship, trainees completed all steps within a 1-year cycle, from research idea to submitted manuscript.¹⁷ We conducted a survey of participants to evaluate the personal impact of this strategy.

Independent of the completed AFRA course in Ethiopia, 8 radiation oncology trainees were e-mailed (by GJ, one of the attending faculty members in AFRA) to create an African RESEARCH network (AFRES) and conduct a shared pilot clinical registry project to acquire real-time data, in 2011, of patterns of practice and treatment. Four of 8 AFRES members (3 trainees in Africa and 1 staff radiation oncologist in Canada) agreed to jointly conduct the study, and of the 8 members only the 7 junior AFRES members were students of the mini-course. Initially a short protocol was written along with a single page form for data collection. The study was implemented over 4 months (24 Dec 2010 - 1 May 2011). Local ethics approval was obtained by the 4 investigators for this prospective observational study, having no randomisation. Each participant documented patient, disease and treatment data for their consecutive curative and palliative cases (described in full elsewhere),¹⁷ and submitted forms to the Data and Methods Centre (DMC) in Canada for analysis.

Following closure of the Pilot Registry Study, the AFRES proto-course was developed to teach 7 junior AFRES members about methods and statistics (Table 1). This provided a collaborative learning environment over 18 weeks (Aug - Dec 2011) using e-mail communications every week from the DMC, with participants free to multi-way communicate by e-mail and Facebook (group, and as individuals). Modules consisted of two parts, one providing 7 - 12 questions about the subject matter, in some cases referent to the pilot project, and one providing summary answers to the questions, between 4 - 10 pages of single-spaced text with diagrams. The 7 modules were orientated to a practical topic (e.g. 'grant-reviewing' the protocol, discussion of ethics, study implementation, data management, analyses and 'peer-reviewing' the manuscript) (Table 1). Therefore, this was both an educational exercise and a critical reporting of data and statistical findings of the practical project. Midway through the course, a survey was conducted that included:

- current gaps in a participant's knowledge of a subject
- relevance of AFRES material
- interest in participating in future research as a result of the pilot project
- barriers to participation
- the value of this educational experience.

Table 1. AFRES pilot course schedule and modules

Date of e-mails (Mondays)	Phase (issue to explore is sent out and feedback from participants)	Sources of the e-mails	Issue under consideration (for each 2-week cycle)
Aug 22	Issue 1	Data centre	Research question and protocol Elements of a good research question; purpose, objectives and format of a protocol; role of literature; study design outcome measures; sample size; and statistical plan
Aug 29	Feedback loop	AFRES participants	Issue summary to follow from data centre
Sept 12	Issue 2	Data centre	Variables and forms Principles of a good form and rules for formatting; standardising of variables and formats; sources of bias; and relevance to data quality
Sept 19	Feedback loop	AFRES participants	Issue summary to follow from data centre
Sept 26	Issue 3	Data centre	Ethics and implementation issues Scientific review and ethics assessment of pilot registry study; patient risk, confidentiality, consent; and potential barriers to implementation
Oct 3	Feedback loop	AFRES participants	Issue summary to follow from data centre
Oct 10	Issue 4	Data centre	Data management Approaching data & cleaning data; identifying outliers; and handling missing values
Oct 17	Feedback loop	AFRES participants	Issue summary to follow from data centre
Oct 24	Issue 5	Data centre	Descriptive statistics Their use in summarising the data-set; and use of graphical methods
Nov 7	Feedback loop	AFRES participants	Issue summary to follow from data centre
Nov 14	Issue 6	Data centre	Association statistics & regression analyses Association v. causation; tests of significance; covariates; adjustments; and reporting findings
Nov 21	Feedback loop	AFRES participants	Issue summary to follow from data centre
Nov 28	Issue 7	Data centre	Manuscript 'registry study' & ethics 'closure letter' Participating in writing the manuscript, and closing letter to ethics committees
Dec 5	Feedback loop	AFRES participants	Appraisal of this 'mini-course' [survey]

Opportunity for continual feedback existed from week to week, which also facilitated a dynamic learning environment customised to student-specific needs. The writing component of this 1-year project (manuscripts and related news items) constituted the final modules.

Results

The registry study included 107 cancer cases, demonstrating feasibility of an international clinical registry. Delays in obtaining ethics approval at some centres did limit the number of cases accrued to the study. There was 99% completion for requisite data. Heterogeneity of clinical practice was observed, and its implications for technology transfer and ongoing

international trials are described in a separate manuscript.¹⁷ Briefly, results from this non-IAEA project indicate continuing relevance to the ongoing trials of the IAEA¹⁷ and difficulties relying on data from some international organisations about African contexts.¹⁸ Overall, it is clear that 5 of 8 AFRES members participated in this pilot project to sufficient depth to constitute a relative success in both the research and teaching aspects. Notably, there are two submitted manuscripts and two new items generated by the strategy which are career-relevant.

From an education, training and clinical perspective, this project demonstrates higher statistical teaching at the level of international

collaboration, focusing on local concerns and practices. The registry approach was positively evaluated. Participants identified the collaboration of countries and support from the DMC as the most beneficial aspects of this practical, learning-in-context exercise. The material presented during the course was well received by AFRES participants. The survey showed that prior to this AFRES pilot project, gaps in knowledge of research methods and statistics were consistent among participants. They identified a poor grasp of formulating relevant and feasible research questions, developing forms for data collection, and applying statistical methods. One participant wrote about gaps: 'In knowing how to approach and identify the appropriate category of research I am willing to embark on and what necessary variables are needed.' Another expressed 'more concern on the statistical part [of research]'. The AFRES course material (Table 1) was scored as relevant to trainee experiences (mean = 3.3 on a 5-point scale, 1 - 5 where 1 = 'not relevant at all' and 5 = 'very relevant'). In contrast, future relevance after graduation was scored uniformly as 5. As a result of participation in AFRES, a majority expressed increased understanding of research methods, principles of evidence-based practice, and interest in pursuing future research. This suggests that the pilot course, using newer methods of teaching, was more effective than the conventional training course which these trainees had experienced in Ethiopia.

Barriers to participation in the project included participants studying for, or the writing of, final examinations, their administrative workloads, country-specific political disruptions, intermittent internet access, and some resistance by local senior staff members to collaborative, international studies. For example, one participant wrote: '... we need to analyse our situation in Africa [with too] few clinicians [who are] facing all kinds of cancer ... [and] have no dedicated assistants like research nurse, statistician, and can't hire any.' The pilot project highlights key obstacles to implementing international projects and training junior professionals. However, we estimate that the amount of time expended related to the Ethiopia course by the faculty and by the students was similar to the time expended on the AFRES Pilot project, but the second of these was decentralised and involved no travel or hotel costs. Therefore we conclude that our strategy is no more labour intensive than conventional methods, and it may be less expensive.

Discussion

Regardless of where one is in the world, there are sets of skills essential to evidence-based practice and participating in research.¹³ Conventional methods of teaching and associated theories of education have come under criticism for being less efficient for, or relevant to, professionals in clinical practice. 'Learning-in-context' was the theme of the last International Conference on Teaching Statistics, held in July 2010.¹³ Possibly, newer methods of teaching skills are essential to optimise training and to help transfer learning into improving clinical practice, and into clinical careers with a research component. We build on more contemporary theories of education¹⁴ and practice with a pilot project exploring the feasibility of learning in context in a collaborative project. Consistent with theory regarding emotional arousal and social networking,¹⁴ our voluntary project had 5 of 8 individuals engaged in the process. Within 1 year we were able to generate manuscripts for publication, and 2 news items. Students demonstrated some research skills (e.g. form completion and manuscript review) and acquired insight into what is required in a career in research.

Our students provided evidence towards meeting CANMEDS 2000 criteria in pre-qualification training for clinical practice.¹⁹

We have identified several lines of potential improvement to our strategy. We sequentially conducted a project and then a proto-type course. The practical and teaching parts of the course may be reconfigured and integrated into a woven pattern that covers the complete arc from idea generation to manuscript submission. The AFRES coordinator (GJ) was the primary writer for the project protocol, with AFRES members acting as reviewers. However, a strategy that involves group members co-writing a protocol would be more valuable, with each taking a section. The early goal should be a shared vision and orientation to the project. As a prototype, the mini-course was limited to 7 modules. A future project would include many more modules or a book with lots of tables and lists (as one participant has suggested). This project was not funded; participation was purely voluntary, resources were limited, and competing responsibilities of trainees hindered full participation. Overcoming challenges remains an issue, and education theories do not identify professional and socio-cultural contexts that can restrict learning. Greater resources (e.g. per-case funding) could give greater rates and more time for participation in the project, and greater learning in the associated mini-course. We targeted only radiation oncology trainees who had attended an AFRA course, who were a convenience sample. However, junior professionals who have qualified for clinical practice might be a more appropriate group for our strategy. Some additional options include integrating our strategy with an AFRA-like course (pre-, in-, and post-course activities), using our strategy for junior staff to fulfil criteria for probation prior to participation in international trials, and establishing a true continent-spanning network with data centre support (data management and investigator training) to assess heterogeneity²⁰ and its determinants in clinical practice.

Methods of learning-in-context for clinicians at the beginning of their professional careers are strategically positioned to develop skills, to provide useful local data to develop evidence-based practice, and to develop positive attitudes to research. Individuals may realise the research potential of routine daily activities which can stimulate local research initiatives,²⁰ refine and add skills, and prompt interest in international research. A project such as a real-time registry of patterns of practice demonstrates a participant's capacity to consistently manage and follow patients. These are criteria for participating effectively in funded, international, randomised trials. A combination of conventional teaching strategies plus methods with 'hot-cognition' and in-context learning may be optimal.

Conclusion

We have reported the results of a pilot test of a strategy centred on an authentic, collaborative and engaging research project with teaching modules for research methods, data management and statistics. Findings suggest that it is more efficient and effective than conventional teaching methods. Overcoming emotional, cognitive, social and professional barriers to learning and research productivity may increase the amount of local evidence informing clinical practice, build the research infrastructure for loco-regional studies, and increase participation rates in international clinical trials. Given the success of this pilot project, we recommend a definitive test of this strategy with an educational research protocol.

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